

#ISEE2021

33rd Annual Conference of the International Society for Environmental Epidemiology

Promoting Environmental
Health and Equity in
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Abstracts'
E-Book



Local Academic Host:
Columbia University
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ABSTRACT E-BOOK

E-POSTER ABSTRACTS



ABSTRACT E-BOOK

P-001

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Normal variability of biomarkers - examined in a "variability biobank"

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BACKGROUND AND AIM: For most biomarkers there is limited information about normal within-individual (day-to-day or within-day) and between-individual variability. For urine there may be diurnal variability making it important to fix the time of day for sampling. Our aim was to examine normal variability.

METHODS: We established a "variability biobank" of blood (plasma, erythrocytes, and whole blood) and urine (six fixed times: first morning, 9:30, 12:00, 14:30, 17:30, 22:00, and 24h excretion) samples from 60 healthy non-smoking participants aged 21-64 years (29 men, 31 women). Blood and urine samples were collected about one week apart. Aliquots are stored frozen (-80°C). Height, weight, estimated glomerular filtration rate are available, as well as flow rate, creatinine, and specific gravity for each urine sample. ICC=between-individual variability/total variability.

RESULTS: Up to now we can report 1) ICCs for 24h excretion of 22 elements were high (0.75–0.90) for Cd, Co, Hg, Pb, Sn, Se, V, and Zn, moderate (0.35–0.75) for As, Br, Cu, Fe, Li, Mn, Mo, Ni, P, S, U, and W, and low for Cr and Sb (<0.35). 2) ICCs for urinary creatinine showed ICC=0.64 for 24h excretion, 0.48 for overnight samples, and 0.23 for all spot samples. 3) For Pb excretion ICCs were 0.81 for 24h urine, 0.71 for overnight, and 0.57 (men) and 0.41 (women) for all spot samples.

CONCLUSIONS: Although 24h excretion is the gold standard for urinary biomonitoring, day-to-day- and within-day-variability is high for some elements. The ICC for urinary creatinine depends on the time of day and the excretion is affected by urinary flow rate. Lead in urine has a diurnal variability. The biobank (≥ 20 000 aliquots) is open for researchers to examine normal variability of their favorite biomarker(s). It is especially suitable for analysis of diurnal variation in urine (12 samples per subject) but could also be used for blood biomarker concentrations.

Keywords: biomarkers of exposure, methodological study design chemical exposure, heavy metals, exposure assessment



ABSTRACT E-BOOK

P-002

Exposure Assessment Methods » Risk assessment

Genetic variation and urine cadmium levels: ABCC1 effects in the Strong Heart Family Study

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BACKGROUND AND AIM: Genetic effects are suspected to influence cadmium internal dose. Our objective was to assess genetic determinants of urine cadmium in American Indian adults participating in the Strong Heart Family Study (SHFS).

METHODS: Urine cadmium levels and genotyped short tandem repeat (STR) markers were available on 1936 SHFS participants. We investigated heritability, including gene-by-sex and smoking interactions, and STR-based quantitative trait locus (QTL) linkage, using a variance-component decomposition approach, which incorporates the genetic information contained in the pedigrees. We also used available single nucleotide polymorphisms (SNPs) from Illumina's MetaboChip and custom panel to assess whether promising QTLs associated regions could be attributed to statistically significant SNPs.

RESULTS: Median urine cadmium levels were 0.44 µg/g creatinine. The heritability of urine cadmium concentrations was 28% in the SHFS, with no evidence of interaction by sex or by smoking. In QTL linkage analysis, we found strong statistical evidence for a genetic locus at chromosome 16 determining urine cadmium concentrations (Logarithm of odds score [LOD] = 3.8). Among the top 20 associated SNPs in this locus, 17 were annotated to ABCC1 (p-values from 0.0002 to 0.02), and attenuated the maximum linkage peak by a ~40%. For suggestive QTL signals (LOD >1.9) in chromosomes 2, 6, 11, 14, and 19, the top associated SNPs were in the genes NDUFA10, PDE10A, PLEKHA7, BAZ1A and CHAF1A, respectively.

CONCLUSIONS: The findings support that urinary cadmium levels are heritable and influenced by a QTL on chromosome 16, which was explained by genetic variation in ABCC1 (potentially involved in glutathione transport and metabolism). Future studies with extended sets of genome-wide markers are needed to confirm these findings and to identify additional metabolism and toxicity pathways for cadmium.



ABSTRACT E-BOOK

Keywords: Exposure assessment, Heavy metals

P-003

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Biomarkers of exposure to metal nanoparticles in workplaces: methodology and preliminary results

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BACKGROUND AND AIM: When the particle size is decreased to the nanoscale range, physical and chemical properties appear to change offering various new opportunities but bringing new risks and uncertainties also. The growing use of metal nanoparticles (MNPs) in industry may potentially lead to an increased human exposure to these substances. In this study, urine and blood as biomarkers of exposure were used to assess the exposure of workers to MNPs in two nanomaterial manufacturing companies.

METHODS: When the particle size is decreased to the nanoscale range, physical and chemical properties appear to change offering various new opportunities but bringing new risks and uncertainties also. The growing use of metal nanoparticles (MNPs) in industry may potentially lead to an increased human exposure to these substances. In this study, urine and blood as biomarkers of exposure were used to assess the exposure of workers to MNPs in two nanomaterial manufacturing companies.

RESULTS: The preliminary results showed NPs of Ag (29 ± 0.5 nm) in urine and NPs of Au (15 ± 0.2 nm), In (38 ± 0.2 nm) and Ti (90 ± 3.2 nm) in blood of workers from the company A. Nanoparticles of Ir, Pd and Pt were not detected neither in urine nor in blood of workers from company B. In addition, Ag NPs in urine, and Au and Ti NPs in blood were also detected in control subjects indicating the importance of daily-life exposure sources.

CONCLUSIONS: The methodology can be recommended because fast and reliable for the measurement of MNPs in humans to contribute to safe workplace environments and health protection.

Keywords: Occupational exposures, heavy metals, biomarkers of exposure



ABSTRACT E-BOOK

P-004

Exposure Assessment Methods » Exposure assessment-general

Towards establishing the national referential on exposure factors in France

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BACKGROUND AND AIM: Availability of up-to-date methods, models, and exposure data is critical to realistically estimate human exposure to environmental contaminants. Exposure factors (EF) are human characteristics and behaviors that are needed for reliable exposure and, thus, risk assessments (RA). These factors determine exposure time, frequency, and intensity. They are usually considered as effect modifiers in epidemiological studies. While the US-EPA Exposure Factors Handbook is under updating, there is no European equivalent that meets RA needs. Therefore, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) launched a working group to define the reference values of specific EFs for the French population.

METHODS: We defined priority EFs based on an inventory of needs identified by ANSES. For each EF, we defined the method, including a systematic review, quality assessment of studies, individual data retrieval, and specific modeling approaches, including descriptive statistics and generalized additive models for location, scale and shape, to derive population distributions for reference values by sex, age, and region. We also conducted uncertainty analyses.

RESULTS: We prioritized three EFs: body mass, time-activity-location patterns, and inhalation rate (IR). For body mass, we pooled individual data from nine large studies to yield age-related distribution per sex, region, and socio-professional categories. For time-activity-location patterns, we estimated the practising individuals fraction and duration of all activities/locations, and frequency of some, as reported in the French Time Use Survey (2009-2010) (FTUS), per age-group (from 11 years), sex and region. For IR, we applied an energy-based approach. We determined energy expenditure per activity (professional and personal) from the FTUS using metabolic equivalent tasks and derived 24-hour IR and per physical activity level (sedentary, light, moderate, vigorous) by age-group, sex, and BMI.



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CONCLUSIONS: The output will allow more precise RA, facilitate the implementation of probabilistic RA approaches and improve comparability of RA results at the international level.

Keywords: body mass, time-activity-location patterns, inhalation rate, energy expenditure, (pooled) analysis of individual data, reference percentiles



ABSTRACT E-BOOK

P-005

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Hemoglobin adducts of acrylamide in human blood – what has been done and what is next?

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BACKGROUND AND AIM: Acrylamide is found in many commonly consumed foods. Dietary exposure is of concern and food is being monitored worldwide as acrylamide is neurotoxic, crosses the placenta, restricts intrauterine growth and increases the risk of certain cancers and obesity. In animals, acrylamide causes heritable mutations, tumors, developmental, reproductive, and neurotoxicity. The impact on human health of dietary exposure to acrylamide remains poorly understood and it is impossible to say what level can be deemed safe as the assessment of acrylamide from diet is uncertain. We aim to summarize the internal dose of acrylamide in humans measured through quantification of hemoglobin (Hb) N-terminal valine adduct levels from acrylamide using mass spectrometric methods

METHODS: We performed a search up to February 2020 and included peer-reviewed articles and reports in English. Data were extracted and mean Hb adduct levels by smoking status and country of origin were calculated.

RESULTS: Methods and results from a total of 75 studies of 31,202 individuals from 15 countries were reviewed. Adduct levels were highest in occupational exposed individuals and three-fold higher in smokers as compared to non-smokers. Adducts ranged from 3 to 210 pmol/g Hb in non-smokers and this wide range suggests that dietary exposure to acrylamide varies largely. Relative to smoking, the correlation between estimated dietary intake of acrylamide and Hb adducts was weak and the validity of the methods used for assessment of dietary intake vary. Non-smokers from the USA and Canada had higher levels as compared with non-smokers from Europe and Asia. Within Europe, individuals from UK had the highest levels.

CONCLUSIONS: Large studies starting with early-life exposures using validated high-throughput analyses of adducts from acrylamide and other heat-generated compounds, together with comprehensive assessment of diet, smoking and socio-economic factors, would improve evaluation of the effects of dietary acrylamide on health.

Keywords: Biomarkers of exposure, Food, Internal exposome



ABSTRACT E-BOOK

P-006

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Human Biomonitoring of metals and OH-PAHs nearby the Waste-to-Energy plant in Italy: a tool to assist evidence-based public health promotion

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BACKGROUND AND AIM: The Waste-to-Energy (WTE) plant in Gerbido (Turin) is one of the biggest facility in Europe that treats non-recyclable wastes, generates renewable energy, and supports the circular waste management. In the health surveillance programme identified as SPoTT (Population Health Surveillance in the Turin incinerator area) Human Biomonitoring (HBM) was used to assess human exposure to inorganic and organic contaminants in a cohort living around the WTE plant, with the aim to evaluate the impact of the plant.

METHODS: Urine samples from subjects residing in areas near and far from the WTE plant, as defined by fallout maps, were collected before the plant start-up (T0, 2013) and after one (T1) and three years of operation (T2), and analyzed for metals, and PAH metabolites (OH-PAHs). From 396 individuals enrolled at T0, only 13.1% declined to adhere to the T2 study (no. 344 in total). Differences in levels of contaminants between the two exposure areas were assessed by the Mann-Whitney test, while changes over time by the Friedman test and Wilcoxon signed-rank test.

RESULTS: Several metals showed a decline in concentration from T0 to T2 HBM campaigns, and in both areas of exposure; exception were the higher Rh and Pt levels in the area far from the WTE, mostly due to traffic pollution. Urinary OH-PAHs quantified in the residents near the WTE plant at T2 were lower than those measured at T0, and respect to the far area. Levels of metals and OH-PAHs were generally comparable with those observed in other HBM studies relative to background exposure scenarios.

CONCLUSIONS: HBM data showed concentrations of metals and OH-PAHs not significantly associated with the 3-years activity of the WTE plant, and with areas of exposure, and did not evidence any impact of the WTE facility on human exposure to environmental contaminants.

Keywords: Chemical exposures, Biomarkers of exposure, Exposure assessment



ABSTRACT E-BOOK

P-007

Exposure Assessment Methods » Other (to be specified with keywords in the keywords section)

Personal measurements of radiofrequency electromagnetic field exposure among workers of high, medium and low exposed occupations in Spain

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BACKGROUND AND AIM: Novel methods for occupational exposure assessment of radiofrequency (RF) electromagnetic fields are needed to address the lack of quantitative data and reduce limitations of current methods used for epidemiological research. In the framework of an international study, we conducted an innovative measurement campaign of personal occupational RF exposure in multiple occupations in Spain in order to enhance a preliminary RF Job Exposure Matrix (RF-JEM).

METHODS: Identification and prioritization of the occupations to be measured were based on exposure levels in the preliminary RF-JEM and expert judgment. Selection of participants was based on reported job titles and sources of RF exposure collected in a screening questionnaire, which was disseminated to potential participants using both broad and targeted approaches. Personal full-shift measurements were conducted following a standardized protocol. Additional data about general and occupational-specific sources of RF exposure during the measured work-shift were captured at the end of each observation day through a “worker diary”.

RESULTS: Personal measurements of RF exposure were conducted and workers oversampled in occupations previously categorized as medium (n = 105) and highly-exposed (n = 26). A preliminary overview of the measurement results obtained in the campaign for various jobs as well as an initial comparison with the preliminary RF-JEM will be presented.

CONCLUSIONS: We conducted the first stage of an innovative international campaign of personal occupational RF exposure measurements in Spain, gathering exposure data for workers from occupations known to be exposed to high, medium and low levels of exposure to RF fields. Further work to conduct personal measurements in the Netherlands and France will also be performed.

Keywords: Exposure assessment, Occupational epidemiology, Occupational exposures



ABSTRACT E-BOOK

P-008

Exposure Assessment Methods » Exposure assessment-air pollution

Household air pollution and personal CO:PM_{2.5} relationships during cooking in the GRAPHS cohort: important covariates include wearing compliance

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BACKGROUND AND AIM: Prior household air pollution studies have seen conflicting results using carbon monoxide (CO) measurements as predictors of personal PM_{2.5} exposures. We evaluated CO:PM_{2.5} relationships in the large Ghana Randomized Air Pollution and Health Study (GRAPHS). **METHODS:** 1,414 expecting mothers were enrolled into the study in rural communities in central Ghana. Participants tended to cook outdoors in dry weather and in semi-enclosed kitchens in wet weather. At baseline all cooking was done on traditional biomass and charcoal cookstoves. Personal exposure was assessed for seven 72-hour periods on each adult participant. CO was measured using Lascar EL-CO-USB devices. PM_{2.5} was also assessed during 2 of the 7 sessions in ~60% of the mothers using RTI MicroPEMs, which measured both real time and integrated PM, and included a motion sensor. We developed regression models to predict PM_{2.5} concentrations based on CO and other covariates. We built linear prediction models using a dataset of 2,118 validated exposure sessions of 24-hour, estimating average exposures in two ways: 1) during cooking hours (6-10 am and 4-8 pm); 2) for 24-hour periods. We conducted a forward stepwise variable selection process, successively adding covariates to the base model.

RESULTS: The base model for the cooking period had an R² of 0.17, which was higher than the model based on 24-hour averages (R² = 0.05). Adding four covariates, month, day, compliance and community, to both models moderately improved statistics (R² = 0.34 to 0.31). When we restricted data to sessions with higher wearing compliance (based on the motion sensor), predictive ability improved (R² = 0.54 - 0.51).

CONCLUSIONS: In general we found limited ability to predict PM_{2.5} from CO and covariates in both 24-hour and 8-hour cooking periods. Poor wearing compliance can weaken associations between personal CO and PM_{2.5}.

Keywords: Air pollution, Particulate matter, Modeling, Exposures



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-009

Exposome » General

The climate exposome: a new tool for addressing the health impacts of climate change

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BACKGROUND AND AIM: The climate policy debate currently focuses on two key aspects: the relevance and proper extent of mitigation measures in order to avoid crossing the point of no return; and the necessity for adaptation measures considering the very different socio-economic state and dynamics across the globe. Assessing the health benefits of policy measures geared towards climate change adaptation is key for accurate impact assessment of the measures envisaged. Reliable quantification of direct and indirect impacts related to both climate change and to climate mitigation policies and measures is a sine qua non for further climate action.

METHODS: The exposome accounts for the totality of exposures over an individual's life course, focusing inevitably on age windows of increased susceptibility. Rendering it operational requires development and adaptation of novel tools for exposure assessment (both external and internal). Making use of the exposome for comprehensive health risk assessment on the population scale requires development of advanced statistical and biochemical/pathology models based on a combination of environmental and high dimensional biological data, enhanced by machine learning and big data analytics. In addition, agent-based models help capture the changing socioeconomic dynamics that influence societal vulnerability to climate-induced health stress.

RESULTS: Considering the change in environmental pressure and human exposure to health stressors linked to climate change would allow us to construct the climate exposome: namely, the exposome of human population subgroups considering the climate change aspects relevant to the ca. 80 years of the human life course.

CONCLUSIONS: The methodological framework for unraveling the climate exposome is presented and examples demonstrating its applicability and usefulness in climate decision-making are given. Novel integrated assessment models entails a schema based on enhanced data fusion and ensemble modelling, supported by big data analytics for filling data gaps. This methodological framework should support science-based decision-making in the climate action arena, notwithstanding the uncertainties.

Keywords: Climate, Exposome, Metabolomics



ABSTRACT E-BOOK

P-010

Exposome » General

Exploring the neurological exposome for precision prevention of neurodegenerative diseases – the role of diet

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BACKGROUND AND AIM: The exposome represents the totality of exposures from conception onwards. Unravelling it requires to simultaneously identify, characterize and quantify exogenous and endogenous exposures and modifiable risk factors that predispose to and predict disease throughout the human life span.

METHODS: Exposome science will help us understand the intricate web of relationships between environmental exposures, lifestyle, genetics and disease, contributing significantly to the determination of causal associations between environmental factors and human health. Determination of causality would support targeted interventions towards precision prevention, contributing significantly towards healthy aging.

RESULTS: Aging brings a lot of physiological changes, usually accompanied by deterioration in cognitive function as a result of neurological degeneration, mediated by oxidative stress and inflammatory processes. However, this process does not follow a standardized course for all individuals, as a result of multiple factors. These factors include genetic susceptibility, exposure to environmental chemicals, lifestyle aspects such as poor nutrition, excessive alcohol ingestion, lack of exercise and stress, health status (e.g. hypertension or diabetes), as well as exposure to chemicals. Although diet is considered as a major exogenous factor, up-regulation of the inflammatory metabolic pathway and in many cases the oxidative stress pathway is triggered or amplified by other exogenous exposures such as exposure to man-made chemicals. Thus, exploring the role of diet in triggering and accelerating the progression of Alzheimer's disease, should account for both the beneficial nutrients and the neurotoxicants associated with specific food items. High dimension biology tools based on a combination of omics technologies are able to identify the molecular fingerprints and pathway changes associated with specific dietary patterns, exposure to chemicals inducing oxidative stress (ambient air PM) and neuroinflammation (Hg) and genetic factors (ApoE e4 carriers).

CONCLUSIONS: Exposomic analysis of the effect of diet on AD is expected to facilitate the coining and implementation of precision prevention strategies.

Keywords: Neurodegenerative outcomes, Exposome, Food/nutrition, Metabolomics



ABSTRACT E-BOOK

P-011

Cancer and Cancer-Precursors » Incidence

Thyroid Nodules and Cancers in Fukushima: Critical Review and Alternative Analysis

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BACKGROUND AND AIM: After the Fukushima–Daiichi nuclear power plant (NPP) disaster, thyroid ultrasound examination (TUE) has been performed in subjects who were aged ≤ 18 years. In the 1st round TUE (October 2011 to March 2014) and the 2nd round TUE, 116 and 71 malignancies (including suspicious cases, "malignancies", hereafter) were detected, respectively. Analysis of the Fukushima is controversial: some studies found significant relationships between radiation dose and detection rate, while others did not

METHODS: Critical literature review on studies that analysed Fukushima TUE was conducted and limitations of them were identified: (1) Most of studies segment 59 municipalities into three to nine regions that affect results. (2) Although analysis of a-bomb survivor identified radiation cause thyroid nodule and cyst, most studies neglect them. To overcome these limitations, alternative analysis was conducted. The relationship between radiation dose and the number of participants with thyroid nodule or malignancy was analysed using publicly available municipality level data without regional grouping (N=59). To analyse two wave screening data, multi-level random-effect Poisson regression model was applied. Interaction between dose and screening round dummy (0 for first and 1 for second screening) was also introduced to take into account latency.

RESULTS: Interaction terms between external dose and screening round dummy were positive and significant ($\beta = 0.681$, $z = 2.05$). Similar results were obtained for UNSCEAR estimated thyroid dose (UNSCEAR 2013) ($\beta = 0.128$, $z = 2.24$) and re-estimated thyroid dose (Suzuki et al. 2018) ($\beta = 0.215$, $z = 2.42$). These robust results are consistent with the conjecture that the first round TUE is the "baseline" that will not correlated with radiation level. The second round TUE detected thyroid cancer caused by radiation from Fukushima NPP that distributed heterogeneously among regions.

CONCLUSIONS: Although this was an ecological study at the municipality level, health follow-up for children in Fukushima is urgent.

Keywords: Radiation, Thyroid cancer, Poisson regression, Ultrasound examination, Fukushima Daiich nuclear accident



ABSTRACT E-BOOK

P-012

Exposure Assessment Methods » Risk assessment

Questionnaire survey for health risk assessment of exposure to semi-volatile organic compounds-contaminated floor dust in housing: preliminary survey on prevalence

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BACKGROUND AND AIM: Phthalates or phosphates present in many products in indoor environment. A majority of those compounds are classified as semi-volatile organic compounds (SVOCs), which are mainly found in both gas and condensed phases. They are easily distributed from their original source over time to indoor air, indoor dust, and other indoor surfaces, including adhesion to foods, toys, or household products. Indoor dust is the main exposure media for low volatile SVOCs. Thus, health risk assessment of human exposure to SVOCs-contaminated indoor dust is essential to appropriately clarify the risk level of indoor environment. We report the preliminary nationwide questionnaire survey for the risk assessment.

METHODS: Web based-surveys were conducted from October through November 2019 and 2020 in five large areas in Japan, including Hokkaido, Kanto, Chubu, Kansai, and Kyushu. Questionnaires to obtain information on characteristics of housing and collection of the floor dust were administered to a family nurturer randomly selected from approximately one hundred seventy thousand monitors registered in a leading online research company. Questionnaires to obtain information on medical histories, symptoms, and housing-related symptoms (HRs), i.e. sick-building syndromes in housing were also administered to the family members.

RESULTS: A total of 154 households and 487 individuals (50.9% females; mean: 34.3 years; range: 0–93 years) responded. Indoor floor dust in 154 houses was collected. Prevalence of hay fever, allergic rhinitis, atopic dermatitis, asthma, allergic conjunctivitis, and depression were 6.8%, 5.3%, 2.7%, 1.9%, 1.7%, and 1.5%, respectively. Prevalence of upper respiratory symptoms, skin symptoms, eye irritation, general symptoms, and any symptoms related to the housing were 6.2%, 2.1%, 1.0%, 0.6%, and 8.6%, respectively.

CONCLUSIONS: Our results suggested that prevalence of allergic diseases and HRs induced in upper airway were high. Future analyses would indicate the associations with SVOCs in flood dust.

Keywords: Allergies, Chemical exposures, Incidence, Multi-pollutant, Risk assessment



ABSTRACT E-BOOK

P-013

Methods » Environmental epidemiology

Case-Only Approach Applied in Environmental Epidemiology: Two Examples of Interaction Effect Using the NHANES Dataset

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BACKGROUND AND AIM: By substituting the general ‘susceptibility factor’ concept for the conventional ‘gene’ concept in the gene-environment interaction case-only approach, this study can broaden the applicability of the case-only approach to environmental epidemiology.

METHODS: This study collectively summarized the logics and equations previously reported in methodology studies with a case-only approach.

RESULTS: (1) When 1 unit of both blood chromium level (mcg/L) and blood glycohemoglobin level (%) increased coincidentally, the multiplicative interaction risk ratio was 0.72 (95% CI 0.47-1.05), with no statistical significance. However, when only the cases were analyzed (case-only approach), the case-only interaction odds ratio was 0.67 (95% CI 0.44-0.90), with a statistical significance (a negative interaction effect). (2) When 1 unit of both blood cobalt level (mcg/L) and age in years increased coincidentally, the multiplicative interaction risk ratio was 1.13 (95% CI 0.99-1.37), with no statistical significance. However, the case-only interaction odds ratio of 1.21 (95% CI 1.06-1.51) was calculated using the case-only approach with a fine-tuning.

CONCLUSIONS: If the independence assumption between susceptibility factor and environmental exposure in the entire population is kept, this case-only approach can provide (i) a more precise interaction effect estimate or (ii) a reliable interaction effect estimate when appropriate controls were not available. The two examples using the NHANES dataset must be investigated meticulously in the following studies. In summary, the case-only approach can be useful either in environmental epidemiology, not only in genetic epidemiology.

Keywords: Environmental epidemiology, Heavy metals



ABSTRACT E-BOOK

P-014

Exposures » Socio-economic factors (non-chemical stressors)

Association Between manganese and cognitive function in US general population

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BACKGROUND AND AIM: Manganese has neurotoxicity when chronically exposed to it. The symptom is similar with Parkinson's syndrome, but the impairment of cognitive function occur faster in neurotoxicity by manganese exposure. This study investigated the association between manganese exposure and cognitive function in the general population of the elderly in the United States.

METHODS: The data used in this study was National Health and Nutrition Examination Survey, collected from 2011 to 2014. The subject for this study were 1626 persons aged 60 years or older, for whom blood manganese and iron concentration measured and cognitive function evaluated. Cognitive function was evaluated through the following tests. 1) Consortium to Establish a Registry for Alzheimer's disease (CERAD), 2) the Animal Fluency test, 3) the Digit Symbol Substitution Test (DSST). We used chi-square test or ANOVA to estimate differences in the demographic characteristics of participants. Multivariable linear regression was used to examine the associations between the quartile group of the blood manganese concentration and the score of cognitive function tests, and adjusted with age, sex, race, BMI, smoking, alcohol intake, serum heavy metals. test for trend was, assuming the association to be linear.

RESULTS: The animal fluency test score was significantly lower in the Q4 of blood manganese concentration compared to Q1 ($\beta=-1.04$ (95% CI -1.97,-0.11)), while not showing meaningful difference in the Q2 and Q3. And no significant differences was observed in CERAD and DSST. No linear trend was observed among quartile groups of blood manganese concentration in all cognitive function tests.

CONCLUSIONS: We found a negative relationship between Blood manganese and one cognitive function tests. But the association was inconsistent in other two tests and we couldn't find any trend among all tests. Further study for general population should be conducted for clarifying the effect of low dose chronic manganese exposure to cognitive function.

Keywords: NHANES, Cognitive function, Manganese



ABSTRACT E-BOOK

P-015

Exposures » Other (to be specified with keywords in the keywords section)

Exposure of Mercury Species in Red Blood Cell and the Effects on Metabolites of Residents Living Near Coal-Fired Power Plants

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BACKGROUND AND AIM: Coal-fired power plant is an important source of mercury for residents nearby. However, it's still not clear for their exposure of different mercury species and the related health effects. Our study aims to assess the exposures of mercury species in residents near a coal-fired power plant and to clarify the effects of mercury species on metabolite profiles in human body.

METHODS: Our study subjects were 152 adult residents living near a coal-fired power plant in central Taiwan, including 76 high-exposure group (HE) and 76 low-exposure group (LE), which were based on previous studies. We detected their inorganic mercury and methyl mercury levels in red blood cells by HPLC-ICPMS and analyzed the differences on levels and ratios between groups by SAS 9.4. The urinary and serum metabolites database of study subjects were established by previous study. MetaboAnalyst 4.0 was used to analyze and visualize the differences in metabolites profiles between the groups with high and low mercury species levels.

RESULTS: The levels of inorganic mercury in red blood cells of HE group was significantly higher than those in LE group ($2.48 \pm 0.48 \mu\text{g} / \text{L}$ and $1.13 \pm 0.60 \mu\text{g} / \text{L}$ respectively) and there was no significant difference between two groups for methylmercury. The ratio of inorganic/total mercury levels were significantly higher in HE group when compared to LE group ($12 \pm 13\%$ and $7 \pm 6\%$ respectively). There was nine urinary and five serum metabolite profiles were significantly regulated by higher inorganic mercury levels of study subjects. There was no urinary and serum metabolite profiles significantly regulated by different methyl mercury levels.

CONCLUSIONS: The levels of inorganic mercury in red blood cells were significantly higher among the residents living closer to the coal-fired power plant, and the higher inorganic mercury exposure might influence the expression of metabolites.

Keywords: Coal-fired power plant, Inorganic mercury, Methyl mercury, Metabolomics



ABSTRACT E-BOOK

P-017

Exposure Assessment Methods » Exposure assessment-air pollution

Exposure assessment by the measuring inward leak rate for airborne ambient particles into the mask

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BACKGROUND AND AIM: With the novel coronavirus outbreak (COVID-19), there has been increasing concern about the dust-proof performance of masks.

In this study, we used a wearing mask fit tester (MT-05: SIBATA) to evaluate the amount of the fine airborne particles (size: 0.3 μm to 0.5 μm) penetrate the mask (leakage rate or penetration rate).

METHODS: During the period September 2017, participants were recruited in the shopping mall in Yamanashi, Japan. They wear two types of masks we had prepared: a sanitary surgical mask (use cut 99% or more in the PFE test) and a cup-shaped mask (use an N 95 filter). Leakage rates were measured in normal breathing before and in motion (head side to side, talking) and normal breathing after the move. Data were analyzed using a linear mixed model. This study was approved by the Ethics Committee of the Faculty of medicine, University of Yamanashi (1710).

RESULTS: We recruited 102 participants by the research coordinator and obtained their informed consent. The mean Difference for leakage rates of the surgical mask vs. the cup mask was 0.281 (95% CI 0.244 to 0.318, $P < 0.001$), women vs. men was 0.225 (-0.411 to -0.040, $P = 0.017$). It showed a trend lower leakage rates of the cup mask and among women significantly in this study. Both masks showed a higher leakage rate during motion (Head side to side, Talking) but a lower leakage rate after motion, indicating that moving the face enhances the fit.

CONCLUSIONS: The purpose of the mask is not achieved simply by wearing it, and if the type of the mask is not selected and handled correctly, it is impossible to prevent the suction of particles sufficiently. The effect is exhibited by simultaneously clearing the filter performance and the fitting property to the individual face.

Keywords: Air pollution, Exposures, Masks, Multi-pollutant, Microbes, COVID-19



ABSTRACT E-BOOK

P-019

Exposures » Multi-pollutant/Multi-media

The Effects of Ambient Air Pollution and Residential Greenness on Metabolic Disease Biomarkers in China

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BACKGROUND AND AIM: We aim to study the association between air pollution, greenness, and metabolic syndrome (MetS) biomarkers, as mechanisms for cardiovascular diseases (CVD) and the mortality among the elderly in China.

METHODS: We used the 2012 wave of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) Biomarker Cohort. The cohort sampled participants from urban and rural areas of eight longevity counties. We matched the annual average fine particulate matter (PM_{2.5}) concentrations in a 1 km × 1 km grid and calculated Normalized Difference Vegetation Index (NDVI) with a 500-meter radius. The medical technicians measured blood cholesterol, fasting glucose, blood pressure, height, weight, and waist circumference. We defined metabolic syndrome using modified Adult Treatment Panel III criteria.

RESULTS: We had 1801 participants. Three-year average NDVI was slightly higher in the rural area than urban area (mean: 0.495 vs. 0.443) while the rural area had a similar three-year average PM_{2.5} level with the urban area (mean: 49.0 vs. 49.1). We found higher PM_{2.5} was associated with higher odds of abdominal obesity (AO) [OR (95%CI): 1.254 (1.159, 1.361)] and MetS [OR (95%CI): 1.165 (1.067, 1.278)]. Higher NDVI was associated with lower risk of AO [0.811 (0.711, 0.925)] and elevated fasting glucose [OR (95%CI): 0.84 (0.721, 0.982)], but was not significantly associated with MetS [OR (95% CI): 0.95 (0.821, 1.104)]. PM_{2.5} and NDVI had significant interaction on the risk of AO but not on the risk of MetS [p value of interaction term: 0.005 and 0.630 respectively].

CONCLUSIONS: We saw convergence of air pollution and greenness levels between urban and rural area among the eight counties studied in our cohort, with higher harmful effect of air pollution in rural areas and higher beneficial effect of greenness in urban areas.

Keywords: metabolic disease, greenness, air pollution, PM_{2.5}, aging, China



ABSTRACT E-BOOK

P-020

Exposome » General

Comparing Effect of FOXO3 Gene and Urban-Rural Environment on Longevity: a Cohort Study among Older Adults in China

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BACKGROUND AND AIM: Empirical evidence points to urban residents having better health than their rural counterparts in several countries. Since lifespan has complex environmental and genetic underpinnings, we aim to study the effects of FOXO3 and the urban-rural disparity on mortality.

METHODS: We used the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The study cohort conducted surveys from 2008 to 2014, roughly biennially. The geographical distribution encompassed 22 out of 34 provinces in China. We used tagging SNPs rs2253310, rs2802292, and rs4946936 to identify the FOXO3A gene. We used residence classifications: village, town, and city. We used the Cox-proportional hazard regression models to assess the main effects and interaction of FOXO SNPs and residence on mortality risk adjusted for covariates. We conducted analysis to assess the effects of fine particulate matter (PM_{2.5}) concentrations (three-year annual average, 1km×1km grid) and residential greenness (Normalized Difference Vegetation Index (NDVI), 500-meter radius) around participant residences.

RESULTS: Among the 3179 participants, the baseline mean age was 85.1 (SD: 11.3) years, 1688 (53%) were female, 32.1% lived in urban areas (city/town), and 67.9% lived in the rural areas (village). The distributions of the six SNPs of FOXO3A are even across populations of different demographic characteristics (except for age and gender), indicating mendelian randomization. We found FOXO3A to have a protective effect on mortality [HR (95% CI): rs2802292 GG vs TT/TG: 0.825 (0.688, 0.989); rs2253310 CC vs. GG/GC 0.825 (0.689,0.989); rs4946936 TT vs. CC: 0.805 (0.655, 0.989)]. We found participants living in rural areas to have a lower risk of mortality [HR of the urban vs. the rural: 0.825 (95% CI: 0.735, 0.926)].

CONCLUSIONS: Higher air pollution and lower residential greenness both contributed to higher mortality. The effect size of the beneficial effect of FOXO3 on mortality is roughly equivalent to that living in urban areas.

Keywords: Longevity, FOXO3A, gene-environment interaction, air pollution, PM_{2.5}, greenness



ABSTRACT E-BOOK

P-021

Exposures » Other (to be specified with keywords in the keywords section)

Spatial variation of outdoor and indoor NO₂ in metropolitan cities in India

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BACKGROUND AND AIM: Exposure to traffic related pollutants is known to affect the cardio-respiratory health in urban population. The residential urban neighborhoods in low- and middle-income countries such as India are in close proximity to major roads, densely packed, and likely have high heterogeneity in air pollution exposures. However, there is very limited data on long-term exposures to air pollutants and their intra-urban spatial variability in such countries. Thus, this study aims to examine the spatial variation of outdoor NO₂, a proxy of traffic air pollution, in metropolitan cities and its relationship with indoor NO₂ levels.

METHODS: As part of a multi-centric adult women cohort, biweekly averaged outdoor NO₂ was measured in the winter at ~60 residential locations each in three metropolitan cities in India – Delhi, Mumbai, and Bengaluru - using passive samplers. Indoor NO₂ was also measured at half of these residences. Household characteristics including indoor activities, likely sources and ventilation conditions were also collected through structured questionnaire surveys.

RESULTS: Mean (±SD) outdoor NO₂ were 58.5±8.8, 57.9±15.8 29.5±8.1 µg/m³ for Delhi, Mumbai and Bengaluru, respectively. Corresponding indoor concentrations were 61.8±18.2, 69.6±20.1 and 53.2±21.1 µg/m³ for the three cities, respectively. Indoor/Outdoor (I/O) ratios of 1.03±0.3 (Delhi), 1.25±0.3 (Mumbai) and 1.82±0.6 (Bangalore) suggest the strong influence of the indoor sources coupled with poor ventilation, in particular in Mumbai and Bengaluru. Moderate to poor correlation was observed between indoor and outdoor NO₂ (Pearson R=0.36, 0.49 and 0.52 respectively). Socio-economic factors, building airtightness, cooking activities as well as occupant's behaviour (e.g. opening windows) are also identified as key factors influencing the I/O ratios.

CONCLUSIONS: Our findings show substantial differences in outdoor NO₂ between and within the cities, the influence of indoor pollution sources and activities on indoor levels. Further investigation delineating the influence of indoor and outdoor sources is underway.

Keywords: Nitrogen dioxide, Exposure assessment, Long-term exposures, Socio-economic factors.



ABSTRACT E-BOOK

P-022

Policy » Research translation to affect policy and practice

Evidence-based decision making in a crisis: lessons for the next emerging epidemic

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BACKGROUND AND AIM: Travel restrictions to control severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19) were rapidly implemented in several countries, including Australia. Despite its apparent efficacy, this proactive approach was criticised as unscientific, and in breach of International Health Regulations (IHRs). The aim of this paper was to review the evidence-base available in February 2020 when criticisms were made, and to provide guidance on early decision making for future emerging epidemics.

METHODS: We looked for indications that (1) policy had been based on the best available relevant information generalisable to this novel respiratory infection (i.e. same transmission route, such as severe acute respiratory syndrome coronavirus (SARS-CoV), influenza, and Middle Eastern Respiratory Syndrome (MERS), but not Ebola), and that (2) the outcome of interest (e.g. prevention versus delay) had been clearly defined.

RESULTS: Available evidence at the time regarding travel restrictions for emerging infectious respiratory diseases (including SARS-CoV and MERS) supported the use of air travel bans to prevent spread: travel restrictions delayed (but did not prevent) the spread of influenza by up to four months, and by up to 10 months if implemented in combination with other local strategies. The delay and attenuation of peak case numbers minimises stresses on health systems, allowing for preparations to be made to better manage the outbreak (upskilling the health workforce, building new facilities, improving access to laboratory testing and ventilators, and stockpiling personal protective equipment).

CONCLUSIONS: The introduction of travel restrictions to reduce SARS-CoV-2 transmission were science-based. In the face of future emerging epidemics, we urge policy makers to be guided by the best available evidence, with consideration for the generalisability of investigated infections to the target infections, and the outcome of interest.

Keywords: Infectious diseases, Policy and Practice, Policy



ABSTRACT E-BOOK

P-024

Methods » Modeling

Empirical validation and simulation of existing CO exposure models with hospital pulmonary function datasets

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BACKGROUND AND AIM: Carbon monoxide (CO) poisoning is a critical global public health issue. Several CO exposure models were built to predict the kinetics of CO uptake and elimination in CO poisoning but based on a limited data set. Therefore, the aim of the study is to extend the CO exposure models to people with a wider range of several characteristic, such as age, sex, height, weight, smoking status. To address this, we tested relationships between these demographic factors, pulmonary function (DLCO), and the rate of CO uptake and CO elimination.

METHODS: We collected pulmonary function datasets from Tri-Service General Hospital in Taiwan (N=1,943 Asian patients), and Royal Berkshire Hospital in the UK (N=691 Caucasian patients). In these data we obtained the DLCO by demographics. Then we used the observed DLCO values within existing CO models (Coburn-Forster-Kane (CFK) models) to predict the rate of CO uptake and elimination for different individuals in different scenarios.

RESULTS: We found that males had a higher value of DLCO than females, and DLCO was positively associated with height ($\beta=0.122$, $p<0.05$) and weight ($\beta=0.104$, $p<0.05$), and negatively associated with age ($\beta=-0.186$, $p<0.05$). Then, we used estimated DLCO from data gathered from pulmonary function datasets to update established CFK models. The results showed that for example: when exposed to 10,000 ppm for 5 min, there is a higher peak of CO ppm in a younger male compared to an older male (COHb (%): 20.8 vs. 19.5).

CONCLUSIONS: In conclusion, the updated model has the advantage of being able to predict CO uptake and elimination for a wider range of individuals compared to previous CFK models, factoring in their age, sex, height, weight, ethnic group, and smoking status. This could help estimate past CO exposure, and help medical staff recognize CO exposure and design optimal treatments for CO exposure victims.

Keywords: Air pollution, Biomarkers of exposure, Epidemiology, Exposures, Exposure assessment, Toxicology



ABSTRACT E-BOOK

P-025

Methods » Environmental epidemiology

Validity evaluation of indirect adjustment method for multiple unmeasured confounders: a simulation and empirical study

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BACKGROUND AND AIM: Indirect adjustment method was developed to control for unmeasured confounders in a large administrative cohort study. Previous simulations assessing the validity of the method suggested that the relative bias did not exceed 20% in most of the realistic scenarios. However, the simulations did not consider the direction of the bias and did not deal with scenarios with multiple missing confounders, which is common in practical situations. This study aimed to evaluate the direction of the bias of the indirect adjustment method and to illustrate how the magnitude of the bias varies in scenarios with multiple correlated unmeasured confounders.

METHODS: In a simulation study, the bias of the indirect adjustment was compared by varying the number of cofounders, the magnitude of the correlation between confounders, and the number of adjustment variables. In an empirical study, the indirect adjustment method was applied in the association between PM10 and mortality using the Korea National Health and Nutrition Examination Survey linked Cause of Death data (2007-2016).

RESULTS: The simulations suggested that 1) when a confounder is positively associated with both exposure and outcome, the indirect adjustment might bias the effect size downward; 2) the magnitude of the bias might depend on the correlation between unmeasured confounders; 3) indirect adjustment for multiple missing confounders at once could result in higher bias than indirect adjustment for some of them. The empirical analyses also showed consistent results, but the bias of indirectly adjusted effect estimates was sometimes larger than the bias of unadjusted effect estimates.

CONCLUSIONS: The indirect adjustment method is a promising technique to reduce the bias of unmeasured confounding, but the method should be used with care, especially when there are multiple unmeasured confounders and they are mutually correlated.

Keywords: Environmental epidemiology, Methodological study design, Air pollution



ABSTRACT E-BOOK

P-026

Policy » Research translation to affect policy and practice

Individual attributes as potential determinants of over-perception of air pollution among adults in South Korea

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BACKGROUND AND AIM: Over-perception of air pollution is to perceive air quality worse than its actual level. It has increased social anxiety and stress, especially in South Korea for recent years. Over-perception can occur differently according to individual vulnerability, related knowledge, and coping ability explained by individual contexts like sex, age, and socioeconomic status. Identifying potential determinants of over-perception could be beneficial in improving the effectiveness of risk communication. Therefore, this study aimed to investigate individual attributes that may affect the over-perception of air pollution.

METHODS: The study subjects (n=111,724) were obtained from the 2018 Community Health Survey conducted by Korea Center for Disease Control and Prevention. Over-perception of air pollution was defined as when the respondents rated their local subjective air quality was bad even though the object air quality was good. The individual attributes included demographic factors (sex, age, and marital status), socioeconomic status (education, occupation, and household income), and health-related variables (drinking status, smoking status, self-rated health, and subjective stress level). The associations between over-perception of air pollution and individual attributes were assessed using logistic regression.

RESULTS: The proportion of over-perception of air pollution in our study population was 27.4%. Over-perception was significantly associated with all demographic factors, SES, and health-related variables after adjusting for measured air pollution and other covariates. Younger respondents had higher odds ratio of over-perception (19-44 years old: OR=2.15, 95% CI=2.01-2.31, reference: over 65 years old). Housewives (OR=1.06, 95% CI=1.01-1.12, ref.: unemployment) and blue collars (OR=1.06, 95% CI=1.00-1.11, ref.: unemployment) had higher ORs than other occupations. Respondents with higher education and lower household income level were more likely to over-perceive air quality. This tendency was also shown among those who rated health and stress level bad.

CONCLUSIONS: This study suggests that considering individual context would enhance the delicacy in risk communication about air pollution.

Keywords: Air pollution, Particulate matter, Socio-economic factors, Science communication,, Policy and practice



ABSTRACT E-BOOK

P-028

Cancer and Cancer-Precursors » Incidence

Age, period, and cohort effect of female lung cancer in China

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BACKGROUND AND AIM: Although the average smoking rate is lower than 3%, the incidence of female lung cancer in China has been rising in the past three decades. The risk factors of female lung cancer in China are still unclear. The objective of this study was to check the trends and explore the age, period, and cohort effects on the trends of female lung cancer in China.

METHODS: We obtained age- sex- and province-specific incidence between 1992 and 2016 from the global burden of disease (GBD) 2016 results. We computed age-standardized rates (ASR) with world standard population and applied joinpoint regression models together with age-period-cohort (APC) models to identify both the secular national trend and province-specific trends.

RESULTS: From 1992 to 2016, the national ASR of incidence (ASIR) of female lung cancer rose up (AAPC=0.7%, 95% CI: 0.6-0.8%). The age relative risk (RR) of incidence was similar in whole China. The positive lung cancer risks became significant in Chinese women aged 50 and older and the peak RR were found in age 75-79. There were significant period risks among all 33 provinces. Except for the period risks in 6 provinces, all the other 27 province-specific period risks rose significantly after 2007. The maximum period effect (RR) among 33 provinces ranged from 1.17(95%CI : 1.07-1.28) to 1.59 (95% CI: 1.40-1.81). The cohort effects of 5 provinces including Heilongjiang province, Liaoning province, Shandong province, Sichuan province, and Xinjiang autonomous region had special upsurge or plateau among certain cohorts. While the cohort effects of the other 28 provinces were descending over all successive cohorts. The dominant cohort effect were focused in the cohorts born in the 1940s or in the 1950s.

CONCLUSIONS: Aging might be closely associated with female lung cancer risk. Special cohort exposures should be explored for the risk of female lung cancer in China.

Keywords: lung cancer, Chinese women, age-period-cohort effect, trend



ABSTRACT E-BOOK

P-029

Exposures » Water quality

A Simplistic Unsaturated Zone Leaching Model-based Probabilistic Human Health Risk Assessment of Groundwater around the Ariyamangalam Dumping Site

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BACKGROUND AND AIM: The human health risk assessment (HHRA) of groundwater around the Ariyamangalam open dumping site was conducted, assuming oral ingestion and dermal contact exposure scenarios.

METHODS: Observed data of metal concentration in the leachate was used to compute non-carcinogenic hazard quotient (HQ) and cancer risk (CR) by integrating the leaching model with probabilistic HHRA framework.

RESULTS: Results from 10,000 Monte Carlo simulations showed that the average value of cadmium (Cd) and lead (Pb) concentration from ground surface up to water table depth exceeded the safe permissible limit. The 95th percentile value of Cd concentration at the water table for sand and silty clay soil was estimated as 0.188 mg/L and 0.104 mg/L, respectively, much higher than safe limit of 0.005 mg/L. The 95th percentile value of HQ for all the subpopulations was found to be 2 - 4 orders higher than safe limit (>1) via oral ingestion exposure to cadmium- and lead-contaminated groundwater. The child I (1-5 year) category was most affected by groundwater, as CR value of 1.86E-03 was observed for oral ingestion scenario, highest among all the considered cases. The 95th percentile and maximum value of cancer risk (CR) due to lead were found to be 10 to 1000 times higher than safe level (>1E-06) for both the soil types. However, for the skin dermal contact scenario, only maximum value of CR for the child (6-10 year) and teen (11-18 year) exceeded the safe level. Variance attribution analysis showed that the metal concentration (>80% variance contribution), as a primary contributor towards uncertainty in the risk estimates, while exposure duration (ED), ingestion rate (IR), and event duration (tevent) were observed as secondary contributors.

CONCLUSIONS: The findings of this study highlighted the significance of model-driven HHRA approach and indicated that people residing in the vicinity of dumpsite should consume only treated groundwater.

Keywords: Unsaturated zone, Leaching Model, Contaminant Transport, Human Health Risk, Cancer Risk, Monte Carlo Simulations



ABSTRACT E-BOOK

P-030

Cancer and Cancer-Precursors » Survival

Cigarette smoking associated with colorectal cancer survival: a nationwide, population-based cohort study

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BACKGROUND AND AIM: The association between cigarette smoking and survival in patients with colorectal cancer (CRC) is inconsistent. Thus, we aim to investigate whether cigarette smoking is associated with the overall survival rates of CRC patients using a nationwide population-based cohort study in Taiwan.

METHODS: Taiwan Cancer Registry and Taiwan's national health insurance research database were used to identify CRC patients from 2011 to 2017. All patients were censored to date of death or the end of 2017. Tobacco use was evaluated by smoking status, duration, and amount of cigarette smoking before cancer diagnosis. Survival was estimated using Kaplan-Meier analysis and Cox regression was used to investigate the effect of smoking on overall survival (OS).

RESULTS: A total of 49,837 CRC patients were included for analysis. The Kaplan–Meier survival analysis illustrated smoking to be significant association with OS in CRC patients (log-rank $p=0.0123$). The multivariable Cox model showed that CRC patients with ever smoking habit had 1.11-fold mortality risk (HR=1.11, 95% CI=1.05-1.16; $p<.0001$) compared with CRC patients whom never smoking. This increased risk was also present in CRC patients who smoking cigarettes >20 per day (HR=1.13; 95% CI=1.02-1.25; $p=0.0149$) or smoking year of 11-30 years (HR=1.15; 95% CI=1.06-1.24; $p=0.0004$). Furthermore, stratified analysis of sex and tumour location showed the impact of smoking was higher in male CRC patients or cancer developed in rectum.

CONCLUSIONS: Our results indicate that cigarette smoking significantly associates with worse survival in CRC patients. An integrated smoking cessation campaign is warranted to prevent the CRC mortality.

Keywords: Colorectal cancer, Cigarette smoking, Survival



ABSTRACT E-BOOK

P-031

Exposures » Other (to be specified with keywords in the keywords section)

A Thrilling Finding behind Kindling Behavior in Rural Northern China: dioxins exposure and its related risk alert

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BACKGROUND AND AIM: During a field research, we discovered a new phenomenon that rural families in northern China were using harmful materials including plastic bottles, bags, and others as kindling material. The aim of this study was to analyze the potential risk behind kindling behavior among Chinese rural families, and to provide insights for policy makers in environmental health.

METHODS: A cluster survey was performed on 113 participant's families using solid fuels for cooking and heating purpose. An electric questionnaire survey on their kindling behavior and family information was administrated. Harmful kindling materials including plastic bottles, plastic planting plates, plastic film mulches, plastic bags, waste foams, and medium density fiberboard (MDF) are targeted in the survey. The population attributable fractions (PAF) for all type cancer and type 2 diabetes (T2D) attributable to dioxins exposure were estimated. A chi square statistics was used for the analysis of driving forces behind these kindling behaviors.

RESULTS: About 1/3 participant's families have ever used the listed harmful material for kindling. Based on literature review and the exposure proportion estimated from the questionnaire, we estimated the PAF for all type cancer (10.48% to 19.48%) and type 2 diabetes (15.57% to 27.86%) attributable to dioxins exposure. The PAF estimates were greater than our expectation from view of the global estimate PAF for cancer and T2D. Availability, age, ignition frequency and favorite kindling material are significantly different among different behavior groups ($p < 0.05$). Moreover, we found farming families are more likely to use their farming related plastic byproducts as kindling material.

CONCLUSIONS: There is a huge knowledge gap among environmental health in rural China. Our survey provided a new research aspect for environmental health research and health education. Strengthened environmental health education, better relevant laws, regulations, and supporting policies for regulate rural and farming waste disposal are highly recommended for policy makers in China.

Keywords: Dioxins exposure, Solid fuels, Indoor air quality, Kindling materials, Public health, Behaviors



ABSTRACT E-BOOK

P-032

Built environment » Other (to be specified with keywords in the keywords section)

The urban lead burden in humans, animals, and the natural world

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BACKGROUND AND AIM: History and active and passive policies have concentrated lead in cities; minority and low-income populations have also been concentrated there. Humans have foisted the lead burden onto wild and domesticated urban animals as well as the natural environment. **METHODS:** Using a One Health approach, we have arrayed the data on the urban lead burden on humans, animals and the natural world.

RESULTS: Lead pollution is not distributed evenly across urban areas. Although average US pediatric lead exposures have declined by 90% since the 1970s, there remain well defined neighborhoods where children continue to have toxic lead exposures; animals are poisoned there, too. Those neighborhoods tend to have disproportionate commercial and industrial lead activity; a history of dense traffic; older and deteriorating housing; past and operating landfills, dumps and hazardous waste sites; and often lead contaminated drinking water. The population there tends to be low income and minority. Urban wild and domesticated animals bear that same lead burden.

Soil, buildings, dust and even trees constitute huge lead repositories throughout urban areas.

CONCLUSIONS: Global warming will increase lead bioavailability and toxicity.

Evidence-based research has shown the efficacy and cost-effectiveness of some US public policies to prevent or reduce these exposures. Potential actions to start unencumbering our urban areas include identifying sources of local contamination such as junk yards and auto body shops, reducing exposures to bare lead-contaminated soil, addressing lead contaminated drinking water in schools and homes, etc.

Keywords: built environment, environmental disparities, climate, children's outcomes, policy and practice



ABSTRACT E-BOOK

P-033

Built environment » Walkability

Neighborhood Walkability and Mortality in a Prospective Cohort of Women

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BACKGROUND AND AIM: Neighborhood walkability (NW) may play a role in preventing chronic disease and increasing life expectancy. Evidence suggests that walking prevents obesity-related illness and mortality. Yet, there is paucity of long-term prospective studies evaluating community-level walkability characteristics in relation to the risk of death. Our aim is to assess the association between baseline measures of NW and risk of death in a large prospective cohort of women.

METHODS: Baseline residential addresses of 13,832 women in the New York University Women's Health Study (NYUWHS) were geo-coded and the Built Environment and Health Neighborhood Walkability Index (BEH-NWI) was estimated for each participant. The participants were recruited from 1985 to 1991 in New York City and followed up for an average of 27 years. We conducted survival analyses using Cox proportional hazards models to assess the association between BEH-NWI and risk of death from any cause, obesity-related diseases, cardiometabolic diseases, and obesity-related cancers.

RESULTS: Residing in a neighborhood with a higher BEH-NWI score was associated with a reduced risk of death. Compared to women in the bottom BEH-NWI tertile, those in the highest tertile were 0.96 times (95% CI: 0.93-0.99), 0.91 times (95% CI: 0.86-0.97), and 0.72 times (95% CI: 0.62-0.85) less likely to die from any cause, obesity-related diseases, and in particular, obesity-related cancers, respectively, while adjusting for potential confounders at both the individual and neighborhood level. No association was found between BEH-NWI and risk of death from cardiometabolic diseases. Results were similar in sensitivity analyses censoring women at moving time, and using propensity scores matching women with high and low BEH-NWI on potential confounders. Outdoor walking, average BMI, and/or history of diabetes mediated approximately 5% to 26% of the association between BEH-NWI and mortality.

CONCLUSIONS: Our findings suggest a protective role of NW in obesity-related mortality in women, particularly obesity-related cancer mortality.

Keywords: walkability, mortality, other (obesity-related mortality), other (women's health)



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-034

Built environment » Walkability

Development and validation of a nationwide walkability index for the Netherlands using transport survey data

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BACKGROUND AND AIM: Neighbourhood walkability indices have been developed and linked to behavioral and health outcomes elsewhere in the world, but not yet in the Netherlands. We aimed to compose a theory-based walkability index for the Netherlands and elucidate its cross-sectional association with adults' walking behaviours.

METHODS: The Dutch walkability index consists of seven components: population density, retail- and service destination density, land-use mix, street connectivity, green space, sidewalk density and public transport density. These components were composed and aggregated to three Euclidean buffer sizes (150m, 500m and 1000m) around every postal code and to every administrative neighbourhood. The normalized walkability index is the sum of its componential z-scores and scaled between 0-100. Data on self-reported demographic characteristics and walking behaviors of adult participants (aged 18-65, n=15716) were extracted from the Dutch National Travel Survey 2017. Using censored regression analysis (tobit model) adjusted for individual and survey-related confounders, we assessed the association between walkability index and total time spent walking, for non-discretionary and discretionary purposes. The main association was also examined across various urbanization degrees, socioeconomic levels, age groups and sexes.

RESULTS: In fully-adjusted models, a 1% increase in walkability was associated with 0.49 minutes increase in walking (95%CI: 0.4-0.58), corresponding to 37 meters (95%CI: 29-44). This association was consistent across buffer sizes and between discretionary and non-discretionary walking. Stratified results showed that associations for minutes of walking were stronger in rural (0.90, 95%CI: 0.54-1.26) compared to highly urbanized areas (0.41, 95%CI 0.23-0.59), for discretionary walking in females (0.53, 95%CI: 0.38-0.67), and non-discretionary walking in males (0.64, 95%CI: 0.44-0.84).

CONCLUSIONS: The walkability index was associated with walking behaviours of people in the Netherlands, indicating its value for further use in the Netherlands.

Keywords: walkability, built environment, travel behaviours



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-035

Exposures » Water quality

Evaluation of multiple disinfection by-products in tap, filtered and bottled water in Barcelona, Spain

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BACKGROUND AND AIM: The formation of disinfection by-products (DBPs) as an unintended consequence of drinking water potabilization is a current global concern due to their potential relation to chronic diseases. With the aim of assessing human exposure to DBPs in drinking water, we quantified 4 trihalomethanes (THMs), 11 haloacetic acids (HAAs), 4 haloacetonitriles (HANs), chlorate, chlorite, 1,1-dichloropropanone (DCP), 1,1,1-trichloropropanone (TCP) and chloropicrin, in different drinking water types in Barcelona, Spain.

METHODS: DBPs and physicochemical parameters such as conductivity and total organic carbon (TOC), were measured in tap water samples collected at 42 households, and in tap water filtered with activated carbon (AC) (N=6) and reverse osmosis (RO) (N=5). Selected DBPs were also analyzed in 10 popular bottled water brands.

RESULTS: All tap water samples contained THMs and HANs, and 98% contained HAAs and chlorate above the limit of quantification (LOQ). Chlorite and TCP were found in 62 and 36% of the tap water samples, respectively, while DCP and chloropicrin were not detected. The median and interquartile range of total THMs, HAAs, HANs, and chlorate in tap water, calculated using values >LOQ, were 42.0 (37.5-48.5), 18.0 (10.5-30.3), 3.2 (2.6-3.9), and 214 (159-296) µg/L, respectively. Conductivity was negatively correlated with bromodichloromethane (R=-0.91), TOC (R=-0.83), total HAAs (R=-0.82), dichloroacetonitrile (R=-0.78), TCP (R=-0.75), chlorite (R=-0.70), and positively correlated with the bromine incorporation factor (BIF) of THMs (R=0.82), DXAA (R=0.66), and TXAA (R=0.65) (X=Br/Cl). Both AC and RO filters reduced DBPs in tap water and none of the analyzed DBPs were detected in bottled water.

CONCLUSIONS: THMs and HAAs were below the EU regulatory limits (Drinking Water Directive 2020/2184). A clear geographical pattern for most DBPs and for the conductivity was found, driven by the water source. With the generated data, we will develop predictive models based on routine monitoring parameters that could be applied in epidemiological research.

Keywords: Water quality, Chemical exposures, Exposure assessment, Multi-pollutant



ABSTRACT E-BOOK

P-036

Built environment » General

Assessing how students' respiratory health mediate socioeconomic status and school building conditions' effects on students' performance

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BACKGROUND AND AIM: Low socioeconomic status (SES) and poor school building conditions (SBCs) have been associated with poor school outcomes, such as low attendance and academic achievements. While a few attempts have been made to understand the potential causal framework, the indirect effect of school SES and SBCs on students' performance through affecting students' respiratory health has not been tested. Our study aimed to assess the mediating effects of students' respiratory health on the relationships between school SES, SBCs, and school outcomes (attendance and test scores).

METHODS: We used the counterfactual based mediation approach. Respiratory visits among children aged 4-18 were obtained from New York (NY) statewide hospital discharge database, and school level hospital visit rates were calculated. SBCs (e.g. IAQ Rating, Heating systems) was collected from the 2010 school building condition survey for public schools in NY state excluding NY City. School SES (e.g. free lunch eligibility, proportion of minority), attendance rate, and test scores were obtained from school report cards. Associations between the mediator and outcomes were assessed in negative binomial models. Natural indirect and direct effects were calculated.

RESULTS: Schools with higher respiratory hospital visits among students reported consistently lower attendance. Poor respiratory health was associated with lower ELA and Math test scores but not with Regents exam scores. The data showed an approximate 7% decrease in school attendance due to low school SES, as mediated by students' respiratory health. While strong total effects were observed between school SES/SBCs and ELA/Math test score, the mediating effect of respiratory health was insignificant.

CONCLUSIONS: Poor respiratory health may be one of the most critical issues to address in improving student attendance and academic performance. Future studies should further explore the mediating effect of other social or parental factors on the path from school SES/SBCs to school outcomes.

Keywords: school building condition, mediation analysis, student attendance



ABSTRACT E-BOOK

P-037

Built environment » General

Development of a novel Obesogenic Built environment CharacterisTic (OBCT) index for the Netherlands

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BACKGROUND AND AIM: Despite the potential synergistic nature of obesogenic built environment characteristics, few studies combined factors across the food and physical activity environments. This study aims to compose a comprehensive, theory-based, expert-informed index to quantify built environment characteristics relevant for adult overweight and obesity for all administrative neighbourhoods in the Netherlands for 2016.

METHODS: The Dutch OBCT-index consists of 16 components related to food environments (density and healthiness of all food outlets) and physical activity environments including exercise availability (density of sports facilities) and transport-related components related to walkability, driveability and bikeability (population density, land use mix, sidewalk density, intersection density, green space, retail- and service destination density, destination accessibility, public transport density, distance to train station, job density, distance to nearest highway ramp, bicycle pathway density and parking pressure). For each neighbourhood, data were collected from public and commercial sources and processed in GIS such that each component was scaled to range between 0-100. The resulting OBCT-index was calculated as an average of component scores across the food and physical activity environments, where higher scores corresponded to more obesogenic neighbourhoods.

RESULTS: The OBCT score was composed for all 12821 administrative neighbourhoods in the Netherlands and ranged from 37.38-86.80 (mean=47.83, SD=3.37). The province of North Holland stood out with Amsterdam having both extremes of obesogenicity. Across urbanization degrees, the most rural neighbourhoods (<500 addresses/km²) scored 4.35 units (95%CI:4.16-4.55, p<0.01) higher than the most urban (>2500 addresses/km²). Similarly, neighbourhoods in the highest quartile of housing prices (mean=€358800, SD=€115431) scored 4.02 units (95%CI:3.54-4.50, p<0.01) higher than the lowest quartile (mean=€95420, SD=€12264).

CONCLUSIONS: The OBCT-index is a potentially useful tool to quantify obesogenicity of neighbourhoods and warrants further research applications.

Keywords: obesogenic environment, built environment, food environment, physical activity environment



ABSTRACT E-BOOK

P-038

Built environment » Walkability

Stress in different travel modes: an observational study of Galvanic Skin Response measurements (GSR)

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BACKGROUND AND AIM: Stress is often associated with urban living, although active travel may reduce stress compared to other modes. Earlier work, however, has relied on self-reported measures of stress, and on study designs that limit our ability to establish causation.

METHODS: Galvanic Skin Response (GSR), a proxy for stress, was collected alongside confounders and travel information from 122 participants across 3 European cities during 3 weeks as part of the Physical Activity through Sustainable Transport Approaches (PASTA) study. Causal effects of daily travel in different modes on GSR were evaluated through propensity score matching (PSM) and linear mixed models (LMMs). Separately, cycling, then walking then motorized (public or private) travel were compared to “any other activity”.

RESULTS: Cycling reduces 1-minute GSR by 7.6% [95% CI: 2.6-22%] to 10.5% [95% CI: 4.9-22.7%] compared to any other activity. Walking is also beneficial, reducing GSR by 4.3% [95% CI: 1.6-11.9%] to 6.2% [95% CI: 2.9-13.3%] compared to any other activity; motorized mode (private or public) in reverse increases GSR by up to 1.4% [95% CI: 0.6-3.2%].

CONCLUSIONS: Active travel offers a welcome way to reduce stress in urban dwellers’ daily lives. Stress can be added to the growing number of evidence based reasons for promoting active travel in cities.

Keywords: Built environment, walkability, causal inference



ABSTRACT E-BOOK

P-039

Built environment » Other (to be specified with keywords in the keywords section)

The Effect of Cold Waves on Mortality in Urban and Rural Areas of Madrid

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BACKGROUND AND AIM: While many studies analyze the effect of extreme thermal events on health, little has been written about the effects of extreme cold on mortality of rural population. Therefore, we try to analyze these effects on urban areas and rural areas from Madrid and to test whether differentiated extreme cold effects exist between both population classes.

METHODS: We analyzed data from the municipalities with over 10,000 inhabitants for the period from January 1, 2000 through December 31, 2013. Municipalities were classified as urban or rural (Eurostat), and they were grouped into similar climatological zones. The dependent variable was the daily mortality rate due to natural causes per million inhabitants (CIE-X: A00-R99) that occurred between the months of November and March for the period. The independent variable was minimum daily temperature (°C). Social and demographic contextual variables were used, including: population > age 64 (%), deprivation index and housing indicators. The analysis was carried out in three phases: 1. determination of the threshold temperature which defines the cold waves; 2. Determination of the relative risk (RR) for cold waves using Poisson linear regression (GLM); 3. Using GLM of the binomial family, Odds Ratios (OR) were calculated to analyze the relationship between the frequency of the appearance of cold waves and the socioeconomic variables.

RESULTS: The urban zone experienced 585 extreme cold events related to attributable increases in the mortality rate. The average number of cold waves in the rural zones was 319. The primary risk factor was the percentage of population over age 64, and the primary protective factor was housing rehabilitation. Globally, the period experienced more cold waves (1,542) than heat waves (1,130).

CONCLUSIONS: The urban zone was more vulnerable than the rural areas. Due to cold spells were more frequent than heat waves, the results support the development of specific prevention plans.

Keywords: Cold-spells, mortality, urban-rural, deprivation, building quality, ageing



ABSTRACT E-BOOK

P-040

Built environment » Other (to be specified with keywords in the keywords section)

Neighborhood drivability and diabetes incidence in Toronto, Canada

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BACKGROUND AND AIM: Reliance on cars contributes to physical inactivity, and therefore may be a risk factor for type 2 diabetes. We investigated whether living in neighborhoods that are highly conducive to driving is associated with an increased incidence of diabetes.

METHODS: Working age adults (20-64 yrs) who were living in Toronto, Canada on April 1st 2011, were followed over 6 yrs for incident diabetes using a validated algorithm based on hospital records and physicians' services claims. For neighborhood drivability, we used a novel index capturing three factors of the built environment: urban sprawl, pedestrian unfriendliness and parking options. Cox regression was used to examine the association between neighborhood drivability quintiles (Q) and diabetes incidence, adjusting for age, sex, income, ethnicity, immigration status and comorbidity, and censoring for death.

RESULTS: Among 1,473,994 individuals in our sample (mean age 40.9±12.2, 48.5% male), 77,835 developed diabetes. Overall, there was a direct relationship between drivability and diabetes incidence, however the magnitude of this effect varied by age and income. Among young adults (20-34 yrs), those living in the most drivable neighborhoods (Q5) had a 58% higher incidence of diabetes (adjusted HR: 1.58 (95%CI: 1.47-1.69)) relative to those in the least drivable neighborhoods (Q1), whereas the same comparison in older adults (55-64 yrs) yielded smaller differences (HR: 1.31 (95%CI: 1.26-1.36)). High drivability was most strongly associated with diabetes risk in the middle income neighborhoods with 96% increased risk for young residents (HR:1.96 (95%CI: 1.64-2.33)) and a 46% increased risk for older residents (HR: 1.46 (95%CI:1.32-1.62)). Associations between drivability and diabetes incidence were significant but of a lesser magnitude in low- and high-income neighborhoods.

CONCLUSIONS: In our setting, neighborhood drivability is a risk factor for the diabetes incidence among working age adults, especially younger, middle-income populations.



ABSTRACT E-BOOK

Keywords: drivability, walkability, built environment, diabetes

P-041

Built environment » Walkability

Neighborhood Walkability and Sex Hormone Levels in Women

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BACKGROUND AND AIM: Neighborhood walkability (NW) has been linked to increased physical activity. Engaging in regular exercise is associated with lower levels of sex hormones in women. However, little is known about the effects of NW on female sex hormones. We conducted a cross-sectional study to evaluate the association between NW and circulating levels of sex hormones in pre- and postmenopausal women.

METHODS: We included a total of 802 premenopausal and 629 postmenopausal women in the New York University Women's Health Study (NYUWHS) who were healthy controls from previous nested case-control studies in which sex hormone levels had been measured. Baseline residential addresses were geo-coded and the Built Environment and Health Neighborhood Walkability Index (BEH-NWI) was derived. Measurements from serum samples collected at recruitment were available for androstenedione, testosterone, dehydroandrosterone sulfate (DHEAS), estradiol and estrone (postmenopausal women), and sex hormone-binding globulin (SHBG). Generalized Estimating Equations were implemented to assess the association between BEH-NWI and sex hormone levels.

RESULTS: One standard deviation (SD) increment in BEH-NWI was associated with 4.2 percent (95% CI 1.6-6.7) and 8.9 percent (95% CI 5.8-11.9) lower DHEAS concentrations in premenopausal and postmenopausal women, respectively, adjusting for individual and neighborhood level factors. One SD increment in BEH-NWI was also related to a 4.3 percent (95% CI 1.1-7.3) lower level of testosterone and a 6.7 percent (95% CI: 4.6-8.8) higher level of SHBG in postmenopausal women, adjusting for covariates. These associations remained significant after controlling additionally for BMI. BEH-NWI was not associated with estradiol, estrone, or androstenedione concentrations.

CONCLUSIONS: Our findings suggest that NW is associated with lower concentrations of DHEAS in both pre- and postmenopausal women, as well as lower testosterone and higher SHBG in postmenopausal women, independent of BMI.

Keywords: walkability, urban health, other (sex steroid hormones), other (women's health)



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-042

Built environment » Noise

Land Use Regression Modelling of traffic-related noise in Athens, Greece for use in epidemiological studies

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BACKGROUND AND AIM: Even though exposure to noise has been associated with higher blood pressure and sleep disturbance, a very limited number of studies have developed Land Use Regression (LUR) models to estimate exposure to transportation noise. Our aim was to develop a LUR model that estimates long-term exposure to road-traffic noise, within the greater Athens area in Greece, for subsequent use in epidemiological studies.

METHODS: We developed a LUR model for road-traffic noise exposure to Lday-evening-night (Lden) using noise measurements conducted at 241 points in the study area, during 2014-2015. We applied a semiparametric approach including linear and smooth functions of spatial covariates and a bivariate smooth thin plate function for the geographical coordinates of the monitoring sites. The final set of explanatory variables was selected based on the adjusted-R². We tested the final model's performance using 10-fold cross-validation (CV). Subsequently, we applied the developed model to estimate exposure to road-traffic noise of 1,321 participants in the National Survey of Morbidity and Risk Factors (EMENO), at their residential addresses. Logistic and linear regression models were used to evaluate the association between exposure to road-traffic noise and the risk of hypertension and mean arterial blood pressure (MAP).

RESULTS: The final set of predictor variables included traffic load variables, number and surrounding area of bus lanes, open space areas and nearest building height. The R² of the developed model was 0.51 (CV-R²:0.39). Mean exposure (SD) of participants to Lden was 56.8 (2.54)dB. A 10dB increase in Lden was associated with an odds ratio (OR) for hypertension of 1.69 (95% confidence interval (CI):0.84, 3.41) and an increase in MAP of 1.3mmHg (95% CI: -2.00, 4.60 mmHg).

CONCLUSIONS: LUR modeling provides a useful tool for estimating exposure to transportation noise for subsequent use in epidemiological studies, but further improvements of exposure are needed.

Keywords: Environmental epidemiology, Exposure assessment, Noise, Long-term exposure, Cardiovascular diseases



ABSTRACT E-BOOK

P-043

Built environment » Other (to be specified with keywords in the keywords section)

Neighborhood Characteristics and Childhood Asthma: Evidence from the National Survey of Children's Health, 2016-2017

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BACKGROUND AND AIM: Although several asthma-related risk factors have been identified, there is a paucity of information on the effects of neighborhood characteristics on childhood asthma in the U.S. We examined the association between asthma and neighborhood characteristics in the U.S. using the National Survey of Children's Health (NSCH) data.

METHODS: We used aggregated data from children aged 0 to 17 years (N = 66,037) which were obtained from the 2016-2017 NSCH cycle. We computed weighted descriptive statistics and multivariable logistic regression to determine the association between current asthma status and the presence of: 1) neighborhood detractors (litter or garbage, poorly kept or rundown housing, and vandalism) and 2) neighborhood amenities (sidewalks or walking paths, parks or playground, recreation center and library or bookmobile). All analyses were performed using SAS.

RESULTS: About 7.93% current asthma prevalence was reported and boys had higher odds of asthma (AOR= 1.32, 95% CI= 1.16 – 1.51) compared to girls. Children who lived in neighborhoods with at least one amenity had lower odds of asthma (AOR= 0.86, 95% CI= 0.75 – 0.99) compared to those who lived in neighborhoods with no amenities. Those who lived in neighborhoods with any detractors had higher odds of asthma (AOR= 1.20, 95% CI= 1.04 – 1.40) compared to those that lived in neighborhoods without any of these elements.

CONCLUSIONS: Our findings illustrate that the neighborhood characteristics are important risk factors for asthma. Childhood asthma should be studied using environmental justice and system analysis frameworks to identify environmental risk factors that could be modified to alleviate current asthma rates in children.

Keywords: asthma, neighborhood detractors, neighborhood amenities, neighborhood characteristics



ABSTRACT E-BOOK

P-044

Built environment » Other (to be specified with keywords in the keywords section)

Tackling Health Inequalities through Sector-Based Policies within the Urban Built Environment in England

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BACKGROUND AND AIM: Health inequalities (HIs) has proven to be a convoluted issue in many urban environments, involving a multitude of sectors for its persistence. Hence, to achieve maximum outcomes, HI-focused interventions require its prioritisation as well as the inter-sectoral collaboration across both the public and private domains. Although this has long been recognised, current systems still lack its best practice. This research aims to evaluate whether key sectors within the built environment or urban planning policy arena have prioritised the issue, and pave way for inter-sectoral collaborations to form. For this study, England is chosen as the geographical scope.

METHODS: To achieve its aim, the research carried out a systematic review of reviews to determine the key policy sectors pertaining to HIs within the built environment. A conceptual framework, connecting the key sectors and determinants to HIs, was then developed based on this review. This resulting framework became basis for the subsequent analysis of public sector documents of the key sectors. Specific mentions and references to HIs and inter-sectoral collaboration were noted and analysed.

RESULTS: The findings reveal that, although the health implications of urban planning are generally acknowledged, explicit mentions to HIs are scarce. Furthermore, policies and strategies specifically targeting low-income and deprived communities were found to be minimal. Interventions tackling the behavioural, compositional explanations to HIs are the most prevalent, despite the continuous calls for investment on upstream, contextual interventions as suggested by the systematic reviews.

CONCLUSIONS: Inequalities, particularly in health, are clearly still widely overlooked in the UK urban planning context. Although tackling HIs cannot be concluded to give a platform for effective and efficient inter-sectoral collaborations to form, there is potential for it to be.

Keywords: built environment, policy, policy and practice, environmental disparities, health co-benefits.



ABSTRACT E-BOOK

P-045

Other » Other (to be specified with keywords in the keywords section)

Associations between nighttime aircraft noise exposure and insufficient sleep in the US-based prospective Nurses' Health Study cohort

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BACKGROUND AND AIM: Chronic sleep disturbances leading to short sleep duration have been linked to chronic diseases (e.g., cardiovascular disease, hypertension). Aircraft noise may contribute to sleep disruption, indicating a potential pathway to chronic disease. However, multivariable-adjusted and longitudinal relationships have infrequently been studied in a large sample of adults. This study investigates associations between nighttime aircraft noise and insufficient sleep in the US-based Nurses' Health Study (NHS).

METHODS: Nighttime aircraft noise levels (LAeqN) were modeled for 90 U.S. airports from 1995-2015 in 5-year intervals using U.S. Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT) and linked to geocoded participants' residential addresses for 2000, 2002, 2008, 2012, and 2014 (years when self-reported habitual sleep duration was available). Participants were classified as exposed if they lived at addresses with modeled LAeqN \geq 45 decibels (dB). Sleep duration was classified as insufficient if \leq 6 hours per night. A repeated measures analysis was conducted using generalized estimating equations. Multivariable models adjusted for participant-level demographics, behaviors, comorbidities, and ambient fine particulate matter.

RESULTS: In 2000, the 35,226 female participants were on average 66.1 years old. The proportion of participants with insufficient sleep varied from 29.6% in 2000 to 37.0% in 2014. The percent exposed to nighttime aircraft noise varied from 1.5% to 0.6%. In age-adjusted longitudinal models the odds of insufficient sleep were 33.1% higher (95% CI: 17.0%, 51.6%) for those exposed to nighttime aircraft noise compared with those not exposed, and the association remained after multivariable adjustment (25.3% higher odds; 95% CI: 10.1%, 42.7%).

CONCLUSIONS: Elevated nighttime aircraft noise was associated with shorter sleep duration in the NHS cohort. The relationship was robust after controlling for multiple confounders and with increased insufficient sleep and decreased aircraft noise exposure over time. Future research will investigate sleep quality as an additional sleep outcome.

Keywords: noise, epidemiology, environmental epidemiology



ABSTRACT E-BOOK

P-046

Built environment » General

Health Effects from Urban Stress in Women in Mexico City

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BACKGROUND AND AIM: Individuals in urban neighborhoods often face disproportionately higher levels of environmental and social stressors; however, the health effects from urban stressors remains poorly understood. We studied the association between urban stress and symptoms of depression, fatigue, and sleep disruption in a cohort of women in Mexico City.

METHODS: Participants included 343 women from the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) birth cohort in Mexico City. Women were administered the urban stress scale, where they were asked to rate their annoyance on select urban situations that city-dwellers face, such as unhealthy air, traffic, noise, lack of green space, and aggression. Six different constructs were summarized to create an overall continuous index and this was dichotomized at the median. Symptoms of depression were assessed at the same study visit using the Edinburgh Depression Scale; the NIH toolbox was used to assess fatigue and sleep disruption. Linear regression models were used to estimate the association with continuous symptoms comparing women with high urban stress to those with lower levels. Models were adjusted for socioeconomic status, education, age, body mass index, and social support.

RESULTS: High urban stress was associated with higher depressive symptoms (β : 1.50; 95% CI: 0.34, 2.65), fatigue (β : 2.18; 95% CI: 0.65, 3.71), and sleep disruption (β : 2.01; 95% CI: 0.45, 3.58). Associations were strongest among women who were highly annoyed by environmental concerns, including unhealthy air and lack of green space.

CONCLUSIONS: Urban stress plays an important role in women's psychological and physical health, highlighting the importance of including these measures in environmental health studies in urban settings.

Keywords: built environment, environmental justice, female, mental health outcomes, socio-economic factors, non-chemical stressors



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-047

Built environment » Light pollution

Artificial light at night and breast cancer risk: A systematic review and dose-response meta-analysis

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BACKGROUND AND AIM: Artificial lightning has been suggested to be one of the environmental risk factor of breast cancer onset and progression, based on epidemiologic evidence and biological plausibility. Possible mechanisms include DNA damage, impairment of melatonin and estrogens secretion, inflammation, and metabolic function.

METHODS: We performed a systematic review of the epidemiological studies examining the association between light-at-night (LAN) exposure and breast cancer risk and we modeled the shape of the relation using a dose-response meta-analysis. After performing an online literature search up to March 21, 2021, we retrieved 16 eligible publications, including eight cohort and eight case-control studies.

RESULTS: In analyses comparing highest versus lowest LAN exposure, there was a positive association between LAN exposure and disease risk (risk ratio (RR)=1.10, 95% confidence interval (CI): 1.06-1.14), with relatively consistent associations observed in case-control studies (RR=1.14, 95% CI: 0.98-1.34) and cohort studies (RR=1.10, 95% CI: 1.06-1.14). In stratified analyses, RRs were similar for outdoor and indoor LAN exposure, while a stronger RR was observed among premenopausal women, women in the BMI category 20-25 kg/m², and for estrogen-receptor positive breast cancer. The dose-response meta-analysis, implemented in studies investigating outdoor LAN only (for comparable exposure assessment), indicated a linear association with increasing risk up to 40 nW/cm²/sr after which a plateau was reached, especially among premenopausal women.

CONCLUSIONS: Overall, this first review assessing the dose-response relation between LAN and breast cancer generally supports a positive association.

Keywords: Light pollution, Cancer and cancer precursors, Environmental epidemiology, Non-chemical stressors



ABSTRACT E-BOOK

P-048

Other » Other (to be specified with keywords in the keywords section)

Scoping review of environmental urban health research in America and Europe, 1992-2020

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BACKGROUND AND AIM: Recent reports from United Nations estimate that the world population will reach 9.3 billion in 2050, 75% in urban areas. Until a couple of decades ago a growing interest in the field of urban health research could be observed. Among its topics environmental health has a leading role. The aim of this study was to explore bibliometric and methodological characteristics of scientific publications on Environmental Urban Health (EUH), in America and Europe during 1992-2020.

METHODS: A Scoping Review was conducted. Literature was searched in PubMed, Bireme-BVS Google Scholar, Redalyc and Dialnet databases, using as search terms: urban health, research, theory, methods, methodology, Social Determination of Health and Inequity. PRISMA guide was used to guarantee the quality and reproducibility of the search, selection and analysis protocol. A qualitative synthesis was carried out for the specific topic of EUH for type of research, country, journals and the study period.

RESULTS: 5177 manuscript were identified, of which 735 were selected. 285 of these corresponded to research on EUH. 74% were observational studies, 16% qualitative research, 13% case studies, and 13.5% mixed methods research. 40% were conducted in North America, 30% in Europe, 23% in Latin America, and 7% were multicenter. 67% of the Research Centers that published these manuscripts were from United States, Brazil, Canada, Spain and United Kingdom. 119 journals published articles on EUH during study period but only 6, published 30% of these. The highest proportion of publications was made between 2011 and 2020.

CONCLUSIONS: The epidemiological research is predominant in EUH field, with studies carried out and published mainly in North America. The publication has been carried out mainly in English-speaking journals, which implies cultural challenges and access to knowledge for the research and action agendas in urban environmental health for Latin America and other regions of the south.

Keywords: Environmental health, Urban Health, scoping review, America, Europe



ABSTRACT E-BOOK

P-049

Built environment » Noise

Land-Use Regression Estimation of Cumulative Environmental Noise Exposure in Jefferson County, Kentucky

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BACKGROUND AND AIM: Noise exposure is generally reported as year-round and source-specific. Recent studies, predominately outside of the US, have reliably estimated environmental noise with land-use regression (LUR). We estimated cumulative environmental noise exposure in Jefferson County, Kentucky via LUR for different seasons and time windows.

METHODS: Noise data were collected using a Class 1 sound level meter at 15 sites for 24 hours in January 2021 and April 2021. Noise data were averaged to represent combinations of season and time of day. LUR models were built based on prior literature and statistical thresholds using geographic predictors, such as Normalized Difference Vegetation Index (NDVI), length of streams, railways, and major roads within a buffer; distance to airports; hospitals and police stations; traffic volume and more. R² values assessed model fit and the leave-one-out cross validation and root-mean squared errors (RMSE) assessed the predictive ability.

RESULTS: Models resulted with R² values ranging from 0.50 to 0.73 and RMSE values between 4.57 and 6.49 decibels. NDVI and distance to flightpaths were consistent predictors of noise across seasons and time windows. Compared to living within 1 km of flightpaths, living further away resulted in lower noise estimates (beta coefficient range: -0.99 to -4.86). A 0.1 increase in NDVI resulted in lower noise estimates (coefficients range: -2.01 to -5.97). Length of major roads (beta=1.5 95% CI -3.3, 6.4) and streams (beta=-4.1 95% CI -13.0, 4.9) were predictors of January noise. Traffic volume and railroad length were positive predictors of April noise but not January noise. Noise was approximately 10 decibels louder in April than in January.

CONCLUSIONS: Multiple models may be needed to estimate environmental noise for varying seasons and times when considering total ambient noise exposures. Consideration of other noise sources (ex. NDVI, streams) in noise LUR models is warranted in future work.

Keywords: Noise, spatial statistics, modeling, exposure assessment, environmental epidemiology



ABSTRACT E-BOOK

P-050

Chemical exposures » Heavy metals

Environmental Exposure to Manganese and Motor Function in Adults

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BACKGROUND AND AIM: Santander, the capital of Cantabria, Spain (172,000 inhabitants) is 7 km from an industrial emission source of Mn (IES) located in a 10,000 inhabitants town (Maliaño) (annual arithmetic air Mn mean=231.8 ng/m³; reference WHO guideline=150 ng/m³). Our objective was to compare the motor function of adult healthy volunteers living in both places.

METHODS: Cross-sectional study analyzing 130 consecutive participants: 95 women and 35 males, mean age 41.72; SD=14.0 years. Motor function was assessed by the Grooved Pegboard (GP) (the more seconds, the worse function) and by the Finger Tapping Test (FTT) (the less tapings, the worse function). Distance from the IES was categorized into “≤1.5 km” versus “>1.5 to <10 km from the IES”. For personal samplers (PS) and biomarkers assessment, exposures were dichotomous categorized according to medians (blood, hair and fingernails medians=9.58 µg/L; 185.31 and 555.28 ng/g respectively).

RESULTS: Regarding GP, overall mean time to complete the test was 59.31 and 65.26 seconds (SD=10.11 and 11.69) for dominant and non-dominant hands respectively. Statistically significant higher times (indicating worse function) were observed when living near the IES in both hands (p = 0.024 and 0.014 respectively). Regarding Mn levels in their PS (in both bioaccessible and non-bioaccessible coarse&fine fractions) higher times were computed in participants with higher levels, but yielding statistical significance only for the bioaccessible-fine fraction. Regarding FTT, the mean number of finger tapings per 10 seconds was 68.27 and 60.25 seconds (SD=11.32 and 11.72) respectively. No statistically significant differences were found for exposure indices.

Regarding biomarkers, statistically significant higher times in GP and lower tapings in the FTT were observed in participants with higher Mn Fingernails levels.

CONCLUSIONS: Our results support poorer motor function as assessed by GP test according to exposure indices, especially in terms of proximity to IES and Mn Fingernails levels.

Keywords: Heavy metals, Neurodevelopmental outcomes, Neurodegenerative outcomes, Particulate matter, Biomarkers of exposure



ABSTRACT E-BOOK

P-051

Chemical exposures » Heavy metals

Environmental Exposure to Manganese and Cognitive Function According to the STROOP Test

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BACKGROUND AND AIM: Santander, the capital of Cantabria, Spain (172,000 inhabitants) is 7 km from an industrial emission source of Mn (IES) located in a 10,000 inhabitants town (Maliaño) (annual arithmetic air Mn mean=231.8 ng/m³; reference WHO guideline=150 ng/m³). Our objective was to compare the cognitive function of adult healthy volunteers living in both places.

METHODS: Cross-sectional study analyzing 130 consecutive participants: 95 women and 35 males, mean age 41.72; SD=14.0 years. Cognitive function was assessed by the STROOP Word Color test and crude scores were standardized according to NEURONORMA norms (by age and study levels). Distance from the IES was categorized into “≤1.5 km” versus “>1.5 to <10 km from the IES”. For personal samplers (PS) and biomarkers assessment, exposures were dichotomous categorized according to medians (blood, hair and fingernails medians=9.58 µg/L; 185.31 and 555.28 ng/g respectively).

RESULTS: Overall mean scores were 10.51; 10.38 and 10.69 (SD=2.67; 2.59; 2.77) for the Word, Color and Word&Color combined parts respectively. Statistically significant lower scores in the word part (indicating worse function) were observed when living near the IES, and with higher levels of Mn in their PS (in both bioaccessible and non-bioaccessible coarse&fine fractions). Regarding the other STROOP parts, significant lower scores were obtained for source distance, but only when restricting to the bioaccessible fraction of coarse&fine modes.

Regarding biomarkers, non-statistically significant differences in participants with higher Mn-Scalp Hair and Fingernails levels were found for the word part, yielding statistical significance in the other parts. For Mn-Blood levels, higher cognitive punctuations were observed (contrary to our hypothesis), yielding significance for the Word&Color Part (p= 0.023).

CONCLUSIONS: Our results support poorer cognitive function as assessed by STROOP test according to exposure indices, especially in terms of proximity to IES. According to biomarkers results, evidence is less suggestive, especially in relation to Blood Mn levels.

Keywords: Heavy metals, Neurodevelopmental outcomes, Neurodegenerative outcomes, Particulate matter, Biomarkers of exposure



ABSTRACT E-BOOK

P-052

Chemical exposures » Heavy metals

Legacy sources to new exposures. A preliminary lead risk assessment to children in the Falun mining area

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BACKGROUND AND AIM: Like many of Sweden's metropolitan areas, the city of Falun faces a shortage of affordable housing. The city's proximity to a historic copper mine presents unique challenges for the growing high-density service and industrial area. Concerns about the feasibility and risks associated with building new housing on land contaminated by the legacy of mining and metal industries motivate a new risk assessment using current reference values for lead.

The aim of this project is to undertake a preliminary environmental health-based risk assessment on the lead levels surrounding the mining area, based on previous samples (dust, soil, biomarkers).

METHODS: We use environmental samples and research done in Falun from 1986 to 1998 to predict blood lead levels (BLL) today by employing the Integrated Exposure Uptake Biokinetic (IEUBK) software. We further compare calculated to measured BLL from 1993 and to current threshold values from Environmental Protection Agency (EPA) and the Scientific Committee on Health and Environmental Risks (SCHER).

RESULTS: The average measured BLL for children <4 years is 3.7 µg/dL and >4 years is 2.8 µg/dL. IEUBK BLL estimates are 1.2-1.4 µg/dL and 0.9-1.1 µg/dL, respectively. Both averages are below the 5 µg/dL threshold used by EPA, and higher or equal than the 1.2 µg/dL associated with the 0,5 µg/dL bodyweight/day tolerable daily intake.

CONCLUSIONS: Based on measured and calculated BLL, the exposure exceeds currently acceptable safe levels. However, samples were taken before the ban on leaded gasoline in Sweden in 1994, but also around active mining and smelting. Furthermore, the lead from mining operations in Falun has low bioavailability 0.5%-2%. The lead in the respirable fraction is more associated with smelting operations and leaded gasoline, which have not existed for almost 30 years. Together, these factors result in a possible overestimation of the current lead exposure to children in Falun.

Keywords: Built environment, Heavy metals, Exposure assessment-biomarkers of exposure, Risk assessment, Children's environmental health



ABSTRACT E-BOOK

P-053

Chemical exposures » Heavy metals

Gene-Environment Joint Linkage and Association Analysis of Arsenic Exposure and Diabetes-Related Traits in the Strong Heart Family Study

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BACKGROUND AND AIM: Inorganic arsenic exposure is of increasing interest as a possible risk factor for diabetes, and although there is growing research on potential toxicological mechanisms, the biology remains incompletely understood.

METHODS: This is a cross-sectional, gene-environment interaction study using data from n=1,915 participants from 40 pedigrees in the Strong Heart Family Study with measured arsenic exposure (sum of inorganic and methylated urine arsenic species, dichotomized for analysis), age, sex, educational attainment, body mass index, genotypes, family relationships, fasting glucose, HOMA-IR, and HOMA-B. We conducted a multipoint variance components linkage analysis testing for arsenic-locus interactions (GxE) predicting glucose, HOMA-IR, or HOMA-B in separate models, adjusted for potential confounders of the arsenic-outcome relationships. We then tested for SNP-trait associations and SNP GxE in linkage regions. Analyses were implemented using the software Sequential Oligogenic Linkage Analysis Routines (SOLAR).

RESULTS: We localized three quantitative trait loci that showed suggestive evidence for differential genetic contributions to the outcome in the presence of higher vs. lower inorganic arsenic exposure. The first was an interaction locus for fasting glucose at chromosome 17q22 (LOD 2.6 in GxE model, LOD 1.5 in standard linkage model without interaction). The second was an interaction locus for HOMA-IR at chromosome 7p13 (LOD 2.0 in GxE model, 0.4 in the standard linkage model). The third was an interaction locus for HOMA-B at chromosome 18q22.2 (LOD 2.0 in GxE model, LOD 1.7 in standard linkage model). Several SNPs showed Bonferroni-significant associations with diabetes-related traits, with the strongest evidence for rs4793861 in the MSI2 gene for glucose; however, no tested SNPs showed Bonferroni-significant interactions with arsenic.



ABSTRACT E-BOOK

CONCLUSIONS: We found suggestive evidence for different locus-specific contributions to diabetes trait variability in the presence of higher inorganic arsenic exposure, and SNPs in these regions that were associated with diabetes traits. Further research (e.g., linkage fine-mapping) might further elucidate this biology.

Keywords: Environmental Epidemiology, Toxicology, Heavy Metals



ABSTRACT E-BOOK

P-054

Chemical exposures » Heavy metals

Urinary Heavy Metals and Longitudinal Changes in Blood Pressure in Midlife Women: the Study of Women's Health Across the Nation

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BACKGROUND AND AIM: Environmental exposure to heavy metals may contribute to increased blood pressure, however, evidence from midlife women who are at greater risk of cardio-metabolic disease, is limited. We evaluated the associations of urinary concentrations of arsenic, cadmium, mercury, and lead with longitudinal changes in blood pressure in the Study of Women's Health Across the Nation Multi-Pollutant Study.

METHODS: The sample included 1,317 White, Black, Chinese and Japanese women, aged 45-56 years at baseline (1999-2000), whose systolic and diastolic blood pressure (SBP and DBP) were measured annually or biannually through 2017. Urinary metal concentrations were determined at baseline. Longitudinal changes in SBP and DBP were modeled using linear mixed effects models by tertiles of metal concentrations.

RESULTS: After multivariable adjustment, estimated annualized increases (95% CI) in SBP in the highest and lowest tertiles were 0.93 (0.85, 1.01) mmHg and 0.74 (0.66, 0.82) mmHg for arsenic, 0.82 (0.75, 0.90) mmHg and 0.72 (0.65, 0.80) mmHg for mercury, and 0.86 (0.78, 0.93) mmHg and 0.72 (0.64, 0.79) mmHg for lead, respectively. Similar results were observed for associations of arsenic, mercury, lead with DBP. Urinary cadmium was associated with a greater rate of increase in SBP only among never smokers. Women with higher concentrations of all four metals had greater annualized increases in SBP and DBP than those with lower concentrations.

CONCLUSIONS: Our findings suggest that exposure to heavy metals may accelerate the increase in blood pressure in midlife women, supporting the need for continued efforts to reduce these environmental exposures.

Keywords: Metals, blood pressure, women, cohort study



ABSTRACT E-BOOK

P-055

Outcomes » Childrens environmental health

Lead exposure in infancy and subsequent growth in childhood

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BACKGROUND AND AIM: Studies suggest that elevated postnatal blood lead levels (BLL) are negatively associated with child growth. None has examined this association in African populations where the prevalence of malnutrition is high. This study aimed to investigate associations of childhood BLL at age 1 and growth outcomes at age 6 in a cohort of children in Allada, Benin.

METHODS: We assessed children for lead in whole blood in 661 children at 12 months and followed them until 6 years (+/- 0.17). Weight, height and head circumference were assessed at a maternity clinic by trained staff at different age points between birth and 6 years. Weight-for-age Z-score (WAZ), height-for-age Z-score (HAZ) and BMI for-age Z-score (BMIZ) were then calculated from modeled individual postnatal growth trajectories from repeated measures of weight and height. Univariate and multivariable regression models examined associations between blood lead levels and growth outcomes with adjustment for potential confounders.

RESULTS: The geometric mean of BLL was 59.3 (95% CI: 56.6 - 62.0) and 58.1% of children presented with BLL > 50 µg/L. Mean WAZ, HAZ, BMIZ and head circumference (HC) in children at age 6 years were -1.24 (+/- 0.78), -0.31 (+/- 0.83), -1.65 (+/-0.87) and 49.9 cm (+/- 1.8), respectively. Overall, there were few associations between BLL and child growth. In boys only, BLL was associated with HC at age 6 in the crude model, but this association was weaker after adjustment for confounding factors ($\beta = -0.38$ cm [95% CI: -0.83, 0.08]). A negative association was observed between BLL at age 1 and HAZ at age 6 in girls, but this association was weaker after adjustment ($\beta = -0.11[-0.27, 0.03]$).

CONCLUSIONS: We found no evidence of a relationship between BLL and physical growth in children living in a resource-poor setting with a high prevalence of undernutrition.

Keywords: Heavy metals Outcomes



ABSTRACT E-BOOK

P-056

Chemical exposures » Heavy metals

Indoor particulate matter linked toxic metals in low socio-economic communities

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BACKGROUND AND AIM: Metals such as copper (Cu), arsenic (As), cadmium (Cd) and lead (Pb) constitute significant potential threats to human health. The aim of this study was to determine the particulate matter (PM) linked toxic metals, the within- and between- home variability of toxic metals and the predictors of this variation in the homes of women participating in the Mother and Child in the Environment (MACE) cohort study.

METHODS: Indoor PM_{2.5} measurements were undertaken in 30 homes (four samplings per home) using MiniVol samplers, in both warm and cold seasons of 2017-2018. A structured walkthrough questionnaire was used to collect information on home materials, occupant activities and outdoor sources. PM linked toxic metals were assessed from indoor PM_{2.5} filters using wavelength-dispersive x-ray fluorescence (WD-XRF) technique. Linear mixed-effects models were applied to investigate the determinants of PM linked toxic metals, along with within- and between- home variance components.

RESULTS: The mean (SD) for levels of toxic metals was 817(30), 249(37), 419(249) and 749(98) ng/m³, respectively for Cu, As, Cd and Pb. Informal homes had significantly higher (315ng/m³) As levels than formal homes (278ng/m³) (P <.05). Homes situated in close proximity to industries (700m) had significantly higher Pb levels (802ng/m³) compared to homes situated further away (741ng/m³) (P <.05). The Cu levels were significantly higher in homes situated near other pollutant generating activities (i.e. construction and field fires) (828ng/m³) compared to homes situated further away (814ng/m³) (P <.05). The within-home variation accounted for a more substantial part of the total variability, Cu(81%), As(93%), Cd(99%) and Pb(92%). A reduction in within-and between- home variability were shown after adding season, outdoor, occupant and household characteristics.

CONCLUSIONS: This study showed the presence of toxic metals in indoor environments of low socio-economic communities. The levels of toxic metals were higher than the levels reported in studies conducted in similar communities.

Keywords: particulate matter linked toxic metals, indoor exposure, mixed-effects model



ABSTRACT E-BOOK

P-057

Chemical exposures » Heavy metals

Environmental exposure to lead and risk of subclinical atherosclerosis

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BACKGROUND AND AIM: Lead exposure is associated with an increased risk of cardiovascular mortality. Atherosclerosis has been hypothesized to be one mechanism underlying this association. Recently, we showed an association between blood lead and risk of carotid plaque in a Swedish cohort recruited in the 90's. The aim of the present study was to confirm our previous findings in a more recent Swedish cohort with lower lead exposure levels.

METHODS: This cross-sectional study was based on the population-based Swedish CardioPulmonary Image Study (SCAPIS), and included 5627 men and women (50-64 years of age), enrolled 2013-2018. Blood lead (B-Pb), measured by inductively coupled plasma mass spectrometry, was used as exposure biomarker (in quartiles). The presence of atherosclerotic plaque in the carotid arteries was determined by ultrasonography. Associations between B-Pb and the risk of plaque was analysed using Poisson regression to estimate prevalence ratios (PR) in models adjusted for age, sex, LDL/HDL ratio, diabetes mellitus, waist circumference and smoking status.

RESULTS: The prevalence of atherosclerotic plaques was 57% and the median B-Pb concentration was 14 µg/L (range: 0.75-203). Individuals in the fourth quartile of B-Pb (Q4) as compared with the first quartile (Q1), had a PR for plaque of 1.08 (95%CI: 1.01, 1.16), which was slightly higher among men (PR 1.11; 95%CI: 1.02, 1.20). PRs were weaker and non-significant among women (PR 1.06; 95%CI: 0.95, 1.17). Among never-smokers, associations were mostly non-significant, except for women in Q3 (PR 1.29; 95%CI: 1.09, 1.53).

CONCLUSIONS: Blood lead in the highest quartile was associated with a slightly increased risk of carotid plaque in this sample of the general population with lead concentrations comparable to those in other European countries and the U.S. Our study provides some support for the hypothesis that atherosclerosis is one of the mechanisms underlying the association between lead and cardiovascular disease.

Keywords: heavy metals, cardiovascular diseases, chemical exposures, environmental epidemiology



ABSTRACT E-BOOK

P-058

Chemical exposures » Heavy metals

Uranium and metal concentrations in community water systems across the United States, 2006-2011

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BACKGROUND AND AIM: The US Environmental Protection Agency (EPA) sets maximum contaminant levels (MCLs) for 9 metals/metalloids in public drinking water systems. Beyond arsenic, no nationwide exposure estimates for public drinking water currently exist for these contaminants. Our objective was to estimate exposure to metals in community water systems (CWSs) across the US, to determine if sociodemographic or regional inequalities in these exposures exist, and to identify patterns of exposure for these metals as a mixture.

METHODS: We evaluated routine compliance monitoring records for antimony, barium, beryllium, cadmium, chromium, mercury, selenium, thallium, and uranium collected from 2006-2011 (2000-2011 for uranium) by the US EPA in support of the Third Six Year Review for 37,915 CWSs. We focused our analysis on barium, chromium, selenium, and uranium (as arsenic has been reported previously and other metals were mostly undetected), comparing the mean contaminant concentration and the percent of CWSs with MCL exceedances across subgroups (US region, sociodemographic county-cluster, size of population served, source water type, and correctional facilities). We evaluated patterns in metal exposure profiles via hierarchical cluster analysis, which also included published CWS arsenic estimates.

RESULTS: The percentage of CWSs exceeding the MCL was highest for uranium (3.1% > MCL of 30 µg/L, nationwide mean 4.37 µg/L), but lower than previously reported arsenic (2.6%). 75th, 95th percentiles for uranium, chromium, barium, and selenium concentrations were highest for CWSs serving *Semi-Urban*, *Hispanic* communities, small CWSs, CWSs reliant on groundwater, and those located in the Southwest, similar to previous CWS arsenic findings. Hierarchical cluster analysis revealed four clusters, including an arsenic-uranium-selenium cluster.

CONCLUSIONS: *Semi-Urban*, *Hispanic* communities experience higher average concentrations of metal contaminants, including uranium and arsenic, in public drinking water. Uranium is an under-recognized contaminant in CWSs. Cluster analyses revealed that arsenic and uranium may co-occur in groundwater sources serving CWSs.

Keywords: exposure, environmental justice, environmental disparities, water quality



ABSTRACT E-BOOK

P-059

Chemical exposures » Heavy metals

Health Risk Assessment, Pollution Indices and Ecological Risk of Chemical Elements in Dust and Soils of Warri Metropolis, Southern Nigeria

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BACKGROUND AND AIM: Adverse health effects have been linked with human exposure to chemical contaminants via diverse environmental pathways. This study assessed pollution levels, ecological risk and health risk of chemical elements in dust and soils of Warri Metropolis, Southern Nigeria. **METHODS:** Forty topsoil and settled dust samples were collected from ten sampling sites and analysed for chemical elements using Inductively Coupled Plasma Mass Spectrophotometry. The results were subjected to descriptive and inferential statistical analysis. Pollution Index (PI), Ecological Risk Index (ERI), Nemerov Integrated Pollution Index (NIPI) and Health Risk [Hazard Quotient (HQ) and Cancer Risk (CR)] were also calculated.

RESULTS: Results revealed high concentrations (mg/kg) of Cu (2.1-38.4), Zn (21.4-268.0), Ag (0.015-2.720), Hg (0.09-0.51), P (120-1230) and B (3.0-7.0) in dusts; and Cu (1.0-42.7), Zn (6.2-492.0), Ag (0.016->100), Hg (0.05-0.33), P (30-1960) and B (3.0-5.0) in soils. Cu, Zn, Hg and P concentrations were highest and exceeded permissible limits in poultry farm dusts and Pessu soils. PI indicated very strong pollution ($P1 > 5$) for Ag and low pollution ($P1 > 1$) for Zn and Pb. Heavy pollution ($NIPI > 3$) in Effurun-Sapele road and Ekpan dusts was attributed to heavy metals. ERI revealed moderate risk for heavy metals in Igbudu market dusts and Pessu soils while other locations had low risks. Non-carcinogenic health risk evaluation showed HQs greater than 1.0 for V, Cr, Mn, Fe, Co, Cu, Zn, Pb, As, Al and Ca, signifying adverse health effects. The CRs of As, Cr, Cd, Ni and Co for children and; Cr and Co for adults were higher than the acceptable limit of 1.0×10^{-4} , suggesting probable development of cancer.

CONCLUSIONS: This study established the occurrence of dust and soil pollution by chemical contaminants from industrial emissions, vehicular sources and open-dumping. The chemical element concentrations pose carcinogenic and non-carcinogenic risks to children and adult residents of the study area.

Keywords: Chemical exposures, Heavy metals, Risk assessment, Cancer and cancer precursors, Children's environmental health



ABSTRACT E-BOOK

P-060

Chemical exposures » Heavy metals

Evaluation of the proteomic profile in saliva of brazilian home-based and informal workers

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BACKGROUND AND AIM: The Brazilian city of Limeira consolidates a pole of jewelry production with homemade and informal processes of assembly, welding, and electroplating, constituting a scenario of outsourced services. These processes can expose workers to potentially toxic elements (PTE: Hg, Pb, Ni, Cd, Zn, As, Cu, Cr, and Sn), and the productive chain encompasses the related families. This study aimed to evaluate the effects of PTE exposure on protein expression performing a proteomic approach.

METHODS: Saliva samples were collected from 26 individuals, Welders Group (n=13) and Control Group (n=13). Blood PTE levels were determined by ICP-MS and saliva samples' proteins by UPLC coupled to a mass spectrometry (Q-TOF), shotgun runs. Bioinformatics analysis was performed using PEAKS Studio 8.5.

RESULTS: Significant differences were found for Sn ($p < 0.000004$) and Cu ($p < 0.0005$) concentrations between the groups. In total, 979 proteins were identified in both groups and, removed the proteins with fifty percent of missing values, and substituted by mean values, 411 proteins. The data was autoscaled, then performed the multivariate analyses using MetaboAnalyst 4.0. Principal components analyses and partial least square discriminate analysis showed a group separation. By t-student test performed, we found 40 significant proteins ($p < 0.05$). Gene ontology analysis showed biological processes more represented for viral transcription, maintenance of cell polarity, nuclear-transcribed mRNA catabolic process, and nonsense-mediated decay. Pearson correlation showed 28 significant proteins correlated with metals ($p < 0.05$). ARP2 and 1433G proteins were correlated with Pb and Sn. IF4A1, ARF6, RS10, PLBL1 and RS9 correlated with Sb. The proteins MNDA, CRBG1, RAB5B, SAP, LV39, NUCB1, CAPZB, HV64D, IMB1, ARP3, LV743, SPR1A, HV459, HV461, HVD82, HVD34, DDX3X, CDC42, PDIA6, CAN1, TM11D, ARG1, FLNB correlated with Sn. We found 16 of these proteins with greater expression in the Welders group.

CONCLUSIONS: The informal, home and outsourced work performed by welders is influencing their internal exposome.

Keywords: Proteomics, toxic elements, informal work.



ABSTRACT E-BOOK

P-061

Chemical exposures » Heavy metals

Cadmium exposure and risk of prediabetes and diabetes: A systematic review and dose-response meta-analysis

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BACKGROUND AND AIM: Elevated cadmium exposure has been associated with altered glucose metabolism, albeit the shape of such relation is still debated. We aimed at investigating the shape of the relation between cadmium exposure and type 2 diabetes and prediabetes.

METHODS: We performed a systematic review with meta-analysis on the relation between biomarkers of cadmium exposure and disease risk. After performing an online literature search through March 15, 2021, we identified 34 eligible studies with cohort, cross-sectional and case-control design.

RESULTS: In the meta-analysis comparing highest-versus-lowest cadmium exposure, there was an increased type 2 diabetes risk, with summary risk ratios (RRs) of 1.30 (95% confidence interval (CI): 1.00-1.69), 1.22 (95% CI 1.00-1.50), and 1.47 (95% CI 1.01-2.13) for blood, urine, and toenail cadmium concentrations, respectively. Similarly, we found a higher prediabetes risk in subjects with higher both urine and blood cadmium concentrations with RRs of 1.41 (95% CI 1.15-1.73) and 1.38 (95% CI 1.16-1.63), respectively. In the dose-response meta-analysis, compared with no exposure, prediabetes risk increased up to approximately 2 µg Cd/g creatinine, above which it reached a plateau with RR of 1.40 (95% CI 1.12-1.76) at 2 µg Cd/g creatinine. We also detected a substantial linear positive association between diabetes risk and urinary cadmium, with RR of 1.30 (95% CI 0.92-1.84) at 2.0 µg Cd/g creatinine. Diabetes risk also appeared to increase with higher blood cadmium concentrations but only above 1 µg/L, with RR of 3.25 (95% CI 1.13-9.37) at 2 µg/L. Despite limited data, there was little indication of differences in association by study design (cohort vs. case-control or cross-sectional), method of cadmium assessment, or sex (male vs. female).

CONCLUSIONS: Overall, there was consistent evidence for a positive association between cadmium exposure and both prediabetes and diabetes risk.

Keywords: Heavy metals, Cardiovascular diseases, Endocrine disrupting chemicals, Environmental epidemiology, Toxicology



ABSTRACT E-BOOK

P-062

Chemical exposures » Heavy metals

Exposure of the Portuguese adult population to arsenic: preliminary results of a human biomonitoring study

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BACKGROUND AND AIM: Although arsenic is an element naturally present in the environment, it is highly toxic in its inorganic forms. Exposure can occur through consumption of drinking water and contaminated food. Long-term exposure was shown to be associated with negative health outcomes. Nevertheless, data on the Portuguese population's exposure to arsenic is scarce. As such, the aim of this work was to assess the exposure to Arsenic in the Portuguese population using samples collected in the study "Exposure of the Portuguese Population to Environmental Chemicals: a study nested in INSEF 2015" (INSEF-ExpoQuim), developed as an aligned study of the European Human Biomonitoring Initiative (HBM4EU).

METHODS: INSEF-ExpoQuim was an epidemiologic study nested in INSEF 2015 including 270 participants aged 28-39 years, living in Portugal for more than 12 months and able to follow an interview in Portuguese. Fieldwork was developed between June 2019 and February 2020. First morning urine samples were collected along with data on socio-demographic characteristics, living conditions and residential history, habits/lifestyle, nutrition, health, occupation and substance specific information covering nearly all exposure pathways. Procedures followed the guidelines of the HBM4EU project. Total urinary arsenic is currently being determined by inductively coupled plasma mass spectrometry.

RESULTS: Preliminary results for 38 samples yielded total urinary arsenic concentrations ranging from 11 to 462 µg/L with an average of 86 ± 94 µg/L. After completion of the determination of the urinary arsenic levels for all the samples a complete analysis of the data will be performed.

CONCLUSIONS: Results from this study will contribute to the knowledge on the Portuguese population's exposure to arsenic and may support the development and implementation of policy measures aimed at minimizing exposure to this chemical and improving the health of the population.

Keywords: Heavy metals, Biomarkers of exposure, Chemical exposures, Environmental epidemiology,



ABSTRACT E-BOOK

Exposure assessment, Exposures

P-063

Chemical exposures » Heavy metals

Mercury levels in a sample of the population in Southern Bolívar - Colombia at risk of environmental exposure

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BACKGROUND AND AIM: Mercury contamination is a relevant problem today, due to the toxic effects it can have, ranging from cancer to nervous system disorders. Artisanal gold mining is an important source of mercury, due to the vapors from the process and the discharge into soils and bodies of water, reaching other trophic chains, biomagnifying and affecting humans

METHODS: This research aimed to determine the serum levels of total mercury and methylmercury in a population under 18 years of age in the south of Bolivar in municipalities such as Barranco de Loba, Pueblo Mejia and Mina Azul in the Department of Bolivar - Colombia As a sampling technique, the protocol for collecting DBS (Dried Blood Spots in 19 inhabitants was implemented and static analysis was performed.

RESULTS: The results showed methylmercury levels of 0.490–11.616 mcg/L, inorganic mercury of 0.302–7.120 mcg/L and total mercury of 1.844–13.772 mcg/L, values above the reference data (United States Environmental Protection Agency). In addition, a strong association was found between age, proximity to the river and total mercury concentrations.

CONCLUSIONS: Note that these are preliminary studies, however, they alert future consequences that may be presented by the population vulnerable to this type of contamination.

Keywords: Heavy metals, Water quality, Exposures, Cancer and cancer precursors



ABSTRACT E-BOOK

P-064

Chemical exposures » Heavy metals

Presence of elements associated with e-waste in teenagers living in Alcalá de Henares (Spain)

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BACKGROUND AND AIM: Electronic and technological waste (e-waste) is growing fast in parallel with economic and technological development. Inappropriate disposal or processing of e-waste can have severe implications for the environment, with unknown harmful effects in humans. As a result, a human monitoring programme was performed to determine the exposure to elements commonly found in technology, specifically silver (Ag), antimony (Sb), bismuth (Bi) and neodymium (Nd), in Alcalá de Henares (Community of Madrid, Spain).

METHODS: Scalp hair was collected from 96 adolescents (13-16 years-old; 28 boys and 68 girls) living in Alcalá, who were recruited following strict selection criteria to minimise the effect of confounding factors. Elements were analysed by ICP-MS in processed samples following appropriate methodologies. Data was processed using statistical methods applied to censored data available in the 'NADA' statistical package.

RESULTS: The concentrations in scalp hair were as follows [data is presented as median and interquartile range (IQR) in µg/g]: Ag 0.065 (0.030, 0.222), Sb 0.009 (0.006, 0.015) and Bi 0.002 (0.001, 0.005). As Nd was detected only in 3.1% of the monitored samples, only the 97.5th percentile is provided for this element (0.013 µg/g). Only the levels of Ag showed sex dependency ($p < 0.001$), being higher in female participants (median values; 0.103 vs. 0.036), which is in agreement with the literature. The presence of these elements were lower relative to those reported in scalp hair from young adults from the Community of Madrid and also Italy, which indicate that Alcalá's adolescents would have not been generally exposed to e-waste. Our results also might indicate minimal exposure to Nd, as the range found (0.015-0.030 µg/g) was much lower than that reported in exposed Chinese adolescents aged 11-15 (0.09-5.27 µg/g).

CONCLUSIONS: Adolescents living in Alcalá de Henares should be regarded as a neglected risk group for e-waste exposure.

Keywords: E-waste, human hair, monitoring, Spanish teenagers, exposure.



ABSTRACT E-BOOK

P-065

Chemical exposures » Heavy metals

Are children exposed to light rare earth elements in urban environments?

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BACKGROUND AND AIM: Human biomonitoring can provide invaluable information on exposure of a specific population to chemical pollutants to appropriately manage the threat. The aim was to identify whether children living in Alcalá de Henares, one of the biggest populated cities in the Community of Madrid (Spain), are exposed to rare earth elements (REEs), specifically cerium (Ce) and neodymium (Nd).

METHODS: Scalp hair was collected from 120 children (6 to 9-years-old; 50 boys, 70 girls). Ce and Nd were analysed by ICP-MS after appropriate removal of exogenous contamination. Data was processed using different statistical models according to the detection frequency with the support of the 'NADA' statistical package.

RESULTS: The limits of detection were (in µg/g): Ce (0.0048) and Nd (0.0028). Both REEs were detected in almost all the hair samples monitored (78.8% & 71.7%, respectively), which would suggest a general exposure to these contaminants as they have been poorly detected in scalp hair from other groups of population living in the Comunidad de Madrid. Concentrations are provided as median and interquartile range in µg/g: Ce 0.011 (0.005, 0.017) and Nd 0.004 (<0.0028, 0.007). Both REEs did not show sex dependency, but Ce showed statistical significance according to zones of residency ($p < 0.01$); the mean concentration of Ce was lower in children's hair living in areas with a higher density of green areas than in those with higher number of buildings/industrial activities (0.008 vs 0.014 µg/g).

CONCLUSIONS: Alcalá's children population have not been significantly exposed to Ce and Nd, as levels of Ce and Nd in scalp hair were of the same order of magnitude as those reported in the literature in non-exposed children. However, the implementation of interventions to minimise the environmental exposure REEs in Alcalá might be needed, as these can affect the physical growth and development, function of immune system and intelligence in children.

Keywords: Cerium, neodymium, human hair, monitoring, Spanish children, exposure.



ABSTRACT E-BOOK

P-066

Neurologic and Mental Health Outcomes » Neurodegenerative outcomes

Low-dose oral pyrethroid exposure induces gastrointestinal dysfunction and alters nigrostriatal dopamine signaling pathways in mice

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BACKGROUND AND AIM: Insecticide exposure is associated with greater risk for developing Parkinson's disease (PD). PD is characterized by motor impairments due to loss of nigrostriatal dopamine (DA) neurons in the midbrain, and patients commonly experience gastrointestinal (GI) dysfunction long before the onset of motor symptoms. Pyrethroids, synthetic insecticides commonly used around the world, disrupt DA signaling pathways. One of the most common routes of pyrethroid exposure is ingestion, so it is plausible that oral exposure acts locally within the GI tract and facilitates PD pathogenesis via the gut-brain axis. Here, we sought to determine the functional and molecular consequences of oral pyrethroid exposure in the adult mouse gut and brain in the context of idiopathic PD.

METHODS: Adult mice were orally gavaged with 3 mg/kg deltamethrin weekly for 3 weeks. Intestinal behaviors were assessed to determine constipation phenotypes. Gut microbiome composition was determined by 16S rRNA sequencing. Intestinal and brain tissues were collected following the final dose to assess changes in gene expression and protein production pathways related to DA and other monoamine signaling, as determined by qPCR and western blot.

RESULTS: Oral deltamethrin exposure significantly impaired GI function compared to vehicle controls. We observed reduced fecal output, changed gene and protein levels important for normal gut function, and altered gut microbial composition in deltamethrin-exposed mice, all of which are reflective of changes observed in PD patients. In the brain, oral deltamethrin exposure significantly altered production of proteins important for DA synthesis and reuptake compared to controls.

CONCLUSIONS: Low-dose oral pyrethroid exposure induces GI dysfunction and alters DA pathways in the brain. These findings support the idea that pyrethroids induce functional and molecular changes relevant to PD pathology from within the gut, and further investigation is warranted to fully understand this phenomenon as a potential trigger in the etiology of PD.

Keywords: Pesticides, Chemical exposures, Neurodegenerative outcomes, Microbes/Microbiome



ABSTRACT E-BOOK

P-067

Neurologic and Mental Health Outcomes » Mental health outcomes

Associations of prenatal organochlorine and metal exposures with anxiety and depressive disorder diagnoses in the New Bedford Cohort

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BACKGROUND AND AIM: The extent to which chemical exposures influence mental health has not been well characterized. We evaluated associations of anxiety and depressive disorder diagnoses with prenatal organochlorine and metal exposures, considering effect modification by quality of the home environment.

METHODS: Participants were 172 adults (19-25 years), from a prospective cohort recruited at birth (1993-1998) in New Bedford, Massachusetts. Hexachlorobenzene, p,p'-dichlorobiphenyl dichloroethylene (p,p'-DDE), polychlorinated biphenyls (Σ PCB4), lead, and manganese levels were analyzed in cord serum or blood. Physician-diagnosis of an anxiety or depressive disorder in the past ten years was ascertained via self-reported medical history. We estimated covariate-adjusted risk ratios, overall and in strata of adolescent Home Observation for Measurement of the Environment (HOME) score, using complete case and inverse probability weighting (IPW).

RESULTS: In our socioeconomically diverse cohort (22% Non-White; 30% household income <\$20,000 at birth), chemical concentrations were consistent with background exposure levels. Higher prenatal p,p'-DDE was associated with increased risk of anxiety and depressive disorder diagnoses, with effect modification by HOME score. For example, a doubling of cord serum p,p'-DDE was associated with 1.51 increased risk [95% confidence interval (CI): 1.08, 2.11] of anxiety in those with higher quality home environments and 0.67 lower risk (95% CI: 0.45, 1.00; p-interaction=0.01) in those with poorer HOME scores. This effect modification pattern was also present for Σ PCB4, but associations were attenuated with IPW compared to complete case. In IPW models, cord blood lead was associated with higher risk of anxiety and depression in those with a higher HOME score (e.g., depression risk ratio: 2.04; 95% CI: 1.28, 3.26 per doubling lead). Hexachlorobenzene and manganese were not associated with either anxiety or depression.

CONCLUSIONS: Prenatal p,p'-DDE and lead exposure may increase susceptibility to anxiety and depression. Varying risk was observed in different HOME strata, demonstrating the importance of considering interactions between chemical and non-chemical stressors.

Keywords: Chemical exposures, heavy metals, metal health outcomes, non-chemical stressors



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-068

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Sexually dimorphic associations between prenatal blood lead exposure and temporal processing in 6- to 7-year-old children in Mexico City

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BACKGROUND AND AIM: Temporal-Response Differentiation (TRD) is an operant testing procedure to assess time perception. Few human studies have assessed whether lead (Pb) affects temporal processing.

METHODS: As part of a prospective cohort study in Mexico, 547 six- to seven-year-old children completed a TRD task to assess temporal processing. Pb was measured in maternal blood collected during the second trimester (2T), third trimester (3T), and on the day of delivery; and, in infant's umbilical cord (CB) at delivery. During the TRD task, children repeatedly held a lever down for 10-14 seconds to receive a reward. We examined the frequency, average duration, and standard deviation of timing holds. General linear models were used to examine associations between each Pb measure and each outcome adjusted for child's age at testing, maternal education, and socioeconomic status. Sexually dimorphic effects were evaluated using 2-way interactions between child sex and exposure.

RESULTS: In the number of holds models, there was a significant interaction between CB lead levels and sex ($\beta=1.5$; 95%CI: 0.12, 2.9) with boys having a reduced number of holds with higher Pb than girls. In the average duration of holds models, there were significant interactions of 3T and delivery Pb with sex ($\beta=-0.72$; 95%CI: -1.33, -0.12 and $\beta=-0.59$; 95%CI: -1.1, -0.1, respectively) with males having longer durations with higher Pb than girls. In the standard deviation of hold durations models, there were significant interactions of 3T, delivery, and CB Pb with sex ($\beta=-0.79$; 95%CI: -1.3, -0.23, $\beta=-0.78$; 95%CI: -1.2, -0.3, and $\beta=-1.1$; 95%CI: -1.7, -0.4, respectively) with boys having greater variability in their hold durations with higher exposure than girls.

CONCLUSIONS: Our results offer new insights into the cognitive mechanisms involved in prenatal Pb-related neurodevelopmental deficits, implicating temporal processing mechanisms, and provide a new approach to evaluate sex-specific effects of lead exposure.

Keywords: Heavy metals, Neurodevelopmental outcomes, Children's environmental health



ABSTRACT E-BOOK

P-069

Neurologic and Mental Health Outcomes » Mental health outcomes

Prospective associations between fine particulate matter exposure, neighborhood deprivation, and internalizing behaviors in adolescents from the ABCD Study

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BACKGROUND AND AIM: Adolescence presents an understudied critical window of vulnerability to environmental exposures. Neighborhood deprivation and PM_{2.5} exposure individually adversely affect neurobehavior, yet joint effects are understudied. We examine interactions between neighborhood deprivation and PM_{2.5} during late childhood on internalizing behaviors in early adolescence.

METHODS: The Adolescent Brain Cognitive Development (ABCD) Study is a large (N = 11,875), well-characterized and diverse sample of 9-10-year-old children recruited across 21 sites in the United States. Based on the geocoded residential address at enrollment, Neighborhood Area Deprivation Index (NADI) was calculated using a validated 18-item scale, and annual average PM_{2.5} exposure (1-km² resolution) was derived using spatiotemporal models. Internalizing behaviors (e.g., depression and anxiety) were measured at baseline and 1-year follow-up using the parent-reported child behavior checklist (CBCL). We used linear mixed effects models to study interactions between baseline NADI and PM_{2.5} and internalizing behaviors measured 1 year later. We adjusted for child sociodemographic characteristics, pubertal status, family history of depression, and baseline internalizing behaviors. We assessed the associations among all subjects and by sex.

RESULTS: Among the 9,315 (48% female; 52% White, 20% Hispanic, 15% Black, 2% Asian, and 11% other race) subjects with complete data, mean baseline PM_{2.5} was 7.53 (SD=2.57) micrograms per cubic meter, NADI was 92.73 (SD=24.82), and internalizing behavior T-scores were 48.45 (SD=10.64) at baseline and 48.58 (SD=10.61) at 1-year follow-up. Among all subjects, we observed a significant positive interaction between baseline PM_{2.5} and NADI with internalizing behaviors at 1-year follow-up (p=0.013). Sex-stratified models suggest this positive interaction was only significant for girls.

CONCLUSIONS: Adverse effects of PM_{2.5} exposure on anxiety and depressive symptoms were only observed among adolescents living in deprived neighborhoods with higher air pollution. Public health efforts to reduce air pollution in deprived neighborhoods has the potential to reduce the burden of environmentally-associated mental health problems.

Keywords: Particulate matter, Children's environmental health, Socio-economic factors, Neurodevelopmental outcomes



ABSTRACT E-BOOK

P-070

Neurologic and Mental Health Outcomes » Neurodegenerative outcomes

Association of childhood lead exposure with MRI measurements of structural brain integrity in midlife

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BACKGROUND AND AIM: Childhood lead exposure has been linked to disrupted brain development, but long-term consequences for structural brain integrity are unknown. This study tested the hypothesis that childhood lead exposure is associated with magnetic resonance imaging (MRI) measurements of lower structural integrity of the brain in midlife.

METHODS: Hypotheses tested in the Dunedin Study, a New Zealand-based population-representative 1972-1973 birth cohort (N=564 analytic sample) followed to age 45 years. Childhood blood-lead levels measured at age 11 years were combined with MRI-measures of brain integrity at age 45 years, including gray matter (cortical thickness, surface area, hippocampal volume), white matter (white matter hyperintensities, fractional anisotropy), and brainAGE, a composite index of the gap between chronological age and a machine-learning algorithm-estimated brain age. Age-45 cognitive function was also assessed, objectively via the Wechsler Adult Intelligence Scale-IV and subjectively via informant and self-reports.

RESULTS: Mean(SD) age-11 blood-lead level was 10.99(4.63)µg/dL. After adjusting for covariates, each 5µg/dL higher childhood blood-lead level was significantly associated with 1.19-cm² smaller cortical surface area (95%CI:-2.35,-0.02, P=.05), 0.10-cm³ smaller hippocampal volume (95%CI:-0.17,-0.03, P=.006), lower global fractional anisotropy (b=-0.12, 95%CI:-0.24,-0.01, P=.04), and 0.77-years older brainAGE (95%CI:0.02, 1.51, P=.05). There were no statistically significant associations between blood-lead level and log-transformed white matter hyperintensity volume (b=0.05 log mm³, 95%CI:-0.02, 0.13, P=.17) or mean cortical thickness (b=-0.004 mm, 95%CI:-0.012, 0.004, P=.39). Each 5µg/dL higher childhood blood-lead level was significantly associated with a 2.07-point lower score (95%CI:-3.39,-0.74, P=.002) in age-45 IQ, and a 0.12-point higher score (95%CI:0.01, 0.23, P=.03) on informant-rated cognitive problems. There was no statistically significant association between childhood blood-lead levels and self-reported cognitive problems (b=-0.02 points, 95%CI: -0.10, 0.07, P=.68).

CONCLUSIONS: In this four-decade study, higher childhood blood-lead level was associated with lower structural brain integrity in midlife. Childhood lead exposure may have long-term consequences for adult brain health.



ABSTRACT E-BOOK

Keywords: Heavy metals, Neurodegenerative outcomes, Environmental epidemiology

P-071

Neurologic and Mental Health Outcomes » Mental health outcomes

Perceived Discrimination and Social Isolation Among Postpartum Hispanic Women in the MADRES Pregnancy Cohort Before and After the COVID-19 Pandemic

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BACKGROUND AND AIM: Previous research has shown that perceived discrimination and social isolation due to immigration policies have important health implications among US Hispanic populations. Moreover, the early postpartum period is characterized by periods of social isolation which may be exacerbated by the COVID-19 pandemic. The pandemic also coincided with a growing awareness of discrimination and structural racism experienced by marginalized communities. We evaluated differences in perceived discrimination and social isolation between early postpartum Hispanic women in Los Angeles before and during the COVID-19 pandemic.

METHODS: Questionnaires were administered at one month postpartum to 176 Hispanic women in the MADRES pregnancy cohort. Perceived discrimination and social isolation are two subscales on the Perceived Immigration Policy Effects (PIPES) questionnaire. Respondents between 9/1/2018–3/1/2020 were classified as “pre-pandemic” (N=129) and between 3/1/2020–9/14/2020 as “during the pandemic” (N=47). Average social isolation and discrimination subscale scores were rounded to the nearest integer. Proportional odds models were used to evaluate COVID-19 pandemic impacts on perceived discrimination and social isolation among postpartum mothers.

RESULTS: Participants were on average 28.9 (SD=5.9) years old and approximately half were born in Latin America (51.7%). Average pre-pandemic scores were 1.2 (SD=0.5) for both discrimination and social isolation and 1.4 (SD=0.6) for discrimination and 1.5 (SD=0.7) for social isolation during the pandemic. After adjusting for age, education, nativity, and postpartum distress, participants at one month postpartum during the pandemic had 3.98 times the odds of a higher score on the perceived discrimination scale (p=0.0017) and 5.29 times the odds of a higher score on the social isolation scale (p<0.0001) than those responding to the questionnaire at one month postpartum before the pandemic.

CONCLUSIONS: Higher perceived discrimination and social isolation at one month postpartum during the COVID-19 pandemic vs. pre-pandemic periods suggest increased social inequities during the pandemic among US Hispanic women.



ABSTRACT E-BOOK

Keywords: COVID-19, Mental health outcomes, Non-chemical stressors

P-072

Neurologic and Mental Health Outcomes » Neurodegenerative outcomes

Long-term exposure to ambient air pollution and incident dementia among older adults in Northern Manhattan

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BACKGROUND AND AIM: Age-related cognitive decline is a growing public health issue as increases in life expectancy and the aging of the population are expected to raise the prevalence of cognitive impairment and dementia. An estimated 47 million individuals live with dementia, with the global prevalence expected to double every 20 years. Evidence is growing that suggests that ambient air pollution from traffic and other sources may be an important risk factor for cognitive decline and dementia. We evaluated the association between long-term exposure to ambient air pollution and incident dementia in a cohort of urban dwelling older adults.

METHODS: The Washington Heights Inwood Community Aging Project (WHICAP) is a prospective, community-based study of aging and dementia in older adults > 65 years old in Northern Manhattan, NYC. At enrollment, participants underwent neuropsychological testing and medical examinations. Follow-up assessments occurred every 18-24 months. Cases are adjudicated for dementia at each follow-up by trained neuropsychologists. We used Cox proportional hazard models with age as the time scale to evaluate the association between markers of ambient air pollution (nitrogen dioxide [NO₂]) and fine particulate matter [PM_{2.5}]) at enrollment and incident dementia, adjusting for sociodemographic factors and temporal trends.

RESULTS: Among 4,122 dementia-free participants with an average of 8 years of follow-up, 14% (n=591) were diagnosed with incident dementia. Participants living in the highest level of ambient PM_{2.5} exposure were 17% more likely than those in the lowest exposure quartile to develop incident dementia in fully adjusted models (HR_{adj} 1.17 95% CI 0.76, 1.80). Results for NO₂ were similar (HR_{adj} = 1.14 95% CI 0.68, 1.89, for highest versus lowest quartile).

CONCLUSIONS: These results add to the growing evidence base implicating the role of air pollution on accelerated cognitive aging and brain health, particularly in aging urban populations.



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ABSTRACT E-BOOK

Keywords: Air pollution, epidemiology, Neurodegenerative outcomes



ABSTRACT E-BOOK

P-073

Neurologic and Mental Health Outcomes » Mental health outcomes

Changes in depression symptoms in Mexican women during the COVID-19 pandemic

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BACKGROUND AND AIM: While COVID-19 infection affects health directly, the pandemic response has widespread implications as physical and social environments were radically changed by social distancing and stay at home measures. Mental health effects are important effects to track. We aimed to examine changes in depression and stress levels before and during the COVID-19 pandemic in women from a longitudinal cohort based in Mexico City.

METHODS: We studied 471 women enrolled in the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) study, who completed the Edinburgh Depression Scale (EDS) prior to the pandemic (2018-2019) and during the pandemic (May-November 2020). Change in EDS score between the two time periods was calculated. New onset depression was defined an EDS score >12 only in the pandemic period. Psychosocial stress for both time periods was ascertained through endorsement of negative life events across 11 domains using the CRISYS questionnaire. Associations between stress at both time periods and depression were analyzed in generalized linear models adjusting for age, socio-economic status and family social support.

RESULTS: Higher stress (>median) during the pandemic, but not prior to it, was associated with an increase in depression score (β : 2.22; 95%CI [1.15, 3.28]), and higher odds of new onset depression (OR: 1.25; 95% CI [1.01, 1.55]). Higher stress during the pandemic in particular domains, including personal relationships (β : 1.82 [95%CI: 0.84, 2.80], home (β :1.41; [95%CI 0.22, 2.60]) and financial (β : 1.72; [95%CI: 0.71, 2.73]) were associated with an increase in depression score. We did not find significant differences in the distribution of depression or stress scores pre and during pandemic.

CONCLUSIONS: High levels of stress during the pandemic were associated with increases in depression scores and new onset depression. Future studies should examine the long-term effects of stress associated with the pandemic on mental and overall health.

Keywords: mental health outcomes, female, covid-19, epidemiology



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-074

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Associations between early life exposure to manganese and developmental trajectories of executive functions

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BACKGROUND AND AIM: Manganese (Mn) is an essential nutrient at low doses, yet high levels can be neurotoxic. Executive functions (EF) are a set of cognitive abilities critical for goal directed behavior, which develop throughout childhood and adolescence. Only few studies examined the influence of early life exposures to Mn and developmental trajectories of EF. In this study, we investigated associations between early-life Mn exposure and changes in EF throughout adolescence.

METHODS: Participants (N=154, 53% females) from the Public Health Impact of Metals Exposure (PHIME) study were included in this analysis. EF were measured using the Conners ADHD Scales (ages 11-14) and Brown ADD scales (ages 17-22). Prenatal, early postnatal and childhood Mn concentrations were measured in naturally shed deciduous teeth using laser ablation-inductively coupled plasma-mass spectrometry. We used general linear models to examine associations between prenatal, postnatal, and childhood dentine Mn with the change in attention (z-scored changes over time), adjusted for sex, and age.

RESULTS: Childhood dentine Mn was significantly associated with developmental changes in attention (i.e., a negative slope; $\beta = -0.98$, $p = 0.0008$). No significant associations with prenatal and postnatal Mn were detected.

CONCLUSIONS: These results indicate that Mn exposure during childhood may protect against increased attention problems, consistent with its nutrient properties. The flatter slope for postnatal and prenatal Mn and attention suggests an absence of protection. These findings support our hypotheses that trajectories are key to understanding the role of early-life metal exposures on EF development.



ABSTRACT E-BOOK

Keywords: Heavy metals, Children's environmental health, Neurodevelopmental outcomes,

P-076

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Dose-response analyses of the 27 human developmental neurotoxicity studies ranked highest quality by National Toxicology Program (NTP) systematic review

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BACKGROUND AND AIM: The National Toxicology Program (NTP) has been conducting a systematic review of the evidence for fluoride's neurotoxicity. Drafts of the NTP report conclude fluoride is a presumed hazard for developmental neurotoxicity, but have not included rigorous dose-response analyses to estimate a safe dose. This is of great public health importance because millions of people are exposed to fluoride added to public water supplies or table salt; or naturally elevated fluoride in drinking water.

METHODS: We conducted several dose-response analyses using data extracted by NTP from 27 human studies NTP ranked high quality. The number of studies finding adverse effects were counted at three exposure levels: <0.7, 0.7–1.5, >1.5mg/L. Meta-analyses were performed with the 14 studies having individual-level exposure data, in two subgroups by mean exposure: ≤1.5mg/L or >1.5mg/L. The same 14 studies were then assessed using meta-regression of IQ loss at mean exposure against mean exposure.

RESULTS: Of the 27 higher quality studies, 25 found adverse neurocognitive effects with 11 at exposures below 0.7mg/L; 4 at 0.7–1.5mg/L; and 10 at >1.5mg/L. None found significant beneficial effects. In the meta-analysis, all 14 studies found loss of IQ, including the 7 in subgroup ≤1.5mg/L which had a pooled effect size of -4.0 (95%CI -6.03, -2.05) IQ points per 1mg/L fluoride. The meta-regression fit a linear dose-response with pooled effect size of -2.94 (95%CI -4.03, -1.84) IQ points per 1mg/L.

CONCLUSIONS: Dose-response analyses of 27 studies ranked high quality by NTP found a remarkable consistency of adverse effects down to very low doses. The magnitude of predicted IQ loss is of considerable concern. Pregnant women and infants should limit exposure to fluoride.

Keywords: fluoride, developmental neurotoxicity, dose-response, IQ, National Toxicology Program, meta-analysis



ABSTRACT E-BOOK

P-078

Methods » Environmental epidemiology

Comparison of Integrated Risk Information System and Navigation Guide approaches for study evaluation in systematic reviews of environmental epidemiology studies

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BACKGROUND AND AIM: There are several approaches available for evaluating risk of bias in environmental epidemiology studies, but few case studies comparing them have been done.

METHODS: The Integrated Risk Information System (IRIS) approach is a domain-based framework where each study is evaluated for risk of bias and study sensitivity. Eick et al. (2020) applied multiple approaches, including IRIS, to studies from a Navigation Guide (NG) systematic review of polybrominated diphenyl ethers (PBDEs) and neurodevelopment (Lam et al., 2017). In the current analysis, trained IRIS staff applied the IRIS approach, including PBDE exposure and cognitive testing-specific considerations, to the 10 studies of IQ and compared the results to those using the NG. This analysis was restricted to comparable domains: Exposure and Outcome Assessment, Confounding, Population/Selection, and Selective Reporting (and NG domains considered within the broader IRIS Exposure and Outcome domains). The IRIS and NG approaches have four rating levels that may not be strictly analogous but were interpreted as similar for identifying study deficiencies.

RESULTS: We identified three studies with multiple “deficient” domain ratings (low confidence overall) using the IRIS approach. These studies also had multiple domains with “probably high risk of bias” in the NG systematic review. Among studies rated as high or medium confidence overall using the IRIS approach, there were differences in ratings between the approaches, but generally within the top two rating levels (IRIS good/adequate; NG low/probably low).

CONCLUSIONS: The approaches identified the same studies as concerning for risk of bias. Among higher quality studies, some rating differences between tools may be attributed to different expertise/interpretations of evaluators. Additional comparisons would be elucidating, ideally with collaboration to ensure application of the approaches consistent with their intended use.

Disclaimer: The views expressed in this abstract are those of the author and do not necessarily reflect the views or policies of the U.S. EPA.

Keywords: risk of bias, systematic review, environmental exposures, risk assessment



ABSTRACT E-BOOK

P-080

Methods » Other (to be specified with keywords in the keywords section)

A risk assessment tool for resumption of research activities during the COVID-19 pandemic

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BACKGROUND AND AIM: The spread of severe acute respiratory syndrome coronavirus-2 has suspended many non-COVID-19 related research activities. Where restarting research activities is permitted, investigators need to evaluate the risks and benefits of resuming data collection and adapt procedures to minimize risk. In the context of the multicountry Household Air Pollution Intervention (HAPIN) trial, we developed a framework to assess the risk of each trial activity and to guide protective measures. Our goal is to maximize integrity of research aims while minimizing infection risk based on the latest understanding of the virus.

METHODS: We drew on a combination of expert consultations, risk assessment frameworks, institutional guidance and literature to develop our framework. We then systematically graded clinical, behavioral, laboratory and field environmental health research activities in four countries for both adult and child subjects using this framework.

RESULTS: Our framework assesses risk based on staff proximity to the participant, exposure time between staff and participants, and potential aerosolization while performing the activity. One of four risk levels, from minimal to unacceptable, is assigned and guidance on protective measures is provided. Those activities which can potentially aerosolize the virus are deemed the highest risk.

CONCLUSIONS: By applying a systematic, procedure-specific approach to risk assessment for each trial activity, we can compare trial activities using the same criteria. This approach allows us to protect our participants and research team and to uphold our ability to deliver on the research commitments we have made to our participants, local communities, and funders.

Keywords: International collaboration, Risk assessment



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-081

Other » Other (to be specified with keywords in the keywords section)

Mortality displacement as a type of selection bias: consequences and causal perspectives

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BACKGROUND AND AIM: Mortality displacement (MD) is a phenomenon in which the observed mortality rate decreases temporarily after exposure, resulting in deaths being moved forward a time period from when they could occur without exposure. However, little is known about whether MD biases rate ratios (RR) in different study designs, the resulting type of bias, and what consequences MD has on observational epidemiology.

METHODS: Here, we present theory to show that: 1) MD is a built-in selection bias under various study settings including survival analysis, time-series analysis, and case-crossover analysis; 2) MD distorts observation of effective exposure periods and effect modifications; and 3) how biased RR can be causally interpreted. To illustrate the consequences, we provide simulation analyses of open and closed cohorts and real-world data analyses of ambient particulate matter and mortality in South Korea and in the US.

RESULTS: We found that: 1) MD is a bias toward the null for effective exposure period and RR; 2) in the distributed lag model framework as a generalized version of time-window methods, MD is a bias decreasing RR of distributed lags; 3) modification of RR may be severely biased due to differential MD across population strata; 4) RRs in population-based studies may be strongly biased by MD; 5) nevertheless, biased RR may be viewed as unbiased RR with a newly defined causal effect with advanced timing of outcomes by exposure; and 6) biased modification of RR may be seen as a new type of effect modification under this newly defined causal effect.

CONCLUSIONS: MD is a selection bias inherently occurring in various study designs. Researchers should consider consequences of MD in analyzing and interpreting associations. Future studies should develop methods to adjust for MD in epidemiologic research; however, adjustment for MD may not be necessary depending on what types of causal effect researchers wish to target.

Keywords: Mortality displacement, selection bias, causal interpretations, effect modification, study designs



ABSTRACT E-BOOK

P-082

Methods » Environmental epidemiology

Having your cake (mix) and eating it too: Independent, interaction, and group effects of mixtures using Bayesian Hierarchical Regression Modelling

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BACKGROUND AND AIM: Mixtures analysis methods are increasingly being applied in environmental epidemiology, but current methods are often limited by either only providing a group effect or independent exposure effects without a group effect. We investigate Bayesian Hierarchical Regression Modelling (BHRM) and show how it can be adapted to handle highly correlated exposures to estimate: 1) independent exposure effects; 2) interactions between exposures; and 3) combined effects for a mixture exposure.

METHODS: BHRM is a flexible framework that can provide robust estimation for highly correlated exposures (via g-prior specification), yield conditional exposure-specific estimates, and include interactions effects. We demonstrate how these general regression models can provide additional inference on the combined effect for a multi-pollutant exposure. To demonstrate potential advantages of certain specifications, we applied BHRM to an analysis of liver injury and exposure to perfluoroalkyl substances (PFAS), including PFOS, PFOA, PFHxS, PFNA, and PFUnDA, in 1105 children from the Human Early Life Exposome (HELIX) project. Liver injury was defined as >90th percentile for any serum liver injury biomarker (ALT, AST, GGT). We used BHRM to estimate the mixture effect and pollutant-specific effects. For comparison, we also applied Bayesian Weighted Quantile Sum regression (BWQS)—an alternative specification within Bayesian Hierarchical Modeling.



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RESULTS: PFAS mixture was associated with childhood liver injury: OR=1.64 (95%CI:1.34-2.00) per increased exposure equivalent to one standard deviation for all PFAS. Within this mixture effect, PFNA was the predominant exposure driving the association with OR=1.62 (95%CI:1.11-1.97) and a posterior inclusion probability of 0.969 (Bayes factor, BF=125). No strong evidence of interactions. Although BWQS estimated a mixture effect of OR=1.85 (95%CI:1.50-2.25) and indicated PFNA had the most substantial estimated weight of 0.513 (BF=4.21), the approach lacks pollutant-specific effects.

CONCLUSIONS: BHRM is an efficient method for mixtures analysis. Estimation of pollutant-specific effects with group effects provide critical data for identifying causal agents in mixtures of environmental contaminants.

Keywords: mixtures, methods, Bayesian Hierarchical Regression Modelling, multi-pollutant



ABSTRACT E-BOOK

P-083

Methods » Environmental epidemiology

Principal component pursuit for exposure pattern recognition: an application to persistent organic pollutants and leukocyte telomere length

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BACKGROUND AND AIM: Environmental health (EH) researchers often aim to identify sources that drive potentially harmful environmental exposures. We have adapted Principal Component Pursuit (PCP), a robust dimensionality reduction algorithm, to pattern recognition in EH. PCP decomposes the exposure matrix into consistent patterns of chemical exposure while separately isolating unique or infrequent outlying exposure events. We further tailored PCP for EH by adding: (1) a non-negativity constraint to enhance interpretability of identified patterns, (2) procedures to accommodate missingness, and (3) a separate penalty for observations below the limit of detection.

METHODS: We began with an exposure mixture of 21 dioxins, furans, and polychlorinated biphenyls (PCBs), collectively referred to as persistent organic pollutants (POPs), measured in 1,000 U.S. adults from the 2001-2002 National Health and Nutrition Examination Survey (NHANES). We applied PCP to this mixture to identify exposure patterns and investigated the association between identified patterns and leukocyte telomere length (LTL), a biomarker associated with chronic disease. We used pattern scores from PCP in linear regression models to evaluate their association with LTL, adjusting for potential confounders.

RESULTS: PCP identified four patterns representing the overall exposure matrix: pattern 1 was characterized by dioxins, pattern 2 by furans, pattern 3 by higher-weight PCBs, while pattern 4 was driven by lower-weight PCBs including two mono-ortho PCBs. In adjusted models, we observed no association between patterns 1, 2, or 3 and LTL. We observed on average a 0.017 (95% CI: 0.000, 0.034) unit increase in log-LTL per one standard deviation increase in the exposure profile described by pattern 4.

CONCLUSIONS: PCP can serve as a useful and robust technique that can accommodate missing values and values below the limit of detection to identify exposure patterns that are amenable to public health messaging and research.

Keywords: Mixtures, Mixtures analysis, Chemical exposures, Environmental epidemiology



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ABSTRACT E-BOOK

P-084

Methods » Science communication

An Evaluation of an Environmental Health Infographic in Community Settings

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BACKGROUND AND AIM: Infographics are a successful way of communicating health-related information due to the enhanced ease of information transmission. In this paper, we discuss the development and evaluation of an infographic about the dangers of ultrafine particles (UFPs) from traffic pollution and actions that readers in disproportionality affected communities can take to protect their health. In particular, we analyze and discuss the feedback from community members.

METHODS: We collected 74 anonymous surveys, as well as a focus group and interviews, with Boston Chinatown and Somerville, MA residents. Community partner organizations assisted us in recruiting participants by sending a recruitment flyer to their listservs and identifying specific people who were interested in participating. Quantitative data were analyzed using SPSS, and qualitative data were analyzed manually.

RESULTS: Data from the surveys, focus group, and interviews yielded eight themes that guided the revision of the infographic. The majority of the participants responded positively to the infographic: 95.9% (n=71) of respondents reported that the purpose of the infographic was clear, that the infographic contained a clear message, and that the infographic uses images to explain important points. Conversely, only 79.2% (n=58) responded that the infographic detailed how UFPs affect people's health, 63.9% (n=47) indicated that the infographic thoroughly defined UFPs, and 55.4% (n=41) reported that the images were clear and uncluttered. We created a revised infographic based on participant feedback.

CONCLUSIONS: The number of recommended revisions highlights the participants' interest in the infographic and its usefulness in various community settings. This suggests the infographic's potential efficacy as a public health communication tool. The multiple steps taken to revise the infographic also indicate that it can be adapted to meet the needs of different communities based on their input and engagement throughout the process of research development, implementation and reporting of results.

Keywords: Air pollution, Community outreach, Multi-media, Outcomes, Science communication



ABSTRACT E-BOOK

P-085

Methods » Causal inference

Does hypertension mediate the relationship between environmental noise and myocardial infarction ?

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BACKGROUND AND AIM: Environmental noise is associated with cardiovascular diseases, including myocardial infarction (MI). We hypothesized that hypertension may be a mediator in the causal pathway linking noise exposure to MI. We aimed to assess the potential mediating effects of hypertension on the relationship between noise and MI, using causal mediation analysis in a population-based cohort.

METHODS: The cohort derives from the linkage of health administrative databases. It includes all residents of Montreal (Canada) between 2000-2014, who were 45 years and older and free of MI and hypertension at time of entry. Incident cases of MI and hypertension were ascertained from validated case definitions. Long-term environmental noise exposure, expressed as level acoustic equivalent 24h (LAeq24h), was estimated from a land use regression model and assigned to participants using their residential postal code at entry in the cohort. We performed causal mediation analysis based on a counterfactual approach, using Cox proportional hazards model for the exposure-outcome model and logistic regression for the exposure-mediator model.

RESULTS: The cohort comprised 912,632 individuals, with 26,966 incident cases of MI and 250,382 cases of hypertension. 36% of MI cases had developed hypertension. Environmental noise was associated with MI and hypertension; adjusted estimates of association were 1.07 (95% confidence interval (CI): 1.06-1.08) for MI and 1.07 (95% CI: 1.06-1.08) for hypertension, per interquartile range increase (54.9 to 60.5 decibel A) in the annual mean LAeq24h. In the causal mediation analysis, there was no evidence of exposure-mediator interaction. The estimated total effect was 1.08 (95% CI: 1.07-1.08), the direct effect of noise was 1.08 (95% CI: 1.07-1.08) and the indirect effect mediated by hypertension was null (1.00; 95% CI: 1.00-1.00), per interquartile range increase in LAeq24h.

CONCLUSIONS: In this population-based cohort study, we found no evidence that the effect of long-term environmental noise exposure on the incidence of MI is mediated through hypertension.

Keywords: noise, mediation analysis, cardiovascular disease, hypertension, myocardial infarction, cohort



ABSTRACT E-BOOK

P-086

Other » Other (to be specified with keywords in the keywords section)

Harmonizing Race and Ethnicity Data to Facilitate Data Analysis of Pooled Environmental Health Studies

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BACKGROUND AND AIM: Race and ethnicity are social constructs that function as necessary tools in environmental health research, helping to identify underserved populations. Despite much discussion of more inclusive ways for individuals to self-identify, there is insufficient consideration for organizing these diverse subgroups for use as data across multiple studies, facilitating comparisons. The HHEAR (Human Health Exposure Analysis Resource) Data Repository houses deidentified data of environmental and exposome studies. Data are harmonized to a common vocabulary to facilitate data pooling. Most HHEAR studies use variations of the current Office of Management and Budget (OMB) standards to place groups of people into categories. These different categorizations can hinder harmonization, as some studies separate race and ethnicity using a two-question format while others construct a combined format. Few incorporate country or region of origin. Additionally, OMB standards are extended to studies that take place outside the United States, which may not have originally used these categorizations.

METHODS: We conducted a review of published literature, standard ontologies used by research collaborations, and national reviews from countries outside the United States to review the harmonization of race and ethnicity and identify methods to facilitate data pooling in the HHEAR repository.

RESULTS: As there was no clear consistency in mappings across literature, we created our own broad data standards to accommodate the diverse definitions incorporating race and ethnicity on both national and international levels. We encourage more standardized reporting in future studies in order to facilitate harmonization.

CONCLUSIONS: Large, diverse datasets allow for investigations with larger sample sizes and greater exposure variability. By improving and standardizing methodology for data harmonization, environmental health studies can promote social justice by informing policy to allocate time and resources to at-risk communities and, in turn, reduce health disparities.

Keywords: Dictionary Mapping, Knowledge Modeling, Data Standards, Harmonization, Race, Ethnicity



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P-087

Methods » Community outreach

Collaborative Research: Partnering with the community to improve the science and its impact

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BACKGROUND AND AIM: The Michigan PBB Research Registry consists of ~7,000 people exposed to polybrominated biphenyls (PBB) following its accidental introduction into Michigan's animal feed. After nearly forty years, the PBB Registry was transferred to Emory University, allowing the research team to engage this community.

METHODS: Community engagement (CE) activities were initiated with goals of disseminating research findings to those affected, responding to educational needs, incorporating community input, and facilitating research participation. CE methods include community meetings, where research results are shared with the affected community and questions/concerns are addressed and documented. At the first community meeting, we asked for volunteers for the Citizens Advisory Board (CAB) to guide us in research and engagement efforts. The CAB joined forces with the Pine River Superfund Citizen Task Force, a community advisory group focused on the remediation of the Superfund sites left from the PBB manufacturer, and the Mid-Michigan District Health Department.

RESULTS: These efforts have evolved into a community-research partnership, where the community identified research questions, helped develop the research approach, and is an integral part of research decision-making. This partnership has led to significant changes in outreach activities, research protocols, and research priorities: community health concerns were added to surveys, the age range for participation was expanded, and chemical workers/family who were removed from the Registry (1990s) due to multiple exposures were re-enrolled with exposome methods to evaluate their complex exposures. Community concerns regarding multi-generational effects and continued high-levels of PBB body burden led to a multi-generational epigenetics study, a clinical trial aimed at accelerating PBB elimination, and an oral history study documenting the lived experience of those affected using qualitative methods. This work will be translated in an online continuing medical education course for healthcare providers.

CONCLUSIONS: The community-research partnership has enhanced the science and its relevancy and potential benefit to the impacted community.

Keywords: Community-engaged research, science communication, exposome, environmental epidemiology, environmental justice



ABSTRACT E-BOOK

P-088

Methods » Toxicology

Anthelmintic activity of extracts of papaya and avocado seed using *Caenorhabditis elegans* as model

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BACKGROUND AND AIM: At present, the human being has sought different alternatives to improve their health, taking into account more naturalistic approaches to the treatment of problems related to the cardiac, digestive and nervous system. The latter can be related to parasites, which cause substantial deaths and morbidity in humans and diseases in livestock and domestic animals. Traditional medicine has been used to combat parasitic diseases, using tea from seeds of several fruits.

METHODS: In this opportunity, the effectiveness in the antiparasitic activity of the aqueous extract of avocado and papaya seeds was evaluated using the soil nematode *Caenorhabditis elegans* as a model, through mortality as an endpoint of acute toxicity. Three solutions of each extract in distilled water (50, 75, 100%) were used to exposure L4-stage larvae of *C. elegans* wild type Bristol N2 for 24 h.

RESULTS: Results indicate a high anthelmintic activity of the two seed extracts, with 86, 91, 94% of mortality with the respective concentration of the avocado seed extract and 63, 76, 90% with the extract of papaya seeds; showing a dose-dependent mortality curve.

CONCLUSIONS: The above demonstrates the anthelmintic power of the avocado and papaya seeds and the ability of *C. elegans* to be used as a model to study anthelmintic activity due to the similarity of the physiological characteristics that shares with the parasitic nematodes that affect health of human beings.

Keywords: Toxicology, Food/nutrition, Health co-benefits



ABSTRACT E-BOOK

P-089

Methods » Modeling

Knot placement in the Distributed non-linear lag models (DNLN) framework

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BACKGROUND AND AIM: Distributed non-linear lag models (DNLN) provide flexible methods to model non-linear exposure-response relationships over time, with common applications in environmental epidemiology. When the lag functions of the cross-basis include a spline function, the number and placement of knots for the function are specified in the model although the preferred number and placement of knots may not be known a priori. Our goal is to develop a flexible algorithm to explore the impact of knot selection on the final model.

METHODS: We use data describing weekly maternal exposure to nitrogen dioxide (NO₂) and fetal growth trajectories during the first 12, 20 and 12-20 weeks of pregnancy for 2,021 women from the Infancia y Medio Ambiente (INMA) project (2003-2008) for the exploration of two knot selection methods. We generated multiple search grids containing potential knot placement for the lag dimension of the cross-basis; each search grid had a distinct level of resolution for knot placement. We compared the number and placement of knots from each grid as well as the inference from the resulting DNLN models utilizing knots selected from each search grid.

RESULTS: Our results showed that models with 12 lags resulted in the same number and placement of knots regardless of search grid used. Similarly, the models with 20 lags (i.e., both the 20 week and 12–20-week fetal growth trajectories), produced the same number of knots regardless of search grid used; however, the placement of the knots changed depending on the search grid utilized.



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CONCLUSIONS: Choosing an appropriate search grid for knot selection in the model may impact the knot vector selected in some contexts. A simulation study to investigate the model impact of different knot selection processes may reveal more detailed information about the overall importance of this step in the DLNM framework and model building.

Keywords: DLNM, knot selection, splines, DLM



ABSTRACT E-BOOK

P-091

Methods » Environmental epidemiology

Environmental Mixture METHODS: Recommendations to Promote Robust Results in the Presence of Random Sampling

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BACKGROUND AND AIM: Statistical learning is being increasingly used in environmental epidemiology, including in health analyses of environmental mixtures. Statistical learning methods, such as shrinkage methods or kernel smoothing methods, can perform well in instances with complex or high-dimensional data—settings in which traditional statistical methods fail. These novel methods, however, often include random sampling which may induce variability in results. Best practices in data science can help to ensure robustness.

METHODS: We used data from the National Health and Nutrition Examination Survey (NHANES) 2001–2002 cycle to evaluate the potential variability in the estimated association between 18 persistent organic pollutants (POPs) and leukocyte telomere length (LTL) among 1,003 US adults, using four statistical learning models that have been applied previously to analyze the relationship between environmental mixtures and health outcomes. We included two penalized regression methods borrowed from machine learning, lasso and group lasso, and two statistical learning methods designed for environmental health data, weighted quantile sum (WQS) regression and Bayesian kernel machine regression (BKMR). We ran each model across 100 initializing values for random number generation ('seeds') and assessed variability in resulting estimation and inference.

RESULTS: All methods exhibited some seed-dependent variability in results. The degree of variability differed across methods and POPs. Regardless of variability, all methods repeatedly identified furan 2,3,4,7,8-pncdf and PCB 126 as bad actors in the mixture. Both WQS and BKMR consistently estimated a harmful overall mixture effect.

CONCLUSIONS: Any statistical learning method reliant on a random seed will exhibit some degree of seed sensitivity. We recommend that researchers repeat their analysis with various seeds as a sensitivity analysis when implementing these methods to enhance interpretability and robustness of results.

Keywords: Mixtures, Mixtures analysis, Modeling, Environmental epidemiology, Epidemiology



ABSTRACT E-BOOK

P-092

Methods » Science communication

Evaluation of a transdisciplinary project-based environmental public health curriculum for primary and secondary students

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BACKGROUND AND AIM: The aim of this research was to develop, evaluate, and enhance a transdisciplinary project-based curriculum in which students engage in citizen-science to introduce them to the field of environmental public health, a subject not traditionally taught outside of tertiary education. The curriculum was designed to educate students on identifying hazards, assessing exposures, estimating and communicating risks, and developing and evaluating education-, policy-, and technology-driven solutions.

METHODS: The curriculum was developed by graduate students and taught successively over the span of two years by teachers in four different public education settings. Curriculum strengths, weaknesses and impacts were documented through student and teacher questionnaires and interviews, which was then used to enhance the curriculum after each round of implementation.

RESULTS: Student feedback indicated a need to limit lecture-based teaching in favor of hands-on activities; include technology-based and career-focused learning; and allow more autonomy in project selection. Teacher feedback indicated a need for guidance in citizen science project implementation; adoption of quiz-based student evaluation tools; alignment with common core standards; and unit independence to facilitate partial curriculum adoption.

CONCLUSIONS: Results suggest that a community-focused project-based transdisciplinary curriculum can impact student knowledge, perceptions, behaviors, motivations and career decisions; but it requires teachers step outside the tradition of compartmentalized learning and standardized testing. The resulting curriculum highlights the need for, and aims to prepare students in, inter-professional collaborative approaches to solve today's complex systems-dependent environmental public health problems.

Keywords: Environment, education, citizen science, project-based, curriculum



ABSTRACT E-BOOK

P-093

Exposures » Other (to be specified with keywords in the keywords section)

Association of Environmental Exposures and Socioeconomic Status with Presymptomatic Type 1 Diabetes Incidence in Children in Bavaria, Germany

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BACKGROUND AND AIM: Increasing incidence of early-onset type 1 diabetes (T1D) has been reported worldwide. Evidence shows that environmental exposures contribute to developing pancreatic islet autoantibodies in individuals with predisposing genes. This study aimed to investigate the effect of environmental exposures and socioeconomic levels on childhood presymptomatic T1D incidence (defined as having at least 2 islet autoantibodies) in Bavaria, Germany.

METHODS: Long-term exposure to air pollution (nitrogen dioxide (NO₂), Ozone (O₃) and particulate matter with a diameter <2.5 µm (PM_{2.5})) and ambient temperature as well as surrounding greenness and area-level socioeconomic status (SES) were assigned to the residential addresses of 52,636 children (<6 years of age) participating in the Fr1da study from 2015 to 2019. Information on demographic characteristics was extracted from self-administered questionnaires. We applied generalized additive models to examine the association of environmental factors and SES with presymptomatic T1D incidence adjusting for sex, age and family history of diabetes. We inspected single as well as multi-exposure models.

RESULTS: 225 children were diagnosed with presymptomatic T1D. Higher age at the time of diagnosis and having family history of diabetes was related to developing presymptomatic T1D (p<0.00). An interquartile range (IQR) increase in O₃ was associated with significantly higher odds of developing presymptomatic T1D (IQR: 5.06, Odds ratio (OR): 1.26; 95% confidence interval (CI): 1.08-1.48). One IQR increase in ambient temperature had an inverse association (IQR: 0.92, OR: 0.78, 95% CI: 0.66-0.93). Multi-exposure models indicated similar results, though both effects estimates were slightly shifted to the null. Other exposures were not associated with presymptomatic T1D.

CONCLUSIONS: Exposure to higher levels of O₃ and low ambient temperature may predispose to T1D development in children.

Keywords: Air pollution, Long-term exposure, Ozone, Temperature, Green space, Socio-economic factors



ABSTRACT E-BOOK

P-094

Exposures » Other (to be specified with keywords in the keywords section)

Multi-decade changes in pollen season onset, duration, and intensity: a concern for public health?

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BACKGROUND AND AIM: Climate change alters pollen seasons, a public health concern for the growing number of individuals with pollen sensitization. Prior aerobiological research has inconsistently applied definitions of the main pollen season (MPS) and drawn heterogeneous conclusions regarding the magnitude, directionality, and significance of long-term pollen trends. We aimed to better understand long-term shifts in MPS onset, duration and intensity through multi-definition analysis.

METHODS: We examined national pollen data in Switzerland between 1990 and 2020, applying six MPS definitions (two retrospective percentage-based, four prospective threshold-based) to twelve relevant allergenic plant species. We analyzed long-term pollen season changes using both linear regression and locally estimated scatterplot smoothing (LOESS).

RESULTS: For four of twelve plants, there is unanimity between the six definitions regarding earlier onset of the pollen season ($p < 0.05$), with magnitude of 31-year change, dependent on specific MPS definition (hazel: 9-18 days; oak: 5-13 days; grasses: 8-25 days; and nettle/hemp: 6-25 days). There is also consensus for altered MPS duration among hazel (21-104% longer), nettle/hemp (8-52% longer), and ash (18-38% shorter). Between-definition agreement is highest for MPS intensity analysis, showing significant increases in seasonal pollen quantity among hazel, birch, oak, beech, and nettle/hemp. The largest relative intensification is noted for hazel (110-146%) and beech (162-237%). LOESS analysis indicates that these multi-decade pollen changes are typically nonlinear.

CONCLUSIONS: Pollen season onset, duration, and intensity have changed for multiple allergenic plants in Switzerland. We found an increase in seasonal pollen quantity emitted for five of twelve species, thus increasing the exposure burden on the allergic population. We identify systematic between-definition differences affecting magnitude and significance of long-term trends, and suggest future studies addressing aeroallergen exposure apply multiple MPS definitions to minimize bias. Further research can determine whether these pollen season shifts correlate with longitudinal differences in population pollen sensitization.

Keywords: Climate, Exposure assessment, Environmental epidemiology, Allergies



ABSTRACT E-BOOK

P-095

Exposures » Other (to be specified with keywords in the keywords section)

Health impact assessment of COVID-19 confinement-related changes in environmental and health behaviour exposures on cardiovascular and mental health

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BACKGROUND AND AIM: COVID-19 confinement changed environmental and health behaviour exposures, which are risk factors for non-communicable diseases. We aimed to quantify changes in physical activity (PA) and nitrogen dioxide (NO₂) levels in response to confinements in Barcelona/Spain, Vienna/Austria, and Stockholm/Sweden, and estimate the number of myocardial infarction (MI), stroke, and depression diagnoses that would be prevented or in addition if observed changes in PA and NO₂ levels were sustained, e.g. over one year.

METHODS: Using the Urban and Transport Planning Health Impact Assessment tool, we calculated differences in exposure to PA and NO₂ between pre-pandemic levels (baseline) and the period of the first COVID-19 surge in Europe between March 15th and April 26th, 2020 (counterfactual exposure) separately, for all three cities. Exposure risk functions were used to estimate the relative risk of the outcome for such a difference in exposure, if the counterfactual scenario exposure levels were sustained. Then, we derived attributable fractions among adult population for the exposure difference.

RESULTS: PA decreased in Barcelona by 95±25%, in Vienna by 76±23%, and in Stockholm by 42±11%. If reduced PA levels in Barcelona were sustained, increases in the annual incidence would be as follows: MI:10% (95%CI: 4–16%), stroke: 10% (0–19%), and depression: 8% (5–10%). Measured NO₂ levels during the counterfactual period were in Barcelona:17.0±2.4ug/m³ (-50±14%), in Vienna:14.2±1.5ug/m³ (-22±10%), and in Stockholm: 11.2±1.1ug/m³ (-9±10%). If reduced NO₂ levels in Barcelona were prolonged, the following decreases in annual incidence would be anticipated for MI:5% (95%CI: -25–5%), stroke: -6% (-22–3%), and depression: -13% (-101–35%).

CONCLUSIONS: COVID-19 confinements in Barcelona, Vienna, and Stockholm resulted in decreases in PA and NO₂ levels in all three cities. With respect to MI and stroke incidences in all three cities, a prolonged decrease in NO₂ levels would not outweigh the detrimental health effects of concomitant physical activity declines as observed in the counterfactual period.

Keywords: health impact assessment, COVID-19 confinement, non-communicable disease, physical activity, air pollution



ABSTRACT E-BOOK

P-096

Exposures » Other (to be specified with keywords in the keywords section)

A Comparative Study on the Health Impact of Radiation on Residents close to Mobile Phone Base-stations in Lagos, Nigeria

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BACKGROUND AND AIM: The increase in public concern in the use of wireless technologies emitting radio-frequency electromagnetic radiation has been the subject of recent interest and study. The aim of this study, therefore, was to evaluate the effect of this radiation on the health related quality of life of residents close to these base stations.

METHODS: This is a comparative study, carried out in six communities with base-stations (BS) in the 3 senatorial districts in Lagos, Nigeria. Respondents were adults grouped into, group A (those living ≤150m from a BS) and group B (those living >150m from a BS). Data collection was via the use of a validated interviewer based questionnaire, for information on socio-demographics characteristics, subjective symptoms, while a WHO tool, short form health survey questionnaire (SF-36) consisting of eight scales, was also used to assess their health quality of life.

RESULTS: Analysis showed that there was no difference in the socio-demographic characteristics across the two groups. The mean age of respondents was 44.4 ±15.8 years, with 65% within 30-39 age group. Most were females (57.4%), and 60.3% were married. 41.16% and 32.9% had secondary and tertiary education, respectively. Most were into trading (37.2%) while 50.5% of respondents earned below the national minimum wage of ₦30,000. Out of the eight scales, emotional wellbeing/mental health was found significant after carrying out a bivariate analysis (p-value <0.05), while multivariate analysis showed (95% C.I = 1.05 – 8.30) after adjusting for confounders. Analysis of the different subjective-symptoms showed no significance across the two groups.

CONCLUSIONS: The study concludes that there is some association between emotional wellbeing/mental health and siting of base stations close to residences. Therefore, it recommends health/safety awareness, to calm these residences, as well as application of the precautionary principles while additional research is being carried out on their public health safety.

Keywords: non-ionizing-radiation, Base-stations, Exposure, Symptoms, environmental-epidemiology, mental health outcomes.



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-097

Exposures » Ionizing radiation

Ionizing radiation exposure during adulthood and risk of developing brain cancer and neurocognitive disorders: a systematic review and meta-analysis

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BACKGROUND AND AIM: Humans are daily exposed to low-dose ionizing radiation (IR), either from natural (cosmic, background radiation) or artificial (medical or industrial) sources. Many studies have suggested that low-dose IR could have a deleterious impact on the brain, but results are not consistent. This study aims to identify evidence from a wide range of literature and present a synthesis of findings on the impact of low-to-moderate doses IR exposure in adulthood on the risk of developing brain tumors and cognitive alterations.

METHODS: We performed a systematic review and meta-analysis following the PRISMA guidelines. Searches were performed using PubMed, Scopus, Web of Science and Google Scholar databases. Articles dealing with IR exposure and brain tumors and/or cognitive disorders in adults were retrieved and screened by two independent reviewers. IR exposure sources and scenarios included space travel, Chernobyl disaster, atomic bomb, occupational exposures in nuclear energy and medical sectors. The Newcastle-Ottawa scale for cohort and case-control studies was used for quality assessment. Pooled estimators were computed when quantitative data was available.

RESULTS: Out of the 3816 recorded articles, 83 studies were included in the systematic review. Most of the included studies did not demonstrate an increased risk or significant association between exposure to IR in adults and brain cancer. Likewise, there was no strong evidence that IR received during adulthood could have adverse effects on cognitive functions.

CONCLUSIONS: The present review does not suggest higher risk of developing brain tumors nor a deleterious impact on cognitive functions after exposure to IR during adulthood among the studied populations. However, the high variability of the assessment tools used by the different studies concerning cognitive disorders made it difficult to synthesize the results. Also, further studies with adequate dosimetry and dose-response assessments would be needed to support these conclusions. Quantitative results of the meta-analysis will be presented at the congress.

Keywords: Ionizing radiation, cancer and cancer precursors, mental health outcomes, epidemiology



ABSTRACT E-BOOK

P-098

Methods » Big data

Spatiotemporal characterization of urban activity and environment with imagery and deep learning

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BACKGROUND AND AIM: There are limited data on human activity and the environment needed to inform policies and target infrastructures to improve the health and wellbeing of residents in cities in sub-Saharan Africa, the world's fastest urbanising region.

METHODS: We collected a bespoke dataset of 2.10 million images in Accra, Ghana, captured at five-minute intervals over ~15 months at 145 representative locations. We retrained a convolutional neural network using a manually labelled subset of images to identify people (including street vendors) and 18 objects – categorised into large vehicles, small vehicles, two wheelers, objects from the market, refuse and animals – that collectively represent important features of human activity and the environment in the city.

RESULTS: We identified 23.5 million of these objects in our dataset. Of these, 9.66 million (41%) were humans, followed by cars (4.19 million; 18%). We found strong correlation among the number of people, large vehicles and market-related objects, which were typically captured in the business and commercial core and high-density residential areas; moderate correlation between these three categories and small vehicles; weak correlation with two wheelers; and inverse correlation with refuse and animals which were more common in the peripheral areas of the city. The frequency of objects changed throughout the day with the extent of variation dependent on the type of object and location. There were noticeable reductions in the number of people, vehicles and market related activity in commercial and business areas during the Covid-19 lockdown, but smaller reductions observed in high-density residential areas.

CONCLUSIONS: Contextual adaptation of computer vision tools can reduce the global gap in data on cities to advance sustainable and healthy urban development. Our data and approach have the potential to be applied to a range of urban environmental topics, including estimating road-traffic volume/flows and identifying sources of air and noise pollution.



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ABSTRACT E-BOOK

Keywords: Big data, imagery, deep learning, built Environment; covid-19; traffic-related



ABSTRACT E-BOOK

P-099

Outcomes » Childrens environmental health

A school-based water, sanitation, and hygiene intervention and children's nutrition status and hydration: a cluster-randomized controlled trial in Manila

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BACKGROUND AND AIM: Inadequate water, sanitation, and hygiene (WaSH) threatens the health of millions of children globally. Urban poor children suffer from health disparities because of inadequate WaSH facilities and limited availability of health education programs in schools. Our study aimed to evaluate the impacts of a school-based WaSH intervention on children's nutrition status and hydration in Manila, Philippines.

METHODS: We conducted a cluster-randomized controlled trial in 15 public schools, assigning two schools to the control group (CG) and randomizing 13 schools to one of three intervention groups (IGs), IGA, IGB, and IGC, which received low-, medium-, and high-intensity health education, respectively. The intervention consisted of: 1) WaSH policy workshops; 2) health education; 3) hygiene supplies; 4) WaSH facilities repairs. We measured: nutrition status (stunting, severe thinness, thinness, overweight, obesity) via anthropometry and the World Health Organization's standards; dehydration, defined as a urine specific gravity (USG) of 1.020 or greater, via urine test strips.

RESULTS: Our sample was 756 and 701 children at baseline and end-line (8 months later), respectively (retention rate ~93%). At baseline 11% of children were stunted and 32% did not have a "normal" weight. About 3% of children were severely thin, 5% were thin, 16% were overweight, and ~10% were obese. Almost 90% of children were dehydrated, including 62% of children who were severely dehydrated (USG = 1.030). After 8 months the prevalence rates of stunting and severe thinness decreased; the odds of stunting were significantly lower in IGA than in the CG. The odds of overweight were significantly lower in IGC than in the CG. Obesity prevalence increased in all study groups. Dehydration prevalence decreased in IGA, IGB, and IGC, compared to the CG.

CONCLUSIONS: We conclude that the intervention decreased children's stunting, overweight, and dehydration. Trials of age- and sex-specific WaSH interventions should be conducted in schools to reduce obesity.

Keywords: Outcomes, children's environmental health, epidemiology.



ABSTRACT E-BOOK

P-100

Methods » Modeling

Estimating the relative contribution of environmental and genetic factors to different aging traits by comprising correlated variables into risk scores

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BACKGROUND AND AIM: Several environmental factors such as air pollution and tobacco smoke can influence our health. The entirety of all environmental exposures from conception onwards has recently been termed as “exposome”. In addition to the exposome, most health outcomes are influenced by genetic factors. Estimating the extent to which each category of the exposome and genetic factors affect health outcomes is methodologically challenging, mainly because the predictors are often highly correlated.

METHODS: We propose to use weighted risk scores to assess the combined effects of categories of such predictors, and a measure of relative importance to quantify the relative contribution of each category. We determine the risk score weights via elastic net regression in a training dataset split off the sample data and estimate the relative contributions in the test dataset by the proportion of explained variance in linear regression. Randomness of the results due to splitting into training and test data is addressed with bootstrapping. We applied our approach to data from the population-based SALIA cohort study of elderly Caucasian women to estimate the relative contribution of, e.g., genetic factors, tobacco smoke, air pollution and obesity on two aging traits, skin aging and lung function (forced expiratory volume in 1 s, FEV1, and forced vital capacity, FVC).

RESULTS: Overall, our models explain 18% (95%-CI: [10%, 29%]) of the outcome’s variance for skin aging and 23% ([11%, 35%]) for lung function. Genetic factors make the largest contribution. While the risk scores for obesity, smoking and air pollution explain in sum only 2.9% ([0.5%, 8.6%]) of the variance in skin aging, about 8.5% of the variance in both lung function parameters are attributable to these risk scores (e.g., 8.6% [3.2%,15.6%] for FEV1).

CONCLUSIONS: Our approach enables to quantify contributions of categories of the exposome and genetic factors, which could facilitate risk assessment related to common diseases.

Keywords: Modeling, Risk assessment, Exposome, Respiratory Outcomes



ABSTRACT E-BOOK

P-102

Exposures » Ionizing radiation

A prospective cohort analysis of residential radon exposure and malignant melanoma mortality in the Swiss population

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BACKGROUND AND AIM: Radon is radioactive noble gas naturally found in earth crust and tend to accumulate in buildings. Studies suggest alpha particles emitted by radon can induce carcinogenic effect and long-term exposure to residential radon can contribute the risk of developing malignant melanoma. The purpose of this study was to investigate the association between residential radon and malignant melanoma mortality.

METHODS: 4.9 million adults were included from the Swiss National Cohort. Cox proportional hazard models were used to estimate hazard ratios (20+ years old; follow-up 2001-2016). Long-term modeled radon and average ambient ultra-violet exposures were assigned at baseline, and included in multi-pollutant models. With age as a time scale, the models were adjusted for calendar time, sex, marital status, education level, mother tongue, socioeconomic position, and outdoor occupation from job-exposure-matrix. Effect modification of adjusted variables on both exposures were investigated.

RESULTS: During ~13.6 years of follow-up, 3,979 malignant melanoma deaths as primary cause and 4,585 deaths including consecutive, concomitant, and initial diseases were observed. The adjusted hazard ratios per 100 Bq/m³ increase in residential radon at age 60 were 1.10 (95% CI: 0.99, 1.23) and 1.13 (95% CI: 1.02, 1.25) for primary cause and all causes, respectively. Association between residential radon and primary deaths from malignant melanoma modified by employment status at baseline and were stronger among females but the effect modification of sex was not statistically significant.

CONCLUSIONS: Residential radon exposure might contribute to mortality from malignant melanoma while accounting for important confounders. Accumulation of radon indoors is preventable and has public health importance.

Keywords: Ionizing radiation, mortality, environmental epidemiology



ABSTRACT E-BOOK

P-103

Methods » Environmental epidemiology

SOOPEN: a tailored systematic observation tool to assess children's physical activity and social interaction in schoolyards

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BACKGROUND AND AIM: Children frequently engage in diverse activities and behaviors that are broadly defined as play. The schoolyard recess offers a unique context for children to be physically active while freely engaging with peers in a variety of activities. Previous validated observational tools which evaluated children's physical activity during schoolyard recess do not collect social interactions (SOPLAY) or if assessed, it is at the individual level (SOCARP) not accounting for group dynamics. In this work, we developed the observational tool SOOPEN (System for Observing Outdoor Play Environments in Neighborhood Schools) to evaluate physical activity and social interaction dynamics at the group level during schoolyard recess.

METHODS: A first version of SOOPEN was designed combining SOPLAY and SOCARP indicators and was piloted in 4 public primary schools in Barcelona during autumn 2019. After two independent researchers had reviewed the initial results, changes were applied to refine the protocol and the fieldwork data recording form. Finally, in autumn 2020 the subsequent tool was used in 11 schools. Schoolyard recess was systematically assessed by two observers, simultaneously and independently, during two different days at each school. After the second cycle of observations, some adjustments were made to improve data recording uniformity regarding activity types, social interactions and shade cover. Exceptional protocol measures implemented in the schools concerning the COVID-19 pandemic were considered to better tailor the tool to the adapted schoolyard use.

RESULTS: The final SOOPEN tool protocol includes a set of coding rules and procedures to record 6 observational quantitative variables related to children's physical activity and social interaction during schoolyard recess at the group level.

CONCLUSIONS: SOOPEN represents a valuable step forward to evaluate children's physical activity and social interaction, providing objective and quantitative reliable data based on systematic observation, adapted to an exceptional scenario where current Covid-19 protocols have redefined the use of schoolyards.

Keywords: Methodological study design, Children's environmental health, Environmental epidemiology



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-104

Respiratory and Allergic Outcomes » Asthma

Acute exposures to air pollutants and asthma hospitalization in the Medicaid population

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BACKGROUND AND AIM: Few studies have investigated roles of air pollutants on asthma among disadvantaged population. It is also unclear whether some sub-populations or communities experience disproportionate risk from air pollutants.

METHODS: We estimated risk of asthma hospitalization associated with moving average exposures to particulate matter (PM_{2.5}), ozone (O₃), and nitrogen dioxide (NO₂) over lag 0 to 6 days among all individuals enrolled in Medicaid, the largest health coverage to Americans with low income or disabilities, 2000–2012, using a time-stratified case-crossover design. To assess the risk at low levels, we restricted the analysis to hospitalizations with exposure below increasingly stringent thresholds, including those well below the national standards. Further, we performed subgroup analyses by individual- and community-level characteristics.

RESULTS: We found positive associations between acute PM_{2.5}, O₃, and NO₂ exposures and risk of asthma hospitalization: 1- $\mu\text{g}/\text{m}^3$ increase in PM_{2.5}, 1-part per billion (ppb) increase in O₃, and 1-ppb increase in NO₂ was associated with 0.31% (95% confidence interval [CI], 0.27%–0.36%), 0.11% (95% CI, 0.07%–0.15%), and 0.28% (95% CI, 0.25%–0.32%) increase in risk of asthma hospitalization, respectively. At low exposure levels, we found greater risk associated with PM_{2.5} and NO₂. Further, we found consistently higher risk for the three exposures among beneficiaries with only one hospitalization during study period and communities with lower population density, higher average BMI, and longer distance to the nearest hospital.

CONCLUSIONS: Our study adds to the existing body of research on acute effects of air pollutants on asthma, bridges the gaps in environmental health disparities, and is useful in informing policy. We found increased risk of asthma hospitalization associated with acute exposures to PM_{2.5}, O₃, and NO₂ among Medicaid beneficiaries, even at levels well below the national standards. Subgroup analyses suggest that beneficiaries with mild to moderate symptoms and those living in disadvantaged communities experienced disproportionately higher risk from the pollutants.

Keywords: Mixtures, Short-term exposure, Asthma, Environmental disparities, Socio-economic factors



ABSTRACT E-BOOK

P-105

Outcomes » Childrens environmental health

Prenatal exposure to metal mixtures and lung function in children from the New Hampshire Birth Cohort Study

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BACKGROUND AND AIM: Prenatal environmental exposure to metals and metalloids (referred to as “metals”) has been associated with childhood lung development, but limited data exist on metal mixtures. We aimed to investigate the association between gestational exposure to metal mixtures and childhood lung function among 267 maternal-child dyads from the New Hampshire Birth Cohort Study.

METHODS: Maternal ~24-28-week gestational urinary arsenic speciation, aluminum, cadmium, cobalt, chromium, copper, iron, mercury, manganese, molybdenum, nickel, tin, lead, antimony, selenium, thallium, uranium, vanadium and zinc concentration were assessed using inductively coupled plasma mass spectroscopy (ICP-MS). Forced vital capacity (FVC), forced expiratory volume in the first second of exhalation (FEV1), and forced expiratory flow between 25% and 75% of FVC (FEF25-75) standardized z-scores were obtained at a median age of 7.4 years. We used quantile g-computation for each outcome and urinary metals adjusted for maternal smoking status, children’s age, sex and height.

RESULTS: Urinary concentrations of cobalt, lead, nickel, cadmium, and chromium were inversely associated with lung function z-scores. Arsenic concentrations were inverse associated specifically with FVC and FEV1 z-scores. In contrast, lung function z-scores increased with vanadium, molybdenum, and thallium urine concentrations.

CONCLUSIONS: Our findings suggest that prenatal exposure to metal mixtures impact lung function, with varying direction and magnitudes of effects.

Keywords: mixture, heavy metals, children’s environmental health, respiratory outcomes, biomarkers of exposure



ABSTRACT E-BOOK

P-106

Respiratory and Allergic Outcomes » Asthma

Associations between maternal asthma and atopy and breast milk-derived extracellular vesicle microRNA profiles in the PRISM pregnancy cohort

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BACKGROUND AND AIM: Maternal asthma is associated with adverse infant and child health including preterm birth and respiratory outcomes. Breast milk contains extracellular vesicle (EV)-encapsulated microRNAs, a form of mother-infant biochemical communication and may represent one pathway by which maternal health impacts child development and health. In this study we investigated associations between maternal asthma and atopy and EV-microRNA profiles in the PRogramming of Intergenerational Stress Mechanisms (PRISM) pregnancy cohort.

METHODS: EVs were isolated from breast milk collected from N=80 mothers 6.1±5.9 weeks postnatally. RNA was extracted and profiled using the TaqMan OpenArray Human miRNA panel. We analyzed associations between maternal asthma and atopy (active during pregnancy and ever) and microRNA detection (yes/no; N=172 microRNAs identified in 20-80% of samples) using logistic regression and expression levels (N=205 microRNA identified in >50% of samples) using robust linear regression adjusted for infant sex, maternal race, education, and postpartum week of breast milk collection.

RESULTS: Asthma and atopy during pregnancy were associated with detection of 3 and 6 microRNAs ($p < 0.05$), and expression levels of 27 and 12 microRNAs (a priori criteria: $p < 0.05$ and $|\text{Bregression}| > 0.2$), respectively. Enriched KEGG pathways for microRNAs differentially expressed with asthma or atopy during pregnancy included glycosaminoglycan biosynthesis, extracellular matrix-receptor remodeling, and PI3K-Akt signaling pathway. There was a trend toward fewer microRNAs associated with maternal asthma and atopy ever (detection: N=3 associated with asthma ever, N=9 associated with atopy ever; expression levels: N=14 associated with asthma ever; N=9 associated with atopy ever).

CONCLUSIONS: Maternal asthma and atopy were associated with detection and expression of breast-milk derived EV-microRNA. Atopy was associated with detection of a greater number of microRNAs, whereas asthma was associated with expression of a greater number of microRNAs. Further research is needed to understand how breast milk microRNAs may affect biological pathways and child health outcomes.



ABSTRACT E-BOOK

Keywords: children's environmental health, asthma, birth outcomes, epigenomics

P-107

Respiratory and Allergic Outcomes » Respiratory outcomes

Predicting high-resolution spatial and temporal variations in summer air temperatures and its effect on asthma and myocardial-infarctions in Montreal, Canada

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BACKGROUND AND AIM: To develop and apply new high-resolution models of within-city spatiotemporal variations in summer air temperatures in Montreal, Canada and evaluate associations with emergency room visits for asthma and myocardial.

METHODS: We developed a new model to predict temperatures across Montreal using a large database of temperature measurements collected from 200 sites across Montreal during the summers of 2018 and 2019. Using these data, we conducted a case crossover study of daily temperature and emergency room visits for asthmas and myocardial infarctions between 2014-2018. Conditional logistic regression models were analyzed using traditional fixed-site monitors and our new high-resolution models.

RESULTS: There was a positive association between daily mean temperature and myocardial infarction using both fixed-site temperature data [OR=1.076 (95% CI: 1.0081-1.149) per 5oC] as well as our new high-resolution model [OR = 1.077 (95% CI: 1.0098-1.148) per 5oC]. Among older women, temperature was more strongly associated with myocardial infarction using our new high-resolution mode (OR = 1.147 (95% CI: 1.0057, 1.309) per 5oC] compared to fixed-site measurements [OR = 1.104 (95% CI: 0.9963, 1.304) per 5oC]. There was a negative association in individuals below the median age of 57 who had asthma using the fixed temperature site [OR = 0.7001 (95% CI: 0.5315-0.9222) per 5oC] as well as the high-resolution model [OR = 0.7423 (95% CI: 0.5710-0.9649) per 5oC].

CONCLUSIONS: Daily variations in summer temperatures are positively associated with acute myocardial infarction. Stronger associations were generally observed using our new high-resolution estimates of spatio-temporal variations in temperature compared to traditional fixed site measurements.

Keywords: Asthma, myocardial infarctions, case-crossover study, heatwaves, extreme temperatures



ABSTRACT E-BOOK

P-108

Respiratory and Allergic Outcomes » Asthma

Organophosphate Ester (OPE) Exposures and Asthma Morbidity Among Urban School-Aged Children in Baltimore City, Maryland

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BACKGROUND AND AIM: OPEs are used as flame retardants and plasticizers in many consumer products. Studies suggest OPEs may be linked with respiratory outcomes among children. We aimed to examine associations between OPEs and asthma morbidity among 179 mostly Black children (93%), aged 5-12 years with asthma enrolled in a panel study between 2009-2013- in Baltimore City.

METHODS: The panel study included up to four seasonal, week-long in-home visits. We collected urine samples on visit-days 4 and 7 (n = 618 samples). We quantified concentrations of 9 OPE metabolites: bis(2-chloroethyl)phosphate(BCETp), bis(1-chloro-2-propyl)phosphate(BCPP), bis(1-chloro-2-propyl)phosphate(BDCPP), di-benzylphosphate(DBuP), di-benzylphosphate(DBzP), di-o-cresylphosphate(DOCP), di-p-cresylphosphate(DPCP), diphenyl-phosphate(DPHP), and 2,3,4,5-tetrabromobenzoic acid(TBBA). At each visit, participants self-reported asthma symptoms. We calculated Spearman's rank (continuous) and tetrachoric (binary) correlation coefficients to assess variability of concentrations on days 4 and 7 and intraclass correlation coefficients (ICCs) to assess variability by visit. We assessed associations between metabolite concentrations and asthma symptoms using logistic regression models with generalized estimating equations. We examined BDCPP and DPHP as continuous variables; dichotomized BCETp, DBuP, and DPCP; and excluded others not frequently detected. We adjusted models for season, visit-day, age, race, sex, BMI, caregiver education, and household income.

RESULTS: Detection frequencies were >95% for BDCPP and DPHP, 4.6-31.1% for BCETp, DBuP and DPCP, respectively and <3% for all other metabolites. OPE concentrations on days 4 and 7 were moderately correlated ($\rho=0.3-0.6$) with low reproducibility across visits ($ICC=0.2-0.4$). In adjusted models, higher DPHP concentrations were associated with greater odds of self-reported difficulty breathing (odds ratio [OR]: 2.0; 95%CI:1.1-3.6), activity limitation due to asthma (OR:1.6; 95%CI:1.0-2.8), and being bothered by asthma (OR:1.9; 95%CI:1.2-3.2). No associations were observed with other OPEs.

CONCLUSIONS: In this predominantly pediatric Black cohort, higher DPHP concentrations were consistently associated with asthma symptoms. We did not observe consistent patterns of association between other OPE metabolites and asthma morbidity.

Keywords: Biomarkers of exposure, Respiratory outcomes, Children's environmental health,



ABSTRACT E-BOOK

Environmental disparities, Environmental epidemiology

P-109

Outcomes » Other (to be specified with keywords in the keywords section)

Effects of poor sleep quality and sleep-disordered breathing and kidney function in adults

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BACKGROUND AND AIM: Obstructive sleep apnea (OSA) and poor sleep quality are associated with chronic kidney disease (CKD) in adults due to inadequate oxygenation resulting in inflammation, oxidative stress and glomerular/tubular dysfunction.

METHODS: In this cross-sectional study, we investigated the association between sleep and kidney function among 24,571 adults who underwent polysomnography (PSG) at a rural healthcare system in Pennsylvania between 2005 to 2020. Serum creatinine was abstracted from the EHR up to 12 months prior to the PSG and used to calculate estimated glomerular filtration rate (eGFR). CKD was defined as an eGFR < 60 mL/min/1.73m². OSA was defined as an apnea-hypoxia index ≥15. Poisson regression was performed to estimate the prevalence ratio (PR) of CKD for various sleep measures while adjusting for age, sex, race, smoking (never, former, current), and body mass index at time of PSG.

RESULTS: In this clinically referred sample, the average age was 51, 49% male, 95% white, and 16% currently smoked. The prevalence of CKD and OSA was 11% and 35%, respectively. Patients with CKD were older, higher percentage female, more likely to be former smokers, had more OSA, and lower average sleep efficiency (SE). Having OSA was associated with an 18% increase in CKD (95% CI: 1.10, 1.27). In addition, for every 5% increase in SE, the prevalence of CKD decreased by 4% (PR=0.96, 95% CI: 0.94, 0.97). Associations were also found with percent time with an oxygen saturation < 90% and the number of sleep stage changes. In the subset of African Americans, the effects for OSA and SE were stronger.

CONCLUSIONS: Future assessments will examine potential health disparities as well as effects of sleep quality on rate of eGFR decline and CKD progression. These findings build on the nascent literature linking disordered breathing and poor sleep quality with CKD although reverse causality cannot be ruled out.

Keywords: environmental epidemiology, Non-chemical stressors, Outcomes, chronic kidney diseases, sleep



ABSTRACT E-BOOK

P-110

Respiratory and Allergic Outcomes » Asthma

Using Bayesian time-stratified case-crossover models to examine associations between air pollution and “asthma seasons” in a low air pollution environment

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BACKGROUND AND AIM: Many areas of the United States have air pollution levels typically below Environmental Protection Agency (EPA) regulatory limits. However, despite evidence suggesting temporally-misaligned intra-annual periods of relative asthma burden, “asthma seasons”, most studies of the health effects of air pollution use meteorological (e.g., warm/cool) or astronomical (e.g., solstice/equinox) definitions of seasons. We introduce asthma seasons to elucidate whether air pollutants were associated with seasonal differences in asthma emergency department (ED) visits in a low air pollution environment.

METHODS: Within a Bayesian time-stratified case-crossover framework, we quantified associations between highly resolved estimates of six criteria air pollutants and asthma ED visits among 66,092 children ages 5-19 living in South Carolina (SC) census tracts over 2005-2014. Asthma seasons were defined by a late, short, and medium burden (16.5 visits/day) Winter, an early and short Spring with medium-high burden (18.9 visits/day), an early and low burden (9.4 visits/day) Summer, and an early and long Fall with high burden (23.5 visits/day).

RESULTS: Coarse particulates (particulate matter <10 μ m and >2.5 μ m: PM_{10-2.5}) and nitrogen oxides (NO_x) may contribute to asthma ED visits across years, but were particularly implicated in the highest burden Fall. Allergenic antigens of respirable size from Fall-blooming plants (e.g., ragweed) should be further investigated as a potentially salient seasonal PM_{10-2.5} component. Fine particulate matter (<2.5 μ m: PM_{2.5}) was only associated in the lowest-burden Summer. Relatively cool and dry conditions in the Summer often following thunderstorms were associated with increased odds. Few significant associations in the medium-burden Winter and Spring suggest other drivers (e.g., viruses in Winter) for each, respectively.

CONCLUSIONS: Even in a low pollution area, there were acute health effects associated with criteria air pollution, but mainly in the Summer and Fall asthma seasons. Future research should explicitly investigate local asthma seasons as well as the seasonal components of PM and other mixtures.

Keywords: asthma, allergies, air pollution, particulate matter, respiratory outcomes, environmental epidemiology



ABSTRACT E-BOOK

P-111

Respiratory and Allergic Outcomes » Asthma

The Association of Environmental Factors and COVID19 on Acute Pediatric Asthma-Related Healthcare Utilization in New York City: A Retrospective Analysis

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BACKGROUND AND AIM: Asthma is a multifactorial disease with well-established environmental triggers that contribute to asthma exacerbations, often requiring acute medical attention. During the onset of the COVID-19 pandemic, healthcare utilization patterns for both preventive and acute services were altered. We aim to identify how the rates of pediatric emergency department (ED) visits and hospitalizations for asthma were impacted by the COVID-19 pandemic in a hospital setting in New York City (NYC).

METHODS: A time series analysis for pediatric asthma-related ED visits and hospitalizations will be analyzed from 3/1/2015 to 2/28/21. Using this data we will develop a statistical inference system to identify healthcare utilization patterns for asthma exacerbations attributable to various environmental triggers (i.e., air pollutants, pollens, infectious agents).

RESULTS: Pediatric asthma-related ED visits and hospitalizations decreased by 78% and 75%, respectively, during the first year of the pandemic (3/1/20-2/28/21). During the initial 12 weeks following NYC's PAUSE order (March 22nd, 2020) a 92% reduction in admissions was observed, relative to the same time period the previous year. We plan to use environmental exposure data to make projections of the number of ED visits and hospitalizations that would have been expected during the 1st year of the outbreak and will then compare this projected data to the observed asthma-related encounters. This counterfactual simulation will provide us insight into the difference between expected and observed asthma-related acute healthcare utilization during the pandemic.

CONCLUSIONS: It is important to develop an inference system to provide insight on how changes in behavioral patterns and environment exposures affect asthma-related health care utilization, in order to plan current and future public health interventions in a timely manner.

Keywords: Asthma, COVID-19, Children's environmental health, Policy research, Environmental justice



ABSTRACT E-BOOK

P-112

Respiratory and Allergic Outcomes » Respiratory outcomes

Tuberculosis incidence among health workers in Brazil from 2008 to 2018

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BACKGROUND AND AIM: Tuberculosis (TB) is a major public health challenge, especially for the lower income countries, which account for over 95% of cases. **OBJECTIVE:** To present TB incidence and coefficients among health workers in Brazil, from 2008 to 2018.

METHODS: Descriptive study using TB records among health workers of both sexes registered in the Information System for Notifiable Diseases (Sinan), the official Brazilian database. Absolute and relative frequencies, variation, and coefficients of incidence and mortality were presented for health workers. Relative risk (RR) and mortality ratio were calculated considering the general population.

RESULTS: In Brazil, 10,728 cases of TB were reported among health workers from 2008-2018, rising from 793 cases in 2008 to 1,220 in 2018 (+54%). About 34% of cases occurred among men and 66% among women. The incidence coefficient remained stable in the period, going from 68.3 to 67.1 (x100,000 health workers) in 2008 and 2018, respectively (mean=66.5). In the period, 77 and 50.602 deaths occurred among health workers and general population, respectively. Compared to the general population, RR was 40% higher, and the mortality ratio was 80% lower among health workers (mean = 2.3 and 0.5 x100,000).

CONCLUSIONS: An increased risk of TB was observed among health workers compared to the general population. However, the lower mortality rate suggests that health workers have better access to health treatment and higher recovery rates. It is highly recommended the promotion of continuous measures to prevent TB and to protect the health of workers exposed to biological risks, such as improving work organization and process and implementing actions to eliminate or minimize the related risks.

Keywords: Respiratory outcomes, Infectious diseases, Occupational exposures



ABSTRACT E-BOOK

P-113

Respiratory and Allergic Outcomes » Asthma

Impact of COVID-19 on Pediatric Asthma-related Healthcare Utilization in New York City: A Community-Based Study

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BACKGROUND AND AIM: Emerging data suggests that during the Coronavirus Disease-19 (COVID-19) pandemic care for chronic health conditions, such as asthma, decreased. Nationally, children were 84% less likely to seek care for asthma in emergency departments during the initial stages of the pandemic compared to the same period in 2019; little is known about the various barriers to asthma-related care for children during this time. Here, we aim to understand the impact of COVID-19 on two adjacent neighborhoods with historic differences in social determinants of health by evaluating their access and need for acute and chronic healthcare in New York City (NYC) during the pandemic.

METHODS: We will conduct a community-based participatory survey of families in each neighborhood: 25 families from East Harlem (EH) and 25 families from the Upper East Side (UES). There are documented disparities in asthma-related health outcomes between these neighborhoods, where the prevalence of asthma is 3.5 times greater in school-aged children in EH compared to the UES. We will include families with children who have active asthma between 5 and 17 years of age. This survey will evaluate differences in environmental conditions, including the built environment, social determinants of health and health care utilization during the first 6 months of the pandemic (March 1st through August 31st 2020).

RESULTS: We will present survey responses and analyze the differences in environmental exposures, social determinants of health and healthcare utilization during the pandemic in each respective neighborhood.

CONCLUSIONS: Our community-based survey results will identify differences regarding environmental exposures as well as barriers and facilitators to healthcare during the initial stages of the COVID-19 pandemic in two distinct neighborhoods in NYC. These data provide an initial step in identifying potential areas of concern to inform future public health interventions and clinical responses to optimize care in vulnerable communities.

Keywords: Asthma, Respiratory outcomes, Children's environmental health, Environmental disparities, Socio-economic factors (non-chemical stressors), COVID-19



ABSTRACT E-BOOK

P-114

Respiratory and Allergic Outcomes » Allergies

Lag associations of four types of pollens with respiratory mortality in Michigan 2006-2021

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BACKGROUND AND AIM: Research on associations between pollen and mortality from respiratory-related causes, such as pneumonia and chronic obstructive pulmonary disease (COPD), is limited. Levels of plant-based aeroallergens such as common ragweed are rising as growing seasons lengthen and CO₂ levels rise. We determined associations of four species of pollens, ragweed, deciduous trees, grass and evergreen trees with pneumonia and COPD-related mortality in Michigan, USA.

METHODS: Death records were obtained for all deaths within Michigan for the years 2006 through 2021 from the Michigan Department of Health and Human Services (MDHHS). The dataset was filtered on specific causes of death based on International Classification of Diseases (ICD) codes. Pollen data came from a prognostic model based raster of daily pollen counts at 25km resolution. Case-crossover models with distributed lag non-linear bases for pollen were used to test associations between lags of daily pollen counts with mortality.

RESULTS: Among 1,399,714 deaths between 2006 and 2021, 130,584 were from all respiratory causes, 71,427 from COPD and 22,723 from pneumonia. Of the four pollen types, only ragweed was found to be associated with all-cause respiratory mortality, and only for high concentrations (100-200 grains/m³) at lags 5-8. Similarly, only ragweed was associated with deaths from COPD and only at lags 4-8 for high concentrations (100-300 grains/m³.) Short term exposures (lags 0-2) of increasing intensity to grass pollens were suggestive of increased risk of death from pneumonia, but this relationship was not significant.

CONCLUSIONS: Our results suggest relationships of exposures of pollens of specific plants with specific causes of death. Intense exposure to ragweed pollens may increase risk for mortality from COPD or other respiratory causes, and grass pollens might be associated with death from pneumonia. Future work will consider how model-based predictions of pollen counts can be used to test associations of pollen exposure with mortality risk over wide areas.

Keywords: allergy, pollen, climate change, respiratory, copd, mortality



ABSTRACT E-BOOK

P-115

Respiratory and Allergic Outcomes » Asthma

Impacts of Urbanization and Climate Change on Asthma and Chronic Bronchitis in Sub-Saharan Africa: A Systematic Review of the Literature

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BACKGROUND AND AIM: With climate change and globalization, range and intensity of exposures to aerosol pollutants and the number of people exposed to them is increasing. Research has shown that incidence of asthma and chronic bronchitis is increasing in much of the world. Less well understood, however, is how asthma and chronic bronchitis is characterized in countries in Sub-Saharan Africa (SSA.) This research systematically reviewed the literature on asthma and chronic bronchitis and how they are influenced by environmental factors associated with urbanization and climate change in Sub-Saharan African countries.

METHODS: We searched PubMed using key words "asthma" "chronic bronchitis" and "urbanization," "climate change" and "air pollution" restricting the search to the 40 countries considered to comprise SSA. Only papers published in scholarly journals, with a defined health outcome and written in English were considered for inclusion. All potentially included papers were entered into a database for review.

RESULTS: Preliminary analysis demonstrates 117 papers were found. Among these, 57 met the inclusion criteria. These papers comprised studies from 13 countries. 34 of these were from just two countries, South Africa (24 papers) and Nigeria (10 papers) leaving just 23 papers from other regions. Research covered subjects as diverse as impacts of ambient air pollution, individual household and environmental risk factors in urban versus rural areas, influence of socioeconomic status and biomass fuel exposure. Populations of interest included adults, adolescents and schoolchildren.

CONCLUSIONS: The paucity of research on asthma and chronic bronchitis in developing countries is pronounced within the African continent, especially when evaluating the impacts of climate change. Future work is needed to understand how climate change, urbanization and exposures to aero-allergens and particulate matter will impact incidence of asthma and chronic bronchitis in SSA. Research should also work to identify solutions to promote environmental health and equity among urban populations in SSA.

Keywords: Asthma, Chronic Bronchitis, Urbanization, Air Pollution, Climate Change, Environmental Justice



ABSTRACT E-BOOK

P-116

Air pollution » General

North Carolina's Changing Energy Generation Profile and Reductions in Key Air Pollutants, 2000-2019

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BACKGROUND AND AIM: Coal combustion releases a number of airborne toxins. The North Carolina (NC) Clean Smokestack Act of 2002 required coal-fired power plants (CFPP) to reduce nitrogen oxide (NOX) emissions by 2009 and sulfur dioxide (SO₂) emissions by 2009 and 2013. The purpose of this analysis is to corroborate the effectiveness of the Clean Smokestacks Act at reducing air pollution across NC and assess a major policy that aimed to benefit environmental health.

METHODS: We utilized publicly available databases from the Energy Information Administration and the Environmental Protection Agency to characterize NC's electricity generation profile from 2000 until 2019 and evaluate corresponding NOX and SO₂ emissions by sector over the same time period.

RESULTS: Between 2000-2008 in NC, approximately 60% of electric power was generated by coal-fired plants. Since then, NC's electric power generation has transformed from predominate dependence on coal to approximately equal dependence on natural gas and nuclear power (each at ~30%), with coal close behind (~25%). Renewables have increased, although marginally compared with the rapid increase in natural gas. Despite the stark drop in reliance on CFPPs for energy in NC, and subsequent drop in emissions, CFPPs still contribute ~60% of SO₂ air pollution as of 2017.

CONCLUSIONS: While this analysis relies upon utilities' self-reported electricity generation and emissions data and publicly available data from federal agencies, the data support environmental health policy and research purposes. NC's electric utilities met the 2009 and 2013 regulatory benchmarks set by the Clean Smokestack Act, which resulted in substantial reductions in SO₂ emissions from the fuel combustion electric generation sector. Still, CFPPs remain the predominant utility-related contributor of SO₂ air pollution in NC.

Keywords: air pollution, sulfur dioxide, coal, natural gas, policy, North Carolina



ABSTRACT E-BOOK

P-117

Policy » Research translation to affect policy and practice

Interactive webbased figure to communicate health effects of ambient air pollution

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BACKGROUND AND AIM: With an ever increasing number of publications on ambient air pollution and its effects on human health it has become difficult to distinguish between causal and accepted effects of air pollutants and suggested effects. We aimed at finding an appealing way to better communicate the accepted short-term and long-term health effects of ambient air pollution.

METHODS: The US EPA's integrated science assessments analyze the level of evidence for health effects of the "criteria pollutants" including particulate matter (PM), oxides of nitrogen (e.g. NO₂), ozone, sulfur dioxide (SO₂) and carbon monoxide (CO). The EPA assesses the relationship between pollutants and potential health effects using a five-point scale. The levels "causal" and "likely to be causal" are the two highest levels on this causality scale. We have translated the causal and likely to be causal relationships into an interactive figure and table.

RESULTS: RESULTS: The interactive figure shows the affected organs and lists the associated health effects.

CONCLUSIONS: We have received positive feedback on our interactive figure and like to invited the research community to share this tool.

Keywords: Communicating evidence to the public, policy, air pollution, communication, short-term effects, long-term effects, research translation to affect policy and practice



ABSTRACT E-BOOK

P-118

Air pollution » General

Associations Between Outdoor Air Pollution and the Retinal Microvasculature in School-aged Children in a Region Impacted by Residential Biomass Burning

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BACKGROUND AND AIM: Disruptions to the microcirculation may be an important pathway by which fine particulate air pollution (PM_{2.5}) and oxidant gases contribute to cardiovascular disease. To date, little is known about the early-life cardiovascular health impacts of air pollution. This study aimed to evaluate associations between outdoor air pollution (PM_{2.5} and oxidant gases) and retinal blood vessel diameter (a measure of microvascular health) in children living in a region impacted by residential biomass burning.

METHODS: In this repeated-measures panel study in rural British Columbia, Canada, a median of 6 retinal vessel measurements were collected from 64 children (ages 4-12 years), for a total of 344 retinal measurements. Daily mean PM_{2.5}, nitrogen dioxide (NO₂) and ozone (O₃) were measured, and the combined oxidant capacity of NO₂ and O₃ was calculated using a redox-weighted average (Ox). Linear mixed-effect models with a random subject intercept were used to estimate associations between PM_{2.5} or Ox (same-day, 3-day, 7-day, and 21-day means) and the diameter of retinal arterioles and venules, adjusting for confounding variables. Models with an interaction term between PM_{2.5} and Ox were also run to assess whether associations between PM_{2.5} and retinal vessel diameter were modified by Ox.

RESULTS: Ox was inversely associated with retinal arteriolar diameter, with the strongest association observed for 7-day mean exposures: each 10 ppb increase in Ox was associated with a 2.63 µm decrease in arteriolar diameter (95% confidence interval: -4.63, -0.63). Moreover, Ox modified associations between PM_{2.5} and arteriolar diameter, with weak inverse associations observed between PM_{2.5} and arteriolar diameter only at higher concentrations of Ox.

CONCLUSIONS: Our results suggest that outdoor air pollution has a measurable impact on the microvasculature of children. Moreover, our findings indicate that interactions between PM_{2.5} and Ox may play a role in determining the magnitude and direction of these associations.

Keywords: children's environmental health, particulate matter, ozone, cardiovascular diseases, short-term exposure



ABSTRACT E-BOOK

P-119

Outcomes » Other (to be specified with keywords in the keywords section)

Secondhand smoke and functional impairments in older adults

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BACKGROUND AND AIM: Secondhand smoke (SHS) is a risk factor of coronary heart disease, lung cancer, and stroke. Recent cross-sectional evidence suggests that it may also increase the risk of functional limitations, especially among older adults

METHODS: We included data from 2828 community dwelling non-smoking older adults from the Seniors-Enrica-2 cohort (Madrid, Spain). Exposure to SHS was assessed by serum cotinine concentrations. At baseline (2017) and follow-up (2019), overall physical function was evaluated using the Spanish version of the physical component summary (PCS) of the 12-Item Short-Form Health questionnaire, lower-extremity performance with the Short Physical Performance Battery (SPPB), muscle weakness with a dynamometer, frailty with a Deficits Accumulation index (DAI), and disability in instrumental activities of daily living (IADL) with the Lawton-Brody questionnaire. Cross-sectional analyses were performed using linear and logistic regression models. Repeated measures models used robust standard error estimates to account for within-participant correlations induced by repeated measurements

RESULTS: The median (IQR) concentrations of serum cotinine was 0.079 (0.035-0.175)ng/mL. After adjustment for potential confounders including sex, age, social class, civil status, tobacco exposure in the past, physical activity and BMI, and compared to participants with cotinine concentrations below the limit of detection (0.05ng/mL), those in the highest quartile of exposure (≥ 0.239 ng/mL) showed baseline mean differences (95%CI) in the PCS, SPPB and muscle strength of -1.43 (-2.68,-0.18) points, -0.26 (-0.47,-0.06) points, and -1.21 (-1.92, -0.49) kilos; as well as a higher mean accumulation of deficits [2.62 (1.51,3.73)] and a higher odds of IADL limitations [1.38 (0.89, 2.14)]. In prospective analyses, the corresponding figures were -1.11 (-2.52,0.21) for PCS, -0.30 (-0.53,-0.07) for SPPB, -1.02 (-1.90,-0.13) for muscle weakness, 1.90 (0.64,3.16) for DAI and 1.15 (0.59,2.23) for IADL disability

CONCLUSIONS: These findings suggest that exposure to SHS during old age may influence functional decline. If confirmed, more efforts would be needed to protect older adults from SHS

Keywords: Secondhand smoke, functional decline, ageing



ABSTRACT E-BOOK

P-120

Air pollution » Ozone

Short-term associations between ground-level ozone exposure and urinary system disease hospital admissions through the emergency room in Beijing, China

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BACKGROUND AND AIM: There is limited evidence on effects of ground-level ozone exposure on urinary system disease (USD). The aim of this study is to assess the association between short-term exposure to ground-level ambient ozone and risk of USD morbidity in Beijing, China.

METHODS: We obtained data on daily average ozone concentrations from 35 fixed monitoring stations, and data on hospital admissions through the emergency room from secondary and tertiary hospitals in Beijing during 2013-2018. USD cases were extracted based on the primary diagnosis ICD-10 code (N00-N39). We estimated district-specific associations between ozone and daily counts of USD admissions on weekdays, using generalized linear models with a quasi-Poisson distribution and controlling for temperature and relative humidity in the model; and then pooled the district-specific estimates using random-effect meta-analysis. Lagged and cumulative effects were evaluated. Effect modification by season and confounding effects from co-pollutants (i.e., PM₁₀, PM_{2.5}, NO₂, SO₂, and CO) were assessed.

RESULTS: We included 41,203 weekday USD admissions. An interquartile range increase of daily ozone exposure at lag 0 day was associated with 4.1% (95% confidence interval: 1.3%-6.9%) higher risk of USD admissions during the warm season (April to September), and was not associated with USD admission risk during the cool season (October to March), with no significant heterogeneity across districts. The heterogeneity of risk estimates between the warm and cool seasons was significant (I²=83%, Q=5.9, p-value=0.015). No lagged or cumulative associations were found. The association of warm-season ozone with risk of USD admissions was robust to adjustment for co-pollutants.

CONCLUSIONS: Short-term exposure to higher ozone pollution is a risk factor for USD in Beijing during the warm season. This finding suggests that USD is a potential adverse health outcome of short-term ozone exposure.

Keywords: Ozone, short-term exposure, urinary system disease



ABSTRACT E-BOOK

P-121

Air pollution » Ozone

Associations between short-term ambient ozone exposure and cause-specific mortality in the rural and urban areas of Jiangsu, China

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BACKGROUND AND AIM: Ambient ozone pollution has been worsening in China. However, current understanding on the acute health effects of ozone is limited to urban areas, partly due to the paucity of air pollutant measurements in rural areas. We here applied modeled ambient ozone exposure covering both rural and urban areas to evaluate the associations between short-term ozone exposure and cause-specific mortality in Jiangsu Province, China, 2015-2018.

METHODS: We divided a total of 86 Jiangsu counties equally into urban and rural based on the median value of the percentage of urban residents across Jiangsu counties. We estimate the county-specific daily maximum 8-hour average ozone concentration using a recently developed spatiotemporal machine learning model in China at a resolution of $0.1^\circ \times 0.1^\circ$. We first estimated county-specific effect of ozone using generalized linear models, adjusting for long-term and seasonal trend, day of week, temperature, and humidity. We then pooled the overall urban and rural area estimates by random-effects meta-analysis.

RESULTS: Short-term ambient ozone exposure was associated with mortality of non-accidental cause in rural areas (percentage increase in mortality per $10 \mu\text{g}/\text{m}^3$, 0.45%; 95% confidence interval [CI], 0.29%-0.61%) and urban areas (0.36%; 95% CI, 0.23%-0.49%). The association was significant for mortality caused by respiratory disease or cardiovascular disease in both areas. Our results remain similar after additional adjustments for $\text{PM}_{2.5}$ and alternative methods of controlling temperature.

CONCLUSIONS: Short-term ambient ozone exposure was associated with increased risk of cause-specific mortality, and the effect size of ozone in rural areas was similar to that in urban areas in Jiangsu Province. This finding suggests that residents in rural areas also suffer adverse health effects from short-term ozone exposure.

Keywords: Air pollution, Ozone, Short-term exposure, Mortality



ABSTRACT E-BOOK

P-122

Air pollution » General

Air pollution, Telomere length and Mortality- A systemic review

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BACKGROUND AND AIM: Adverse effects of air pollution on cardiovascular morbidity, mortality, and all-cause mortality have been demonstrated over the last few decades. Acceleration of biological aging by air pollution could be a plausible underlying mechanism. Telomeres are tandem repetitive DNA complexes, considered as one of the critical markers of aging. This study sought to review the existing literature on the association between air pollution and telomere length (TL) as well as the association between TL and mortality to elucidate the underlying mechanism between air pollution and mortality.

METHODS: We have searched on electronic databases including PUBMED, SCOPUS, and WEB OF SCIENCE using keywords “air pollution,” “telomere length,” and “all-cause mortality” from 2003-2017.

RESULTS: A total of 20 articles remained for final review with 10,488 subjects to explore the association between air pollution and telomere length. Most of the observational studies were cross-sectional (12), remaining studies were cohort (5) and case-control (3). Eighteen (90%) assessed leukocyte telomere length (LTL), of which 15 found associations between air pollution and shorter TL, 2 with longer TL, and 1 had no association. Only two studies found shorter TL from saliva was associated with household air pollutants. Particulate matter was investigated in 70% of articles (14), and the remainder assessed black carbon (BC), Ozone, benzene, and NO₂.

We have found 21 published articles to explore the association between TL and all-cause mortality. Of which 11 studies found an association between shorter TL and all-cause mortality. The remainder found no association. However, we could not perform a quantitative meta-analysis due to discordance in the reporting formats.

CONCLUSIONS: Most of the studies support the association of air pollution with shorter TL as well as mortality with shorter TL- that suggested a possible explanation of how environmental stress may promote earlier onset of age-related diseases and mortality if the observed associations are causal.

Keywords: Air pollution, Telomere length, All-cause mortality



ABSTRACT E-BOOK

P-123

Omics Technologies » Metabolomics

Duration of PM_{2.5} exposure and alterations in the serum metabolome

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BACKGROUND AND AIM: Acute and chronic fine particulate matter (PM_{2.5}) exposures have been linked to negative outcomes; however, the underlying biological pathways remain unclear. Metabolomics can describe these biological pathways yet previous studies have only focused on a singular PM_{2.5} exposure window. We sought to compare alterations in the serum metabolome by comparing various short- and long-term residential PM_{2.5} exposures.

METHODS: Participants were women undergoing in vitro fertilization at a New England fertility clinic (n=200). Women provided their residential address at enrollment and a blood sample during controlled ovarian stimulation. Residential PM_{2.5} exposure was estimated using a validated hybrid model. We derived five PM_{2.5} exposure windows: 1, 2, and 3 days, 2 weeks, and 3 months prior to blood collection. We utilized liquid chromatography with high resolution mass spectrometry and two columns (C18 negative and HILIC positive) to identify metabolites. We used generalized linear models to test for significant associations between each metabolomic feature and exposure window after adjusting for potential confounders. Significant metabolites (p<0.005) were used for pathway analysis and metabolite identification using level-1 evidence.

RESULTS: We identified 17 pathways related to amino acid, lipid, energy, and nutrient metabolism that were solely associated with acute PM_{2.5} exposure. Fifteen pathways, mostly, pro-inflammatory, anti-inflammatory, amino acid, and energy metabolism, were solely associated with long-term PM_{2.5} exposure. Seven pathways were associated with the majority of exposure windows and were mostly related to anti-inflammatory and lipid metabolism. Using level-1 evidence, we identified 12 unique metabolites associated with PM_{2.5} exposures of varying duration, 3 of which were part of identified metabolic pathways.

CONCLUSIONS: We identified significant serum metabolites and metabolic pathways uniquely associated with acute versus chronic PM_{2.5} exposure. These different biologic pathways may help explain differences seen in disease states when investigating different durations of PM_{2.5} exposure and may inform biomarker studies examining PM_{2.5} exposure.

Keywords: Biomarkers of exposure, Long-term exposure, Particulate matter, Short-term exposure



ABSTRACT E-BOOK

P-124

Air pollution » Particle components

Association between exposure to PM_{2.5} components and disease aggravation in amyotrophic lateral sclerosis: an analysis in New York State

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BACKGROUND AND AIM: In a previous study we found that long-term exposure to fine particle matter (PM_{2.5}) may contribute to disease aggravation in amyotrophic lateral sclerosis (ALS). However, PM_{2.5} is a heterogeneous mixture of particles whose composition changes over time and space. In this study, we examined the association between ALS disease aggravation and long-term exposure to specific PM_{2.5} components. Our study brings insight into whether PM_{2.5} composition influences its toxicity and shed light into potentially relevant pollution sources.

METHODS: We used data from the New York Department of Health Statewide Planning and Research Cooperative System (2000–2014) to construct annual county counts of first hospitalizations with an ALS diagnosis. We used well-validated prediction models at 1km² resolution to estimate county-level population-weighted annual concentrations of six PM_{2.5} components: black carbon, organic matter, nitrate, sulfate, sea salt, and soil. Exposure was assigned based on county of residence. We used mixed quasi-Poisson models with county-specific random intercepts to estimate rate ratios (RRs) and 95% confidence intervals (CI) for a 1-year exposure to each PM_{2.5} component. We allowed for nonlinear exposure–outcome relationships using penalized splines and accounted for potential geospatial and temporal confounders.

RESULTS: On average, nitrate and organic matter constituted most of the total PM_{2.5} mass, 35 and 31% respectively. Sulfate had the strongest correlation with PM_{2.5} with a Spearman correlation coefficient of 0.88. We found a linear positive association between one-year exposure to organic matter and disease aggravation in ALS (RR=1.20, 95%CI: 1.13, 1.27 per one standard deviation increase). We found no association between the outcome and nitrate, sulfate, sea salt, or soil exposure.

CONCLUSIONS: Our results suggest that PM_{2.5} adverse effects on ALS may vary by particle composition, and we identified organic matter as a potentially relevant PM_{2.5} component.

Keywords: Neurodegenerative diseases, air pollution, particle components, long-term exposures, disease aggravation, ALS



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-125

Policy » Other (to be specified with keywords in the keywords section)

Changes in air particulate matter concentration in Kraków in years 2009-2019 in relation to air pollution prevention and control action

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BACKGROUND AND AIM: Last decades brought more interest to air pollution harmful effect; evidence has emerged that air pollution can affect every major organ system. Kraków, the second largest city in Poland, from years belongs to the most polluted cities in Europe. Prospective cohort study conducted in Krakow confirmed detrimental effects of air pollution. Increased awareness of health consequences forced local government to undertake some mitigation measures. The aim of the current study was to assess relationship between preventing actions undertaken in Kraków and changes of particulate matter levels during heating seasons in years 2009 – 2019.

METHODS: Information about daily particulate matter concentration (PM₁₀ and PM_{2.5}) levels were obtained from Provincial Environmental Protection Inspectorate in Krakow. As the increased air pollution in Poland shows seasonal variability, we assessed the changes in mean concentration of PM₁₀ and PM_{2.5} in heating season only.

RESULTS: During the years 2009-2019 local government implemented a series of regulations and took some control actions to improve air quality, for example Inspections of waste incineration in heating stoves, inventory of sources of emission, Local Shield program for the poorest - co-financing program to help residents replace coal stoves to one from pro-ecological system, prohibiting the heating of houses / flats with low-quality coal, developing proposals for changes in Polish law that would enable an effective fight against pollution at the local level; and ultimately, from September 1, 2019, a total ban on burning solid fuels in the area of the municipality of Kraków. During analyzed time period the level of particulate matter in air pollution dropped gradually, decreasing by approximately 18.1 ug/m³ for PM₁₀ and 21.6 ug/m³ for PM_{2.5}. Also, number of days with exceeded the permissible level of pollution decreased.

CONCLUSIONS: Implemented regulations and control actions resulted in lowering level of particulate matter air pollution.

Keywords: Air pollution, Particulate matter, Policy and practice



ABSTRACT E-BOOK

P-126

Air pollution » Particle components

Association between exposure to PM_{2.5} components and disease aggravation in Parkinson's disease: an analysis in New York State

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BACKGROUND AND AIM: Studies suggest that long-term fine particle matter (PM_{2.5}) exposure may contribute to aggravation of Parkinson's disease (PD), but overall results have been inconsistent. Among other factors, the differences may arise from variations in PM_{2.5} composition. In a previous study in New York State, we found a nonlinear PM_{2.5}–PD association. To further characterize this association, here we evaluated long-term exposure to specific PM_{2.5} components in the same cohort.

METHODS: We used data from the New York Department of Health Statewide Planning and Research Cooperative System (2000–2014) to construct annual county counts of first hospitalizations with a PD diagnosis. We used well-validated prediction models at 1km² resolution to calculate county-level population-weighted annual concentrations of six PM_{2.5} components: black carbon, organic matter, nitrate, sulfate, sea salt, and soil. Exposure was assigned based on county of residence. We used mixed quasi-Poisson models with county-specific random intercepts to estimate rate ratios (RRs) and 95% confidence intervals (CI) for a 1-year exposure to each PM_{2.5} component. We allowed for nonlinear exposure–outcome relationships using penalized splines and accounted for potential geospatial and temporal confounders.

RESULTS: We estimated a linear positive association between organic matter and disease aggravation in PD (RR=1.06, 95%CI: 1.04, 1.09 per one standard deviation (SD) increase) and a positive linear association with nitrate (RR=1.06, 95%CI: 1.03, 1.10 per one SD increase). We found no association with sulfate, sea salt, or soil exposure.

CONCLUSIONS: Our results support that particle composition of PM_{2.5} may influence its adverse effects on PD. Specifically, we identified organic matter and nitrate as potentially important components in the PD–PM_{2.5} association.

Keywords: Air pollution, particle composition, Parkinson's disease, long-term exposures, disease aggravation



ABSTRACT E-BOOK

P-127

Air pollution » Ozone

Risk Assessment: COPD Mortality Burden due to Ozone Exposure in Europe

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BACKGROUND AND AIM: High ground-level ozone may lead to respiratory diseases, thus, ozone levels are important to monitor over time to implement quality control systems. We aim to conduct a health risk assessment on the burden of mortality from chronic obstructive pulmonary disease (COPD) due to ozone exposure in Europe using spatiotemporal analysis to find areas at highest risk.

METHODS: A health risk assessment was conducted using COPD mortality rates from the Global Burden of Disease (GBD) data retrieval tool and ozone data (1990-2017) from Tropospheric Ozone Assessment Report (TOAR). Ozone concentrations are presented as a mixing ratio in ppb as the six-month ozone season average of the daily 8-hr maximum ozone concentration (OSDMA8). A triple nested space/time exponential covariance model was applied. Bayesian Maximum Entropy (BME) geostatistical method was used for OSDMA8 estimates. An RR of 1.09 (1.05-1.13 95%CI) for COPD attributed to a 10 ppb increase in OSDMA8 combined with BME estimates and mortality rates (Y) were used to estimate the premature mortality burden (DY) of COPD due to ozone exposure in Europe. Monte Carlo simulations were applied to the model to propagate uncertainty.

RESULTS: South-Eastern European countries had the highest ozone concentrations consistently from 1990-2017, with the Scandinavian region having the lowest. The DY attributable to ozone exposure in Europe (per 100,000 person years) is highest in the areas of Debar, North Macedonia (16.0035); Lazaropole, North Macedonia (15.8856); Milan, Italy (14.4279); Murcia, Spain (14.3085); Vicenza, Italy (14.1843); Trentino, Italy (13.884).

CONCLUSIONS: The areas of Northern Italy and North Macedonia may represent a vulnerable sub-population in Europe. This may be due to agricultural techniques as well as industrial sources. To implement proper quality control systems for the health and safety of these communities, further studies should be conducted on the regional variability of ozone exposures to determine causes.

Keywords: Air pollution, Risk Assessment, Mortality, Ozone



ABSTRACT E-BOOK

P-128

Exposure Assessment Methods » Spatial statistics

Clustering of childhood cancer in Colombia: a nationwide study

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BACKGROUND AND AIM: Childhood cancer is considered as one of the most important causes of death in children and adolescents, despite having a low incidence in this population. Spatial analysis has been previously used for the study of childhood cancer to study the geographical distribution of leukemias. This study aimed to identify the presence of space-time clusters of childhood cancer excluding leukemia in Colombia between 2014 and 2017.

METHODS: All incident cancer cases excluding leukemia in children under the age of 15 years that have confirmed by the National Surveillance System of Childhood Cancer between 2014 and 2017 were included. Kulldorf's circular scan test was used to identify clusters using the municipality of residence as the spatial unit of analysis and the year of diagnosis as the temporal unit of analysis. A sensitivity analysis was conducted with different upper limit parameters for the at-risk population.

RESULTS: A total of 2006 cases of non-leukemia childhood cancer were analyzed, distributed in 432 municipalities with a mean annual incidence rate of 44 cases per million children under the age of 15. Central nervous system (CNS) tumors were the most frequent type. Four spatial clusters and two space-time clusters were identified in the central and southwest regions of the country. In the analysis for CNS tumors, a spatial cluster was identified in the central region of the country.

CONCLUSIONS: The distribution of non-leukemia childhood cancer seems to have a clustered distribution in some Colombian regions that may suggest infectious or environmental factors associated with its incidence.

Keywords: Outcomes, Children's environmental health, Spatial statistics



ABSTRACT E-BOOK

P-129

Exposure Assessment Methods » Exposure assessment-general

A Review of Exposure Assessment Methods Utilized in Studies of Disinfection Byproducts (DBPs) and Birth Defects

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BACKGROUND AND AIM: Epidemiologic studies of disinfection byproducts (DBPs) and birth defects have employed a variety of exposure assessment methods. Because there is 1) no gold standard exposure assessment method for DBPs, and 2) documented variability in exposure based on spatial, temporal, and personal behavior patterns, it is important to compare methods and understand their potential impact on health effect estimates. This question is particularly relevant for studies measuring exposures for developmental outcomes such as birth defects, with a narrow critical window.

METHODS: We reviewed epidemiologic studies of DBPs and birth defects published prior to 2021. Information on exposure assessment methods and critical windows of pregnancy captured by exposure assessment was extracted by one author, with quality control by two authors. Data were organized and summarized based on complexity of the method, including their ability to characterize and address temporal or spatial variability and personal water-use patterns.

RESULTS: We identified exposure assessment methods utilized in 21 studies of DBPs and birth defects; 6 studies used non-specific DBP indicators, such as water type or disinfection method; 17 studies developed spatial, temporal, or spatiotemporal-informed estimates based on data collected by public monitoring systems in conjunction with additional modeling; 7 studies incorporated personal behavior information to help address route-specific exposure; 4 of these incorporated DBP uptake factors. Most studies incorporated 1 or 2 exposure assessment methods, while 5 studies included 3 or more approaches; 14 studies developed exposure estimates based on the critical window for birth defects.

CONCLUSIONS: There is heterogeneity in exposure assessment methods among studies of DBPs and birth defects. These methods vary in complexity and capture distinct sources of DBP variation. The choice of metric affects the anticipated magnitude of exposure misclassification. More consistent consideration of spatiotemporal patterns and the critical window of development will improve exposure assessment in future studies.

*Abstract does not reflect EPA policy

Keywords: Exposures, Exposure assessment, Birth outcomes, Water quality



ABSTRACT E-BOOK

P-130

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Methods for accounting for urine dilution in arsenic analyses: comparisons to blood and water arsenic in FACT and FOX

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BACKGROUND AND AIM: Millions of people worldwide are exposed to arsenic (As). Urinary As (uAs) is a biomarker of As exposure. Urinary creatinine (uCr), a breakdown product of creatine, is used to correct uAs for urine dilution. However, uCr levels are influenced by meat intake, muscle mass, and factors related to As methylation/elimination. An alternative method utilizes specific gravity (SG), which has limitations in individuals with kidney damage and/or diabetes. We compared uAs corrected for uCr or SG vs. blood As (bAs) and water As (wAs), which do not require dilution adjustment. **METHODS:** We used data from 539 participants from the Folic Acid and Creatine Trial (FACT) and 343 participants from the Folate and Oxidative Stress (FOX) study. bAs and wAs were log₂-transformed. Models were adjusted for log₂-transformed uAs, age, sex, and BMI, and further adjusted for log₂-transformed uCr or SG, separately.

RESULTS: Median uAs/bAs/wAs concentrations were 113/8.4/102 and 140/12.3/114 µg/L in FACT and FOX, respectively. uCr and SG were highly correlated with each other (Spearman correlations > 0.86). A two-fold increase in total uAs was related to 35% and 24% increases in bAs and 18% and 13% increases in wAs concentrations with respective uCr and SG adjustment, in FACT; 40% and 23% increases in bAs and 14% and 8% wAs in FOX.

CONCLUSIONS: The association of uAs with bAs and wAs was stronger after adjustment for uCr vs. SG in a Bangladeshi population exposed to high water As levels, supporting that adjusting for uCr is an adequate method to account for urine dilution. However, individual studies should consider whether their outcomes are impacted by factors that also influence uCr. Additionally, evaluation of populations with differing sociodemographic characteristics and levels of As exposure are needed to assess the consistency of these findings and optimization of urine dilution adjustment methods in As-related research.

Keywords: Biomarkers of exposure, exposure assessment



ABSTRACT E-BOOK

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Exposure Assessment Methods » Mixtures analysis

Machine Learning Approaches for Environmental Mixtures Studies with Time-to-Event Outcomes and their Application to the Strong Heart Study

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BACKGROUND AND AIM: Machine learning approaches are increasingly used in environmental mixtures epidemiology. We evaluated the operating characteristics of currently available machine learning approaches in estimating individual exposure and joint mixture effects along with interaction effects on a time-to-event outcome.

METHODS: We conducted an extensive search for methods which allow for: time-to-event outcomes, multiple continuous exposures, non-linear and interaction effects on the outcome, and inferences (i.e. provide estimates and standard errors). We selected: Bayesian Additive Regression Trees (BART), Cox Proportional-Hazards model with penalized splines, Gaussian Process Regression (GPR), and Multivariate Adaptive Regression Splines (MARS). Additionally, we included the Cox Proportional-Hazards model and Cox Elastic-Net due to their popularity. We compared estimates across approaches on the association of six metals with incident cardiovascular disease in the Strong Heart Study.

RESULTS: The estimates of the hazard ratio for the main metal of interest, selenium, at its 75th versus 25th percentile, holding all other metals constant, ranged from 1.29 (1.17, 1.39) to 2.00 (1.09, 3.19), estimated using Cox Elastic-Net and BART, respectively. Similar trends were found for estimates of the overall mixture effect on the hazard ratio scale when all metals are at their 75th versus 25th percentile. The estimates ranged from 2.09 (1.82, 3.29) to 4.21 (2.83, 6.93), estimated using Cox Elastic-Net and GPR, respectively. The more flexible approaches estimated higher effects with larger uncertainty.

CONCLUSIONS: In this study, results across approaches tended to be the same qualitatively but different quantitatively. Increased hazards were found at higher levels of metals, but the magnitude varied. Although the overall conclusion is consistent, estimates may have different clinical impacts. The fact that the more flexible methods detected interaction and non-linear effects of metals but had higher uncertainty reveals a substantial bias-variance tradeoff. To enhance reproducibility in environmental epidemiology, it is important to show whether results are robust across different modeling approaches.

Keywords: Survival, Mixtures analysis, Modeling, Cardiovascular diseases



ABSTRACT E-BOOK

P-132

Exposures » Multi-pollutant/Multi-media

Environmental chemical-wide associations with immune biomarkers in the US: A cross-sectional analysis

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BACKGROUND AND AIM: Many studies focus on the effects of one chemical or chemical class on the immune system, but humans are exposed to a wide range of chemicals. Thus, a comprehensive analysis of impacts of multiple chemical classes on immune biomarkers is needed. In this study, we tested the associations between environmental chemicals and immune biomarkers.

METHODS: We analyzed data from the National Health and Nutrition Examination Survey (NHANES 1999-2018). Chemicals were measured in blood or urine and included if >50% of measurements were above the limit of detection (n=207 chemicals, n=18 classes). Immune biomarkers were percentages of lymphocytes, neutrophils, monocytes, basophils, and eosinophils, and counts of red blood cells, white blood cells, and mean corpuscular volume. We conducted multivariable linear regressions of log-transformed chemicals on immune measures, adjusted for age, race/ethnicity, poverty-income ratio, and waist circumference. We accounted for multiple comparisons using a false discovery rate (FDR=0.05).

RESULTS: Among 71,380 participants, the mean age was 34.1 years (sd: 23.5), 50.5% were female, and 38.8% were Non-Hispanic White. Out of the total 207 chemicals, 170 were associated (FDR<0.05) with at least one of the eight immune biomarkers. Out of 24 metals, 95.8% were associated (FDR<0.05) with at least one immune biomarker, as were 100% of the 11 smoking-related compounds. There were 78 chemicals associated with percent lymphocytes (FDR<0.05). For example, a 75% increase in blood cadmium was associated with 0.6% decrease in lymphocytes (95% CI: -0.6– -0.5; FDR=1.1x10⁻⁹²). A 75% increase in urinary cotinine was associated with an increase of 50 white blood cells per μ L (95% CI: 50–56; FDR=6.0x10⁻²⁷²).

CONCLUSIONS: Concentrations of chemicals such as metals and smoking-related compounds are highly associated with immune system biomarkers, with implications for immune function and molecular epidemiology studies. This exposome study identifies chemicals from multiple classes for further investigation.

Keywords: Chemical exposures, Toxicology, Environmental epidemiology, Big data



ABSTRACT E-BOOK

P-133

Exposure Assessment Methods » Exposure assessment-general

Occupational Exposure of Noise and Its Health Impacts among Fish Harvesters in Newfoundland and Labrador

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BACKGROUND AND AIM: The fishery is considered one of the most hazardous occupations. Noise exposure is a highly prevalent risk among fish harvesters causing significant occupational health issues. Occupational noise exposure can result in auditory health problems such as Noise-Induced Hearing Loss and non-auditory health problems, including annoyance, hypertension, sleep disturbance, cognitive impairment, affecting the overall quality of life. This study explores the perception of noise exposure and highlights self-reported hearing loss among fish harvesters in Newfoundland and Labrador (NL), Canada.

METHODS: A cross-sectional online survey was conducted (2021) among NL fish harvesters. As the study is exploratory, the maximum number of fish harvesters working in NL was approached. The study tool was developed and validated by Suzanne C Purdy and Warwick Williams (2002). It consists of 20-item questions including perceived benefits, barriers, self-efficacy, attitude, and susceptibility towards noise and hearing loss. Additional, 16-item questions related to socio-demographic information, job profile, vessel characteristics, and self-reported hearing loss were included.

RESULTS: The study is still ongoing. The preliminary results are based on the data of 78 survey participants. About 54.84 and 68% of participants agreed that work would be less stressful if it is quieter and noise has bad effects on their health other than hearing. The majority (80%) of participants felt that vessel owners are not interested in occupational health and safety. Nearly 52 and 84% disagreed that reducing noise at work and making quieter equipment is difficult. Around 55, 60% had self-reported tinnitus and hearing difficulty.

CONCLUSIONS: Overall, noise is identified as a significant health risk and the leading cause of hearing loss among fish harvesters. Further quantitative research with a larger sample size and broader geographical area can help to identify other health conditions, and quantitative research can explore the existing barriers and challenges of onboard noise prevention.

Keywords: Occupational exposures, Occupational epidemiology



ABSTRACT E-BOOK

P-134

Exposure Assessment Methods » Exposure assessment-air pollution

Estimating 2005-2019 NO₂ Exposure with High Spatiotemporal Resolution in China Using an Ensemble Model

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BACKGROUND AND AIM: China faces serious air pollution problems, especially for traffic-related pollutants such as nitrogen dioxide (NO₂). Epidemiological studies in China were much less focused on NO₂ exposure and consequent health effects as compared to fine particles exposure at national scale, mainly due to lack of high-quality exposure model for accurate NO₂ predictions over a long period. We aim to develop a national model in estimating long-term NO₂ exposure in China with high spatiotemporal resolution.

METHODS: We proposed an advanced modeling framework that incorporated multisource, high-quality predictors data (e.g., satellite observations [OMI NO₂, TROPOMI NO₂, and MAIAC AOD], chemical transport model simulations, high-resolution geographical variables) and three independent machine learning algorithms into an ensemble model. The model included three-stages: (1) filling missing satellite data; (2) building an ensemble model and predicting daily NO₂ levels from 2005 to 2019 across China at 1-km resolution; (3) downscaling the predictions to 100-meter resolution at city scale.

RESULTS: Our model achieved a high performance with an overall cross-validated (CV) R² of 0.72 and a spatial R² of 0.85. The model has the potential to be extrapolated to previous years (2005-2012) or regions without monitoring data, with moderately good performance (CV R² > 0.68). We identified a clear decreasing trend of NO₂ exposure from 2005 to 2019 across the country with the largest reduction in suburban and rural areas. Our downscaled model further improved the prediction ability by 4% in some megacities and captured substantial NO₂ variations within 1-km grids in urban areas especially near major roads.



ABSTRACT E-BOOK

CONCLUSIONS: We developed a NO₂ national model with very high spatiotemporal resolution (daily, 1-km grid). Our model provided flexibility at both temporal and spatial scales that can be useful for exposure assessment and epidemiological studies with various study domains (e.g. national or citywide) and settings (e.g. long-term and short-term).

Keywords: air pollution, oxides of nitrogen, exposure assessment, long-term exposure, modeling



ABSTRACT E-BOOK

P-135

Exposure Assessment Methods » Risk assessment

Incremental lifetime cancer risk associated with airborne arsenic, nickel and lead exposure in the megacity of Sao Paulo

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BACKGROUND AND AIM: Particulate matter (PM) emitted by the burning of fuels is the main source of environmental exposure to toxic elements present in atmospheric air in urban centers. Therefore, this study aimed to investigate the incremental lifetime cancer risk (IRLT) associated with airborne arsenic, nickel and lead exposure in PM₁₀ (diameter $\leq 10 \mu\text{m}$) in the megacity of Sao Paulo, Brazil, an area with more than 7 million vehicles.

METHODS: Concentrations of metals in the filter samples used in this study were provided by the São Paulo State Environmental Protection Agency (CETESB), sampled at Cerqueira Cesar station, near a busy street in the megacity, for the years 2002, 2006, 2009, and 2012. ProUCL software was used to estimate the upper confidence limits (95%UCL). The cancer risk assessment was carried out for each age group (<1 to 70 years old), by inhalation route, and IRLT was calculated according to the methods of the USEPA.

RESULTS: Airborne arsenic and lead concentrations showed higher means during the winter than in other seasons ($p < 0.05$). During this season, arsenic concentration was the highest one, even above international regulations. IRLT mean (UCL95%) for the exposed population to arsenic was $1.60\text{E-}05$ ($2.11\text{E-}05$) in winter and $8.30\text{E-}06$ ($1.20\text{E-}05$) for other seasons. For nickel, it was $1.58\text{E-}06$ ($1.98\text{E-}06$) in winter and $1.48\text{E-}06$ ($2.21\text{E-}06$) for other seasons. For lead, it was found $4.52\text{E-}07$ ($5.33\text{E-}07$) in winter and $2.79\text{E-}07$ ($3.15\text{E-}07$) for other seasons. Therefore, arsenic showed the highest risk, followed by nickel and lead.

CONCLUSIONS: IRLT of airborne arsenic exposure was found to be greater than the value considered tolerable in many countries ($1\text{E-}06$). These findings highlight the importance of air pollution as a risk factor for population health, especially in urban centers with high vehicular traffic. Actions to reduce air pollution exposure should be prioritized in environmental and health policies agendas. Funded: FAPESP (2018/18391-0) and CAPES.

Keywords: particulate matter, heavy metals, risk assessment



ABSTRACT E-BOOK

P-136

Exposure Assessment Methods » Mixtures analysis

A geospatial modeling approach to quantifying risk of exposure to environmental chemical mixtures via a common molecular initiating event

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BACKGROUND AND AIM: The exposome, a measure of all chemical exposures experienced through a lifetime, plays an important role in human health outcomes. Thus, identifying and quantifying lifetime exposure to chemicals present in the environment is important for risk assessment. Linking health outcomes to environmental chemicals exposures is challenging, as real-world exposures involve multiple chemicals and unresolved spatial and temporal distributions. To address these challenges, we propose a geospatially resolved biological target-based risk assessment for exposure to chemical mixtures. This approach models the geospatial distribution of environmental chemicals based on common activation of toxicological adverse outcome pathways (AOPs) as indicated by Tox21 high throughput assays.

METHODS: We exemplify this with a USA-wide proof-of-concept that quantifies the predicted geospatial likelihood of thyroid peroxidase (TPO) inhibition. This enzyme is necessary for producing the thyroid hormone T3 and T4, and inhibition has been associated with decreased cognitive function. First, environmental chemicals were identified that both 1) inhibit TPO based on Tox21 data, and 2) were measured by the USGS and EPA in environmental samples (surface water). Next, the geospatial chemical distributions were modeled with combined land-use regression and Gaussian process models. The individual chemical exposure surfaces can be combined into an aggregate risk surface using an unweighted approach or weighted by chemical potency from the toxicological assay concentration-response data.

RESULTS: Maps of the aggregate risk surface will identify regions where thyroid peroxidase inhibition is more likely based on combined environmental chemical exposures and chemical potency.

CONCLUSIONS: This work will help advance risk assessment methods by providing a method for assessing the geospatial risk of exposure to environmental chemical mixtures and identifying regions with a higher cumulative risk of activating the selected molecular pathways, which may lead to adverse health outcomes.

Keywords: Mixtures, External exposome, Exposure assessment-general, risk assessment, Spatial statistics, big data



ABSTRACT E-BOOK

P-137

Exposures » Hazardous waste

Associations between maternal residential proximity to hazardous waste sites and adverse birth outcomes in North Carolina

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BACKGROUND AND AIM: Human health effects of hazardous waste sites (HWS) are a topic of scientific and public concern. We conducted a retrospective cohort study to investigate relationships between residential proximity to HWS in North Carolina (NC) and two adverse birth outcomes that have previously been shown to be associated with pollution and other environmental exposures: preterm birth (PTB, <37 weeks completed gestation) and term low birth weight (LBW).

METHODS: We developed a comprehensive geodatabase of all HWS in NC including toxic industrial sites, superfund sites, and landfills. Using birth certificates, we assembled a cohort of 1,597,635 births in NC from 2003-2015, and geocoded the maternal residential address provided on the birth certificate. PTB (N=170,406) and LBW (N=42,368) were ascertained from the birth certificate. We used log-binomial regression models to estimate adjusted risk ratios (aRR) and 95% confidence intervals (CI) for associations between exposure to HWS (defined as maternal residence within one mile of HWS) and each outcome individually, adjusting for maternal age, maternal smoking, maternal Medicaid status, and maternal education.

RESULTS: We observed weak associations between residential proximity to HWS and both PTB [aRR(95% CI): 1.06(1.04,1.07)] and LBW [1.09(1.07,1.12)]. Secondary analyses examining exposure to different types and characteristics of HWS found higher risk of LBW among births exposed to toxic industrial sites [1.09(1.06,1.12)] and superfund sites [1.14(1.08,1.21)], compared to births exposed to landfills [0.95(0.87,1.04)]. Additionally, risk of LBW was slightly greater among births exposed to HWS emitting toxins into water [1.13(1.08,1.21)], compared to HWS with either land emissions [1.09(1.06,1.12)] or air emissions [1.10(1.07,1.13)].

CONCLUSIONS: This study contributes to the growing body of evidence regarding potential reproductive health effects of HWS. We explored heterogeneity in the associations between maternal residential proximity to HWS and adverse birth outcomes by differentiating between different types of HWS and including information about the specific characteristics of each HWS.

Keywords: hazardous waste sites, adverse birth outcomes, preterm birth, low birth weight, GIS



ABSTRACT E-BOOK

P-138

Exposure Assessment Methods » Risk assessment

Perception and knowledge about pesticide exposure in rural schoolchildren in the Maule region, Chile: Psychometric Validation

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BACKGROUND AND AIM: Exposure to pesticides is a significant public health concern, especially in agricultural regions. In particular, exposure during infancy is associated with numerous adverse health outcomes, especially as it relates to neurodevelopment. To date, the assessment of knowledge and perception of pesticide exposure and risk among children has not been thoroughly studied. This study evaluates the reliability and validity of a questionnaire developed to assess the knowledge and perception of exposure to organophosphate pesticides among rural schoolchildren.

METHODS: The questionnaire was administered to 151 schoolchildren between 9 - 13 years, selected randomly from four rural schools in the Maule Region, Chile. Internal consistency analysis of ordinal's coefficient alpha equal to or greater than 0.70 was used to assess reliability. Polychoric factor analysis for categorical data was used to assess validity. R-studio software package was used for the analysis.

RESULTS: The ordinal alpha obtained was 0.95. The Bartlett sphericity test was significant ($p < 0.001$). Polychoric matrices of rotated components show the 17 questions summarized pesticide knowledge in 5 factors extracted after varimax rotation. This factorial model explains 56.3% of the variance. The factor loads were more significant than 0.33, and each factor has two or more items. The questions were grouped as follows: knowledge about pesticides (Factor 1); knowledge of health effects related to pesticides exposure (Factor 2); pesticide exposure through the growing of fruits and vegetables (Factor 3); perception and action against pesticides exposure at school (Factor 4); and perception and action against pesticides exposure at home (Factor 5).

CONCLUSIONS: The questionnaire has a high internal consistency (95%) and a suitable factorial validity to assess the knowledge and perception of exposure to pesticides on rural schoolchildren. Additionally, it provides a valuable tool for examining pesticide exposure in agricultural regions, allowing younger community members to participate.

Keywords: Pesticides, Children's environmental health, Risk Assessment



ABSTRACT E-BOOK

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Exposome » External exposome

Personal External Exposomes from Around the World

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BACKGROUND AND AIM: Industrial advances have led to a plethora of anthropogenic chemicals in our air, water, and soil. Exposures to a subset of these chemicals can lead to illnesses including respiratory illnesses, auto-immune disorders, inhibited immune response, and various cancers. Most studies focus on particulate matter or a select set of chemicals, missing chemicals of potential concern. Therefore, we have developed a personal exposure monitoring technology and workflow to comprehensively determine airborne chemical exposures of concern in populations across the globe.

METHODS: Polydimethylsiloxane (PDMS) passive samplers placed in wristbands were deployed in South Africa, China, United States, Canada, and India, both in rural and urban regions. Samplers were shipped to Yale University and analyzed by direct thermal desorption gas-chromatography high-resolution mass spectrometry using a Q-Exactive orbitrap mass spectrometer. A software was developed to rank suspect screening annotations in terms of confidence, normalize for batch effects, filter out chemicals from background contamination, and remove redundant chemical annotations. Furthermore, a workflow implementing tools on the US EPA CompTox Chemicals Dashboard and prototype Hazard Comparison Dashboard was developed to automatically determine chemicals of most concern from a health perspective.

RESULTS: Unique chemicals of concern, including pesticides used for malaria control in South Africa and for household pest control in China, fungicides deployed in the United States, and anti-microbial agents found in all populations, were determined. Participants were likely inhaling some of these chemicals, which poses health concerns. Chemical exposures were dynamic, with seasonal variation predominating any other factor among studies in different locations.

CONCLUSIONS: We are finding that people around the world, from children in rural South African villages to the elderly in Chinese metropolis, to college students at Yale, are inhaling chemicals of concern, including biocides. These chemical exposures are dynamic, with season seeming to have the greatest influence on exposure profiles.

Keywords: Air pollution, external exposome, exposure assessment, omics technologies, mixtures, pesticides



ABSTRACT E-BOOK

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Exposure Assessment Methods » Risk assessment

Application of Meta-Analysis to Derivation of Points-of-Departure for Short-Term Inhalation Exposure Levels of Hazardous Chemicals

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Agency for Toxic Substances and Disease Registry

BACKGROUND AND AIM: For short-term chemical inhalation exposures to hazardous chemicals, the incidence of a health effect usually conforms to a generalized linear model with a bivariate probit link function dependent on inhalant concentration (C) and the duration of exposure (t). The National Academy's Acute Exposure Guideline Levels (AEGLs) Committee relies on this model when deriving AEGLs. Threshold concentrations at AEGL durations are established by the toxic load equation, $C^n \times t = \text{constant}$, which Toxic Load Exponent n (TLE or n -value) directly follows from the probit model. When multiple probit datasets are available, often they cannot be directly pooled together because of disparities in experimental design.

METHODS: Recently, we reported both a meta-analytical framework for multiple studies and an application of the new methodology to dimethyl sulfide. The new methodology allows accurate TLE estimation even if multiple datasets are heterogenous. The utilized techniques include categorical regression, common-effect and random-effects models. The proposed framework was applied to multiple-study datasets from AEGL technical support documents.

RESULTS: Using the framework, both new TLEs and confidence intervals on them were derived. The recalculated TLEs and points-of-departure include ammonia ($n = 2.13$, 95% CI: 1.98–2.27), allyl alcohol ($n = 0.95$, 95% CI: 0.76–1.15), 1,1,1-trichloroethane ($n = 3.46$, 95% CI: 2.85–4.07), carbon tetrachloride ($n = 2.51$, 95% CI: 2.27–2.76), and oxygen difluoride ($n = 1.29$, 95% CI: 0.26–2.32).

CONCLUSIONS: The new TLEs and their confidence intervals were applied in calculations of short-term inhalation points of departure at five reference AEGL durations.

Disclaimer: The findings and conclusions in this presentation have not been formally disseminated by the Centers for Disease Control and Prevention/the Agency for Toxic Substances and Disease Registry and should not be construed to represent any agency determination or policy.

Keywords: Risk Assessment, Meta-analysis, Toxic Load Exponent (TLE), n -value, Probit, Categorical Regression



ABSTRACT E-BOOK

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Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Signature Genes for Type 2 Diabetes in an African American Population

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BACKGROUND AND AIM: Diabetes disproportionately affects racial/ethnic minority populations. Type 2 Diabetes Mellitus (T2DM) is viewed as an outcome of the interaction of environmental and biological risk factors. Our previous studies established the biomarkers (genes) of T2DM-related biological pathways in Caucasian and Asian populations. This present work aims to investigate on T2DM-related metabolic pathways in a diabetic African American population.

METHODS: RNAs were extracted from blood samples of an African American (AA) population (n=48 Diabetic-cases) compared to Calibrator (matched non-diabetic-Controls; Male/Female) recruited in Washington DC, between the ages of 45-65 years; High-throughput Taqman Low Density Array (TLDA) provided analysis of differential gene expression. We used a custom array containing genes (24 transcripts) related to diabetes and metabolic dysfunction.

RESULTS: Differential gene expression analysis revealed distinct differences in T2DM compared to controls in the AA population. 90% of the 24 genes were downregulated in the participants with T2DM, including INSR, ARNT, CYP2D6, RRAD, IL6, HNF1B, INS, and SLC2A2, which are associated with dysregulated homeostasis and xenobiotic metabolism.

CONCLUSIONS: The importance of gene-environment (GxE) interactions lies not only in a better understanding of the complex interplay of genetic and environmental risk factors relevant to human diseases; the identification of GxE can also influence risk prediction and identify subgroups of individuals that are most genetically susceptible developing diabetes. The results obtained here contrast with our previous results and therefore tend to confirm the GxE model. Further large-scale population validation with the addition of gender- age, smoking, and other epigenomic conditions may further delineate the sensitivity of relative gene expressions in fine tuning towards clinical application of these markers.

Keywords: Exposures, Obesity & Metabolic Disorders, Omics Technologies



ABSTRACT E-BOOK

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Exposures » Microplastics

Comparison of primary microplastics from Cartagena Bay and their toxicological evaluation using "Caenorhabditis elegans" as a biological model

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BACKGROUND AND AIM: Microplastic pollution in world oceans is an issue of great concern, since they cause damage to marine ecosystems. When ingested, they can exert toxicity, causing oxidative stress, cell damage and inflammation, compromising somatic processes such as fertility and reproduction among others, and affecting humans through the ingestion of marine contaminated food.

METHODS: This research includes a statistical comparison and toxicity evaluation of black/tarred and degraded microplastic pellets present on Cartagena Bay beaches – Colombia, against industrial microplastics pellets. Samples of pellets were collected from Castillogrande and Bocagrande beaches, two urban beaches with a high presence of microplastic pollution coming from the nearby plastic industry. Sod-4, gpx-4, mtl- 2 fluorescent Caenorhabditis elegans strains were expose to microplastics pellets soxhlet extraction previously characterized by Gas Chromatography/Mass Spectrometry. Mortality and gene expression test were performed. Relationships were made considering the location and chemical composition of the collected pellets. The nematode was exposed during 24 h to whole black pellet extract solution and a 50% dilution extract.

RESULTS: In terms of the lethality tests, a higher mortality of the nematode was obtained using the 50% dilution extract (45%) compared to the concentrated solution (20%). For the gene expression assay the genes with the highest exposure in all the dilutions were sod-4 and mtl-2 showing superoxide dismutase activity and metallothionein-2, respectively. The chemical characterization, showed a 30% of long-chain hydrocarbons, 14.8% of pesticides and 3.1% of hormones as the more relevant chemicals present in black pellets but not in industrial pellets. For degraded pellets, 45.5% of long-chain hydrocarbons, 10.9% of pesticides and 7.3% of acid anhydrides as relevant results. Significant differences were found, considering Dunnet analysis.

CONCLUSIONS: The above results showed that microplastic pellets can adsorb contaminants present in water that can interfere with biological processes, contributing to the poor health of this touristic sector and nearby ecosystems.

Keywords: Microplastics, Toxicology, Chemical exposures



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Exposures » Multi-pollutant/Multi-media

Cumulative Lead Exposure Resulting from Coal Power Plants in India

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BACKGROUND AND AIM: Coal pollution can lead to a myriad of toxic exposures and toxicity resulting from coal power generation has not been well-defined. As part of this study, we sought to identify cumulative lead exposure measured as bone lead in communities living near coal power plants. **METHODS:** We chose three communities at 1 km (n=50), 9 km (n=50), and 38 km (n=50) from coal power plants near Chennai, India and measured their bone lead using a portable x-ray fluorescence device.

RESULTS: The bone lead identified in all participants was significantly higher than that found in typical occupationally exposed populations in the United States. We identified a dependency on location with the community living within 1 km of coal power plants experiencing higher cumulative lead exposure than the community farthest from the coal power plants. Lead exposure decreased at a rate of 0.92 ug/g/km. From our models, a 40-year-old adult at 1 km from a coal power plant would have an average bone lead level of 22.3 ug/g, whereas a 40-year-old at 10 km would have an average bone lead level of 14.3 ug/g. Further, we identified a population of over 704,185 that would be living in communities within 1 km of a coal power plant, equivalent to our highest exposure group.

CONCLUSIONS: Our study was the first to identify a relationship between cumulative lead exposure and coal pollution, demonstrating a dramatic increase in lead exposure for communities near coal power plants. The community within 1 km of the coal power plants experienced bone lead on average 1.5 times higher than our control group. The control group had higher cumulative lead exposure than typical occupational exposures in the United States. These exposures would lead to drastic consequences throughout the body including cardiovascular and neurologic health impacts while ultimately increasing mortality from all causes.

Keywords: Coal, lead, cumulative, xrf, India, bone lead



ABSTRACT E-BOOK

P-144

Exposure Assessment Methods » Exposure assessment-air pollution

Predictions of Long-term PM_{10-2.5} in Six US Urban Areas Using Satellite Data

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BACKGROUND AND AIM: A major challenge in assessing the health risks of PM_{10-2.5} in the United States is the limited measurement data from which to estimate exposure. This is especially problematic for studying long-term PM_{10-2.5} health effects since PM_{10-2.5} is more spatially variable than PM_{2.5} or PM₁₀, particularly in urban areas, which have considerable PM_{10-2.5} spatial variability. Fortunately, data from satellites offers opportunities to assess PM_{10-2.5} across space. Our project leverages Aerosol Optical Depth (AOD) measurements from NASA's MODIS satellite to estimate long-term PM_{10-2.5} in six urban areas for 2000-2012.

METHODS: We calibrated daily AOD (1 km² resolution) with EPA monitored PM₁₀ and PM_{2.5} in six urban areas (Los Angeles, Chicago, St Paul, Baltimore, New York, and Winston-Salem) using land-use regression in a linear mixed-model with daily random slopes. Long-term PM_{10-2.5} was estimated after taking the difference of spatially matched PM₁₀ and PM_{2.5} daily predictions. Calibration model performance was evaluated using leave-one-station-out cross-validation and compared to an alternative, nearest-monitor approach.

RESULTS: Long-term PM_{10-2.5} predictions performed very well compared to measurements from co-located PM_{2.5} and PM₁₀ sites in four of the six urban areas, with spatial R² from 0.6 to 0.9. Two areas had poor to fair performance (R²: 0 and 0.4). All predictions performed better than the nearest-monitor alternative.

CONCLUSIONS: Long-term PM_{10-2.5} predictions had fair to very good spatial performance in the five study areas with sufficient measured data on which to build our models. Given the superior performance of our spatial predictions compared to the nearest-monitor alternative and the high costs of field sampling, our results show the potential for combining AOD data with land-use regression to estimate long-term PM_{10-2.5} concentrations in localized areas.

Keywords: Air pollution, Exposure assessment, Long-term exposure, Particulate matter



ABSTRACT E-BOOK

P-145

Exposures » Occupational exposures

Mesothelioma Mortality in Brazil from 2000 to 2019: Despite underreporting, an overview for the necessary public policy approach

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BACKGROUND AND AIM: Asbestos identifies a group of minerals widely used by the industry due to the low cost of exploration. Asbestos is carcinogenic, causes lung cancer and mesothelioma. Mortality due to mesothelioma is a public health problem and in Brazil the number of Asbestos-Related Diseases is increasing at the expense of diagnosis and underreporting. Brazil is among the five largest global suppliers and consumers of asbestos. Work-related carcinogens are responsible for considerable disease burden worldwide. The results provide guidance for prevention and control initiatives. In the world, occupational Lung cancer accounted for 86% of the deaths, mesothelioma for 7.9%. Asbestos was responsible for the largest number of deaths due to occupational carcinogens (63%). **AIM:** to describe mesothelioma mortality rates in Brazil. Period 2000 to 2019.

METHODS: Descriptive study with data collection through DataSus / MS and Brazilian Institute of Geography and Statistics - IBGE.

RESULTS: Mortality rate in Brazil in the year 2000 was 0.35 / 100 thousand inhabitants and in 2019 it was 1.02. States with higher rates concentrate a high degree of urbanization and the use of asbestos in civil construction. The underreporting and latency of occurrence of Mesothelioma influenced the results. In Brazil in 2007 it was 0.41 deaths / million inhabitants. In the United Kingdom 17.8 deaths / million inhabitants, Australia 16.5; USA 13.32 and Italy 10.3 all in 2007. The United States imported 300 tons of asbestos from Brazil in 2020, an increase of 30% compared to 2019

CONCLUSIONS: There is a significant increase in mortality rates by mesothelioma in Brazil. Knowing the mortality rates contributes to the adoption of public policies and actions in primary care and a better notification of cases and deaths. It is necessary to promoting on occupational and environmental health and a policy to ban asbestos in Brazil is necessary.

Keywords: Occupational epidemiology, Mortality, Cancer and cancer precursors, Policy and practice



ABSTRACT E-BOOK

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Exposures » Occupational exposures

Occupational exposure to potentially toxic elements in home-based and informal workers

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BACKGROUND AND AIM: Biological matrices, such as blood, can be used to monitor occupational exposure to potentially toxic elements (PTEs). This research intended to evaluate the PTEs exposure in informal outsourced workers from Limeira–SP, Brazil, who perform jewelry soldering in the home environment.

METHODS: Sixty-six individuals from the exposed group (informal workers and families) and 49 controls (without occupational chemical exposure) were included. As, Mn, Ni, Cd, Sb, Sn, Cu, Zn, Pb, and Hg concentrations in blood was determined by inductively coupled plasma mass spectrometry. Health information was collected using a questionnaire.

RESULTS: Most participants were adults (53.9%), all those were female aged 19 to 62 years, and children and adolescents (1-18 years old) were 50.9% male and 49.1% female. No significant differences were found between the groups for smoking, exercise, medication consumption, educational level, and skin color variables ($p > 0.05$). Alcohol consumption ($p = 0.02$; 60% of the exposed workers reported consuming alcohol) and time residing in the region ($p = 0.0005$; 80.6% of the exposed group lived in the region for more than 15 years) were statistically significant variables. Among the health responses, only the symptom of shortness of breath showed a statistically significant difference between the groups ($p = 0.004$; 88.9% of the exposed participants reported experiencing shortness of breath frequently). Although we did not have observed differences for respiratory diseases, 40.9% of the participants reported having bronchitis, asthma, or upper respiratory tract infection. Blood PTEs concentrations proved to be higher in the exposure group for As ($0.44 \mu\text{g L}^{-1}$), Cd ($0.21 \mu\text{g L}^{-1}$) and Pb ($1.88 \mu\text{g L}^{-1}$) compared to controls (As= $0.35 \mu\text{g L}^{-1}$, Cd= $0.01 \mu\text{g L}^{-1}$, Pb= $1.04 \mu\text{g L}^{-1}$).

CONCLUSIONS: The workers and relatives constitute a particular risk group because of the home environment with uncontrolled occupational activity. The higher concentrations of PTEs in exposed population raises a concern and may impact health outcomes. Funded by FAPESP (#2018/18391-0; #2017/25424-9; #2017/20752-8).

Keywords: Biomonitoring, Occupational Exposure, Toxic Elements, Informality, Health



ABSTRACT E-BOOK

P-147

Exposures » Occupational exposures

Cancer Survival among World Trade Center Rescue and Recovery Workers: A Collaborative Cohort Study

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BACKGROUND AND AIM: World Trade Center (WTC)-exposed responders may be eligible to receive no-cost medical monitoring and treatment for certified conditions, including cancer. The survival of responders with cancer has not previously been investigated

METHODS: This study compared the estimated relative survival of WTC-exposed responders who developed cancer while enrolled in two WTC medical monitoring and treatment programs in New York City (WTC-MMTP responders) to WTC-exposed responders not enrolled (WTC-non-MMTP responders) and to non-responders from New York State (NYS-non-responders), all restricted to the 11-southernmost NYS counties, where most responders resided. Parametric survival models estimated cancer-specific and all-cause mortality. Follow-up ended at death or 12/31/2016.

RESULTS: From 1/1/2005-12/31/2016, there were: 2,037 cancer cases and 303 deaths (248 cancer-related deaths) among WTC-MMTP responders; 564 cancer cases and 143 deaths (106 cancer-related deaths) among WTC-non-MMTP responders; and, 574,075 cancer cases and 224,040 deaths (158,645 cancer-related deaths) among the NYS-non-responder population. Comparing WTC-MMTP responders with NYS-non-responders, the cancer-specific mortality hazard ratio (HR) was 0.72 (95% CI=0.64-0.82), and all-cause mortality HR was 0.64 (95% CI=0.58-0.72). Comparing WTC-MMTP responders with WTC-non-MMTP responders, the cancer-specific mortality HR was 0.77 (95% CI=0.61-0.97), and all-cause mortality HR was 0.69 (95% CI=0.57-0.84). The cancer-specific HR was 0.94 (95% CI=0.78-1.14), and all-cause mortality HR was 0.93 (95% CI=0.79-1.10) comparing WTC-non-MMTP responders to the NYS-non-responder population.

CONCLUSIONS: WTC-MMTP responders had lower mortality compared with WTC-non-MMTP responders and with NYS-non-responders, after controlling for demographic factors and temporal trends. There may be survival benefits from no-out-of-pocket-cost medical care, which could have important implications for healthcare policy

Keywords: cancer survival, occupational epidemiology



ABSTRACT E-BOOK

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Methods » Occupational epidemiology

COVID-19: Epidemiological Analysis of 3034 cases in health professionals from the largest Hospital Complex in Latin America

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BACKGROUND AND AIM: According to a WHO note, since March 11, 2020, the planet has been living with an important pandemic. Human behavior and the environment are different at this point. There are countless deaths. Health workers are the main group exposed to COVID-19. Until Feb 9 2021, there were in Brazil 9599565 infected people. The aim of this work is to know the health professional (HP) profile of biggest Latin American hospital and which are the initial symptoms to better understand the disease.

METHODS: This study describes healthcare profile of workers with COVID-19 symptoms in a 22000 employees' hospital, Apr 13 2020-Feb 10 2021. Data was collected from exclusive registration system of medical attendance for symptomatic HP.

RESULTS: There were 15540 medical attendances, of which 10660 RT/PCR exams were collected and 3034 (28,5%) had it positive to COVID-19. According to professional category, there were incidence of: 36,1% positive cases (PC) in the nursing team, 19,2% doctors, 12,3% female and the average age of PC was 38,4 yo. The main symptoms in PC were: 67,7% headache, 61,1% coughing, 55,1%, odynophagia, 44,8% coryza, 38,5% changing of smell and taste, 36,5% adynamia, 35,9% fever, 14,5% diarrhea, 13,2% dyspnea, 12,3% nausea/vomiting. 385 had comorbidities: 70,4% cardiovascular disease and 20,8% pulmonary diseases. 65,3% knew who could had passed them the disease and to 70,0% it happened at work. Comparing to all symptomatic people in 15540 medical attendances, the percentage of symptoms was similar to PC.

CONCLUSIONS: The epidemiology of HP affected by COVID 19 helps in the creation of specific measures in the area of occupational health, especially when there is exclusive organizational structure for their medical attendance of these professionals. Identifying symptoms in HP contributes to identifying the profile and adopting health promotion and equity during the pandemic, and discussing about the environment.

Keywords: Epidemiology, Occupational epidemiology, Respiratory outcomes



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-149

Exposures » Occupational exposures

Effect of Wildland Fire Smoke Exposure on Acute Cardiovascular Responses among Wildland Firefighters Working at Prescribed Burns

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BACKGROUND AND AIM: Wildland firefighters at prescribed burns are exposed to elevated levels of wildland fire smoke (WFS) while performing physically demanding tasks. WFS exposure has been linked to increase in hospital/emergency admission for cardiovascular disorders in the general population. Working arduously in high heat-stress conditions also places a great demand on the cardiovascular system. However, knowledge about the cardiovascular effect of occupational WFS exposure during prescribed burns among wildland firefighters is relatively limited.

METHODS: Between 2016 and 2019, a total of 38 wildland firefighters (34 males and 4 females, an average age of 35.63 ± 9.31 years and a firefighting career length of 9.08 ± 7.94 years) employed by the USFS–Wayne National Forest and the Ohio Department of Natural Resources–Division of Forestry participated in this study. Resting systolic/diastolic blood pressure (SBP/DBP) and heart rate (HR) of wildland firefighters were measured before (pre-shift), after (post-shift), and the morning (next-morning) following prescribed burn shifts (burn days) and regular work shifts (non-burn days).

RESULTS: On burn days, HR significantly increased from pre- to post-shift ($p < 0.01$) while SBP significantly decreased in the morning following the prescribed burns compared to pre-shift ($p = 0.04$). However, this was due to the decrease of SBP in the firefighters who were hypertensive. Significant cross-shift reductions were observed in SBP on burn days compared to non-burn days ($p < 0.01$). A significant reduction on burn days was also observed from pre-shift to next-morning for HR compared to non-burn day ($p = 0.02$) while HR significantly increased in pre- to post-shift on burn days compared to non-burn days ($p < 0.01$).

CONCLUSIONS: Cross-shift changes in SBP and HR might be attributable to WFS exposure and physical exertion during the prescribed burns. The results suggest that wildland firefighting exposure might cause a distinct hemodynamic response, including SBP reduction and HR increment, especially for those who had pre-existing hypertension.

Keywords: Air pollution, Wildfires, Occupational exposures, Occupational epidemiology.



ABSTRACT E-BOOK

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Exposures » Occupational exposures

Biomonitoring of Uruguayan workers exposed to arsenic from chromated copper arsenate (CCA) used in wood impregnation process

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BACKGROUND AND AIM: In Uruguay there are 20 wood-impregnation plants which mostly use chromated copper arsenate (CCA) as preservative. This study aims to show the results of our CCA-woodworkers' Arsenic exposure biomonitoring for over seven years. In CCA plants, the wood is impregnated into a pressure cylinder performing different cycles of vacuum-pressure-vacuum. Exposure to arsenic in woodworkers may occur through inhalation, dermal exposure, and ingestion during working hours. Owing to the difficulty of replacing CCA for economic reasons, Uruguayan authorities promote the use of GMP that consider recommendations of international occupational safety organizations to minimize negative impacts on the environment and workers' health. In this regard, the "Guidelines on good practices in wood impregnation" were published in 2007 which establish safety and prevention measures including the use of personal protection equipment.

As Uruguay adopted the American Conference of Governmental Industrial Hygienists (ACGIH) recommendations, urine samples of exposed workers must be collected twice a year, for urinary inorganic arsenic plus metabolites analysis (As-U). The recommended biological limits values (BLV) provided by ACGIH for As-U should be below to 35 µgL⁻¹

METHODS: We present and discuss the working conditions and results of As-U from 2014 to 2020, in 479 urine samples from workers of six CCA impregnation plants that were analyzed in our lab by Hydride Generation Atomic Absorption Spectrometry.

RESULTS: The As-U results were below BLV in 96,5% of samples. Only 17 samples were higher and after a minimum period of 15 days of workplace removal as requested by guidelines, the workers re-established safe As-U values.

CONCLUSIONS: As shown, results indicate low occupational exposure risks to arsenic and reveal the importance of the correct use of personal protective equipment and the relevance of having national guidelines for these practices. Besides the biological control, it is necessary to identify possible causes and carry out the appropriate corrective actions.

Keywords: arsenic, chromated copper arsenate (CCA), biomonitoring arsenic



ABSTRACT E-BOOK

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Exposures » Occupational exposures

Hidden Health Hazards: Toxins in Museum Collections

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BACKGROUND AND AIM: Museum collections frequently contain hidden hazards that put staff at risk. The application of chemical pesticides, including arsenic and mercury, on collection objects began in the eighteenth century as a preventive measure to protect against insects, rodents, and mold. In addition to these poisons, some collection objects are made of materials inherently hazardous to human health including silica dust, lead paint, and infectious agents. It is important to ensure all museum staff who come into direct contact with collection objects are aware of exposure risks and know how to identify and protect themselves from these often-invisible hazards.

METHODS: Through a literature review including research from the Canadian Conservation Institute, Cambridge University Press, and PubMed, we have identified five hazardous materials that pose a threat to museum workers. We have highlighted policies and practices staff can use to protect themselves from these hazards.

RESULTS: Silica dust, lead paint, arsenic, mercury, and infectious agents are five common hazards found within museum collections. Archeological artifacts and stone sculptures can be sources of silica dust. When handling or cleaning these materials, personal protective equipment should be worn, and the area must be well-ventilated. Many historic homes contain lead paint and wallpaper that has been treated with arsenic. Lead paint should be closely monitored for flaking and peeling. Many textiles, papers, and ethnographic collections have been treated with arsenic and mercury. Some of these collections contain infectious agents as well. It is important to isolate objects treated with these toxins in polypropylene bags and create a label warning of their contamination.

CONCLUSIONS: Many hidden hazards exist within museum collections. It is important for all museum staff to be aware of possible exposure risks. Museums must also ensure they have policies and practices in place to safely handle hazardous materials and to mitigate staff and visitor exposures.

Keywords: Occupational exposures, Policy and practices, Risk assessment



ABSTRACT E-BOOK

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Exposures » Occupational exposures

Traumatic Brain Injury and Subsequent Musculoskeletal Injury Risk by Body Region

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BACKGROUND AND AIM: Traumatic brain injuries (TBI) have been associated with increased risk of musculoskeletal (MSK) injuries, particularly lower extremity injuries as TBIs may influence gait and postural stability. This study evaluated the association across multiple body regions.

METHODS: Incident TBI and MSK injuries were identified from accessible electronic medical records among active-duty U.S. Army Soldiers in 2016 through 2019. TBI was defined using International Classification of Diseases (ICD)-9 and -10 and Department of Defense codes. MSK injuries were grouped into body regions based on ICD-10 codes. Each Soldier with TBI (n=21,625) was matched with replacement to five Soldiers without TBI (n=108,125) on age, sex, and calendar month. Hazard ratios (HR) and 95% confidence intervals (CI) were calculated from Cox proportional hazards regression models stratified by matching factors and adjusted for race, education, rank, years of service, military occupational specialty, and history of deployment to combat countries.

RESULTS: Soldiers were 30.3 (9.1) years old at the start of follow-up and predominantly male (87.3%) and White (69.8%). By the end of follow-up, there were 15,335 any MSK injuries in 10,965 person-years among Soldiers with TBI and 55,860 any MSK injuries in 104,396 person-years among Soldiers without TBI. Soldiers with TBI had significantly elevated rates of injury for any MSK [HR (95% CI): 2.33 (2.29, 2.37)], lower extremity [1.43 (1.39, 1.46)], upper extremity [2.00 (1.95, 2.06)], head/neck/cervical [4.16 (4.02, 4.30)], torso [3.44 (3.31, 3.59)], low back/pelvis [2.03 (1.98, 2.09)], spine [2.98 (2.83, 3.15)], and other [3.61 (3.43, 3.81)].

CONCLUSIONS: In addition to lower extremity injuries, TBI may increase MSK injuries risk in multiple other body regions. The mechanisms underlying how TBI could affect MSK injuries across the body should be evaluated.

The views expressed are those of the authors and do not reflect the official policy of the Department of Army, Department of Defense, or the U.S. Government.

Keywords: Occupational epidemiology, occupational exposures, exposures



ABSTRACT E-BOOK

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Exposures » Occupational exposures

Temporal Association of Cancer Incidence with World Trade Center Rescue/Recovery Work

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BACKGROUND AND AIM: The latency period between exposure to carcinogens and the diagnosis of cancer is of interest from both clinical and public health perspectives. The collapse of the World Trade Center (WTC) towers on 9/11/2001, and the subsequent months of rescue/recovery work led to the widespread exposure of responders to hazardous materials including carcinogens. While earlier studies reported increased risks of prostate cancer, melanoma, thyroid cancer, and non-Hodgkin's lymphoma, none have evaluated the latency period associated with these toxic exposures.

METHODS: Participants from the WTC Combined Rescue/Recovery Cohort were observed between 3/12/2002 and 12/31/2015. Cancer data were obtained via linkages with 13 state registries. Poisson regression was used to estimate hazard ratios (HR) and 95% confidence intervals (CI), using the New York State (NYS) population as reference. In internal analyses, time (date) first worked at the disaster site was used as a proxy for intensity of exposure. Changepoints in the HRs were estimated using profile likelihood.

RESULTS: Beginning in 2007, an increased risk of prostate cancer was observed among WTC rescue/recovery workers when compared with NYS (HR: 1.2, 95% CI 1.2-1.3). For melanoma, no increased risk was detected between 2002 and 2004, but from 2005-2015, the HR was 1.3 (95% CI 1.2-1.5). We observed no changepoint in thyroid cancer incidence, but overall, the rates were twice that of the NYS population (HR: 2.3; 95% CI: 2.0-2.7). A small increase in non-Hodgkin's lymphoma incidence was detected between 2002 and 2003 (HR: 1.3; 95% CI: 0.6-2.8), but not in subsequent years. An elevated non-Hodgkin's lymphoma risk was observed from 2004-2015 among participants who were most highly exposed, according to time first worked on the WTC effort (HR:1.3; 95% CI 0.9-1.9).

CONCLUSIONS: This research may increase understanding of the latency period between environmental exposure and cancer incidence in human populations.

Keywords: cancer, occupational exposures, epidemiology



ABSTRACT E-BOOK

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Exposures » Occupational exposures

Restructuring the workday to reduce occupational exposure to solar ultraviolet radiation (UVR)

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BACKGROUND AND AIM: Messaging about sun avoidance strategies is often not practical for outdoor workers. The objective of this study was to use personal monitoring data to determine when peak UVR exposure occurs for outdoor workers, estimate how much UVR could be reduced by altering the timing of shady tasks or breaks during peak exposure times, and compare these to peak periods of ambient UVR. The aim was to provide evidence-based sun avoidance recommendations for outdoor workers in British Columbia, Canada.

METHODS: UVR exposure data [standard erythemal dose (SED)] were collected during the 2013 summer months in Vancouver, using personal electronic dosimeters. Mixed-effect models were used to estimate the 60-, 30-, and 15-min time intervals at which maximum exposure occurred for the months of July and August. Ambient UVR was also collected using data from the nearest Brewer spectrophotometer station and parallel analyses were conducted.

RESULTS: There were 73 workers and 321 participant-days available for analysis. Models indicated that periods of maximum exposure for 15-, 30-, and 60-min intervals began at 12:28 pm, 12:17 pm, and 11:52 am, respectively, for sunny days in July. These periods were similar in August. The median exposure during these time periods and the potential for reducing UVR was 0.03 SED (2.8% potential daily exposure reduction), 0.09 SED (7.1%), and 0.18 SED (15.9%), respectively. However, there was a large range in exposure estimates as some workers experienced up to 84.8% of their exposure in the peak 60-min interval.

CONCLUSIONS: Skin cancer prevention messaging does not include practical messages for outdoor workers. Providing workers with information on the timing of peak UVR can help to modify work tasks for the the greatest reductions in exposure. Prevention measures including shady breaks, increased sun protection, and task reorganization during these peak times are recommended to reduce UVR exposure among those at highest risk.

Keywords: Occupational exposure, solar radiation, outdoor workers, ultraviolet radiation, prevention



ABSTRACT E-BOOK

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Exposures » Occupational exposures

A non-targeted approach to identify potential breast carcinogens in women firefighters after a fire event

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BACKGROUND AND AIM: Female firefighters remain understudied in both exposure and epidemiology studies. Furthermore, occupational studies generally focus on toxic chemicals that are well characterized. The objective of this study was to identify potentially novel chemical exposures associated with a fire event among female firefighters.

METHODS: We applied non-targeted analysis methods to three longitudinal serum samples collected in the days and weeks after a fire. To assess exposure to potential breast carcinogens among women workers after an urban structural fire event the Women Workers Biomonitoring Collaborative (WWBC), we recruited female firefighters in San Francisco and developed a biospecimen archive. Female firefighters (n=18) were recruited and provided 3 serum samples—within 48 hours, 1 week, and 1 month after fighting a fire. We applied a non-targeted analytical approach with liquid chromatography quadrupole time of flight mass spectrometry (LC-QTOF/MS) in both the positive and negative ionization modes.

RESULTS: We detected over 20,000 features, representing potential chemical exposures in study participants. Exact masses of features were matched to a curated in-house library of 7,935 environmental chemicals and potential breast carcinogens, tentatively identifying 1,667 chemicals. MS/MS fragmentation analysis allowed us to further confirm 181 candidate chemicals based on the predicted fragmentation pattern of each chemical. These chemicals included per-/poly-fluoroalkyl substances, endocrine disrupting chemicals and chemicals associated with mammary tumor development. We will confirm the identity of at least 5 of these novel chemicals by re-running the samples with known standards.

CONCLUSIONS: Non-targeted analytical approaches in carefully designed exposure studies can help “look beyond the lamp post” to identify novel exposures with health concerns.

Keywords: non-targeted analysis, generalized suspect screen, occupational exposures, internal exposome



ABSTRACT E-BOOK

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Exposures » Occupational exposures

Analysis of the worker's health surveillance in the vector control program in Mexico

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BACKGROUND AND AIM: The vector control program in Mexico has authorized about twenty pesticides in the last decade; some of them have been categorized as Highly Hazardous Pesticides (HHP) under the extended criteria of the International Pesticide Action Network in 2019. The only guideline for occupational exposures (NOM-047-SSA1-2011) specifically establishes reference values for exposure to acetylcholinesterase inhibitors (AChI) and an operative document guides the monitoring of the workers' exposure to AChI. The aim of this study was to analyze the interpretation and implementation of these policies from the perspective of both workers and directors of the vector control program.

METHODS: A mixed methods research was conducted in four states of Mexico including semi-structured interviews and data on pesticide amounts applied and the workers' results for plasmatic acetylcholinesterase activity analysis (PACh) collected from the states' registries.

RESULTS: There is a varied and extended use of HHP in the vector control program and the risk perception of the occupational exposure to pesticides varies between directors and workers. Women mainly apply pesticides by hand while men spray them; thus PACh activity determinations are primarily done in men, as they are considered to have higher exposure. The processes for monitoring occupational exposure to AChI are different amongst the states, though none of them estimate the individual biological index of exposure (BIE) as established by the guideline. We found significant differences between the PACh activity values in women compared to men, while there were no significant differences when comparing the BIE by sex.

CONCLUSIONS: The knowledge about the policies related to workers' health surveillance have to be strengthened, and there is an urgent need to enhance the content of the existing policies in order to include the multiple, combined and long term occupational exposure of workers in the vector control program in Mexico.

Keywords: Biomarkers of exposure, Pesticides, Policy, Policy and practice, Chemical exposures, Occupational exposures.



ABSTRACT E-BOOK

P-157

Exposures » Occupational exposures

Guestworker safety and health in Louisiana: Lessons from the Covid-19 pandemic

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BACKGROUND AND AIM: Guestworkers are a critical labor component of many industries considered essential to U.S infrastructure. Despite their essential role in the U.S. labor force, guestworkers are vulnerable to exploitative labor practices. This research aims to document guestworkers' experiences in the Louisiana's crawfish industry, and to demonstrate the marginalized role of guestworker labor in a major Louisiana industry.

METHODS: News articles were reviewed to draw upon examples of workers' experiences across the spectrum of labor abuse, ranging from worker mistreatment and non-payment of wages to workplace safety hazards and labor trafficking. Data on COVID-19 outbreaks at food processing plants reported by the Louisiana Department of Health were also evaluated.

RESULTS: COVID-19 outbreaks at food processing plants in Louisiana resulted in the greatest number of cases in all state workplaces, representing about one in every five outbreak cases. As of March 2021, there were forty-one outbreaks and 1059 cases. Although not all the outbreaks occurred at seafood processing plants, more than one hundred workers at three Louisiana crawfish farms developed symptoms of COVID-19. Two whistleblower accounts filed with representation from the Seafood Workers' Alliance, a New Orleans-based worker collective, depicted unsafe working and living conditions and a disregard of public health COVID-19 recommendations.

CONCLUSIONS: The COVID-19 pandemic compounded guestworkers' vulnerability to include a lack of public health protective measures in addition to longstanding labor abuses. This research highlights structural determinants of health inequities, such as unsafe and exploitative working conditions; and examines local public health approaches that can bring attention and resources to labor issues. As public health increases its focus on social and structural determinants of health, it can contribute to improved labor conditions for guestworkers.

Keywords: guestworkers, crawfish, labor rights, public health, COVID-19



ABSTRACT E-BOOK

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Exposures » Food/nutrition

Serum antioxidant status and mortality from influenza and pneumonia in US Adults

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BACKGROUND AND AIM: Some research suggests that antioxidant supplementation may alleviate the severity of viral respiratory infections, but the evidence from prospective population studies is limited. We examined the prospective association between serum antioxidant status and mortality from influenza and pneumonia using data from the US National Health and Nutrition Examination Survey (NHANES)-III.

METHODS: We included 7428 NHANES-III participants ≥ 45 years of age and their data on serum concentrations of the antioxidants vitamin C, vitamin A, vitamin E, total carotene (α - and β -forms), β -cryptoxanthin, lutein+zeaxanthin, and lycopene. We also computed total antioxidant capacity (TAC) as a measure of composite antioxidant status in serum. Survey-weighted Cox proportional hazard models were used to compute hazard ratios (HRs) and 95% confidence intervals (CIs) comparing quartiles of each antioxidant and TAC.

RESULTS: With a weighted-median follow-up of 16.8 years, 154 participants died from influenza/pneumonia (weighted incidence rate=0.88 per 1000 person-years). After adjustment for sex, race/ethnicity, phase, education, cholesterol, body mass index, and smoking history, serum vitamin C, total carotene, and TAC were non-linearly associated with influenza/pneumonia mortality, with the statistically significant smallest HRs at the third quartile vs the first quartile [HRs=0.32 (95% CI: 0.15–0.67), 0.25 (0.14–0.45), and 0.24 (0.11–0.51), respectively]. HRs comparing the fourth vs the first quartiles were weaker and non-significant: 0.56 (95% CI: 0.26–1.18), 0.68 (0.40–1.17), and 0.63 (0.30–1.34), respectively. Serum lycopene had a monotonic association with influenza/pneumonia mortality [HR=0.45 (95% CI: 0.24–0.85) comparing the fourth vs the first quartile, P-for-trend=0.01]. No statistically significant associations were found for other antioxidants.

CONCLUSIONS: This study suggests that antioxidant intake may reduce mortality risk from influenza or pneumonia in the US general population. These findings warrant further research, including investigations that can address whether antioxidant intake can blunt the risk of mortality from COVID-19.

Keywords: Food/nutrition, infectious diseases, mortality, respiratory outcomes



ABSTRACT E-BOOK

P-159

Exposures » Food/nutrition

Dietary exposure to metal mixtures throughout infants' first year of life in the New Hampshire Birth Cohort Study

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BACKGROUND AND AIM: Recent reports have raised concerns about infants' exposure to metals and metalloids (here, "metals") via their first solid foods. Although early exposure to metals may cause lifelong health effects, epidemiologic studies on infants' dietary exposure to metal mixtures are still scarce. We aimed to assess the impact of diet on urinary metal concentrations over the first year of life among 348 children from the New Hampshire Birth Cohort Study.

METHODS: We used inductively coupled plasma mass spectroscopy (ICP-MS) to measure infant urinary arsenic speciation, cadmium, cobalt, chromium, copper, iron, mercury, manganese, molybdenum, lead, antimony, selenium, uranium, vanadium and zinc concentrations. Caregivers completed a 3-day food diary before infant urine collection at 6 weeks and 4, 6, and 12 months of age.

RESULTS: We determined the weights of each metal and the impact of the mixture at 6 weeks and 12 months of age. Using quantile g-computation we found that urinary concentration of arsenic, molybdenum and cobalt increased from ~6 weeks to 12 months of age, and that urinary selenium and copper decreased. We observed similar findings in a subset of infants (n = 19) during weaning from 4 to 6 months of age. We are now focusing on identifying specific groups of foods responsible for these changes.

CONCLUSIONS: Determining dietary contributors to infants' exposure to potential harmful metals is a critical step in preventing their long-term consequences.

Keywords: mixture, heavy metals, food, biomarkers of exposure



ABSTRACT E-BOOK

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Exposures » Food/nutrition

Serum selenium and non-alcoholic fatty liver disease (NAFLD) in U.S. adults: National Health and Nutrition Examination Survey (NHANES) 2011-2016

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BACKGROUND AND AIM: Selenium is an essential trace element that shows beneficial or adverse health effects depending on the dose. Laboratory studies suggest that high selenium may contribute to the development of non-alcoholic fatty liver disease (NAFLD). However, human evidence is limited. We evaluated the associations of serum selenium level with serum alanine aminotransferase (ALT) activity and suspected NAFLD prevalence in U.S. adults.

METHODS: We conducted the cross-sectional analysis in 3,827 adults aged 20 years and older without viral hepatitis, hemochromatosis, or alcoholic liver disease who participated in the National Health and Nutrition Examination Survey (NHANES) 2011-2012, 2013-2014, and 2015-2016. Serum selenium was measured using inductively coupled plasma dynamic reaction cell mass spectrometry. Suspected NAFLD cases were defined in the presence of serum ALT > 30 IU/L in men and > 19 IU/L in women in the absence of other identifiable causes of liver disease.

RESULTS: The median (interquartile range) of serum selenium level was 127.9 (117.9, 139.4) µg/L. Non-linear associations of serum selenium with NAFLD prevalence and serum ALT activity were observed in the generalized additive models with penalized splines. After adjustment for sociodemographic variables, lifestyle factors, body mass index, and NHANES survey cycles, positive associations were found at > ~130 µg/L serum selenium with both NAFLD and ALT, whereas the associations were flattened at < ~130 µg/L.

CONCLUSIONS: Our findings provide evidence of non-linear associations of serum selenium with ALT activity and NAFLD prevalence. In particular, positive associations were found above serum selenium level of 130 µg/L, whereas no association was observed below this value. This finding requires confirmation in future prospective cohort studies.

Keywords: selenium, NAFLD, alanine aminotransferase, nutrients.



ABSTRACT E-BOOK

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Exposures » Food/nutrition

Dietary predictors of prenatal per- and poly-fluoroalkyl substances (PFAS) exposure

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BACKGROUND AND AIM: Per- and poly-fluoroalkyl substances (PFAS) are commonly detected in a variety of foods and food packaging materials. However, few studies have examined diet as a potential source of PFAS exposure during pregnancy. In the present cross-sectional study, we examined prenatal PFAS levels in relation to self-reported consumption of meats, dairy products, and processed foods during pregnancy.

METHODS: Participants were enrolled in the Chemicals in Our Bodies study, a demographically diverse pregnancy cohort in San Francisco, CA (N=510). Diet was assessed using a self-reported interview questionnaire administered during the 2nd trimester. Participants were asked how many times a day, week, or month they ate certain foods since becoming pregnant. Responses were categorized as at least once a week or less than once a week. Twelve PFAS (ng/mL) were measured in 2nd trimester serum samples. We investigated relationships between consumption of dairy products, meats, and processed foods and natural log transformed PFAS using separate linear regression models adjusted for maternal age, education, and race/ethnicity.

RESULTS: PFNA, PFOA, PFOS, PFHxS, Me-PFOA-AcOH, PFDeA and PFUdA were detected in >69% of participants. Consumption of dairy milk and cheese at least once a week was significantly associated with elevated levels of PFNA, PFOA, PFOS, and PFDeA relative to those who ate dairy products less than once a week. Eating fish, poultry, and red meat at least once a week was associated with higher levels of PFUdA, PFDeA, PFNA, and PFOS. Reported consumption of processed foods, including fast food, french fries, and take-out pizza, was not associated with PFAS levels.

CONCLUSIONS: Results indicate that consumption of animal products may contribute to elevated prenatal PFAS levels.

Keywords: diet, pregnancy, PFAS



ABSTRACT E-BOOK

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Exposures » Food/nutrition

Investigating Bidirectional Associations of Blood Metals and Vitamin D levels throughout Pregnancy: The MIREC Cohort Study

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BACKGROUND AND AIM: The standard biomarker of vitamin D status is plasma 25-hydroxyvitamin D (25OHD). Low 25OHD is associated with reduced immune function and adverse pregnancy outcomes including preterm birth. There is evidence that high exposure to lead (Pb) and cadmium (Cd) is associated with lower vitamin D status. However, the directionality of these associations is uncertain, particularly for low-level Pb and Cd exposure. In this study we explore the bidirectional relationship of heavy metal biomarkers (Pb and Cd) with 25OHD.

METHODS: In the longitudinal MIREC Study, we measured maternal blood 25OHD and metals in the 1st (n=1905) and 3rd (n=1649) trimester and 25OHD at delivery (n=1542). We used multivariable linear regressions and latent growth curve models (LGCMs) to explore the impact of Cd and Pb on 25OHD levels throughout pregnancy. Using Cross Lag Panel Models we examined the bidirectional relationship of metals and 25OHD.

RESULTS: The majority of women (~85%) had 25OHD levels >50 nmol/L at each visit. We found weak inverse associations between Cd and 25OHD concentrations cross-sectionally and longitudinally, with stronger estimates in smokers. LGCMs suggested 1st trimester Cd and Pb concentrations more strongly affect a woman's 25OHD baseline value (1st trimester) than her 25OHD trajectory in pregnancy; however, confidence intervals crossed the null. In contrast, the bidirectional analysis showed that for each doubling in 1st trimester 25OHD there was a 12% reduction in Cd (95% CI: -20%, -4%) and 5% reduction in Pb (95% CI: -9.42, 0.2%) concentrations in the 3rd trimester.

CONCLUSIONS: Our results suggest higher early pregnancy 25OHD values are associated with a lowering of 3rd trimester metal concentrations. There was no evidence for an effect of early pregnancy metals on later 25OHD. To our knowledge, this is the first study to investigate the bidirectional relationship between vitamin D status and metals in pregnancy.

Keywords: Vitamin D metals, Cross Lag Panel Model, Pregnancy, Biomarkers



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Exposures » Food/nutrition

Diet quality (adequacy, variety, moderation) in relation to biomarkers of metal exposure in school-age children

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BACKGROUND AND AIM: The relationship between dietary consumption and exposure to toxic metals/metalloids is complex. Foods may be a source of toxicant exposure, but they also provide many nutrients that compete with toxicants for intestinal absorption or contribute to lowering the toxicity of toxicants. Previous studies found associations between specific foods and blood or urinary lead (ex., dairy), arsenic (rice) or cadmium (grains) biomarkers in children. Basing dietary recommendations on individual foods or single toxicants could result in contradictory or potentially harmful guidance. Our objective was to relate measures of overall diet quality with biomarkers of arsenic, lead and cadmium exposure in school-age children.

METHODS: We constructed measures of dietary variety (servings of meats/eggs, dairy/beans, grains, fruits, vegetables), adequacy (intake of vegetables, fruit, grains, fiber, protein, iron, calcium and vitamin C) and moderation (intake of total fat, sugar sweetened beverages, pastries, sweets and chips) based on two non-consecutive 24-hr diet recalls conducted among parents of ~7 year old children in Montevideo Uruguay. Blood lead levels (BLL) were measured using atomic absorption spectrometry and total urinary arsenic (U-As) and cadmium (U-Cd) were measured via IC-PMS. Using linear regression models, we estimated the association between dietary quality and toxicant biomarkers, adjusting for child age, sex, and household socioeconomic status.

RESULTS: U-As (median [5%, 95%]: 9.9 [4.1, 27.3] µg/L), U-Cd (0.06 [0.02, 0.15] µg/L) and BLL (3.8 [0.8, 7.8] µg/dL) indicated low-to-moderate exposure. Mean variety, adequacy and moderation scores were, respectively: 9.7±3.9 (out of 20), 25.0±4.7 (out of 40) and 12.3±4.8 (out of 30). Biomarkers of lead or arsenic were not associated with diet quality. Dietary variety and moderation were inversely associated with urinary cadmium concentrations.

CONCLUSIONS: Diets that are varied and provide adequate levels of nutrients do not contribute to biomarkers of children's exposure to arsenic, cadmium and lead.

Keywords: diet quality, lead, cadmium, arsenic, child



ABSTRACT E-BOOK

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Exposures » Food/nutrition

Nutritional modulation of fetal susceptibility to iAs-associated gene expression underlying oxidative stress and inflammation in cord blood

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BACKGROUND AND AIM: iAs contamination of drinking water has been identified in 70 countries at levels exceeding the World Health Organization limit of 10 ppb. The fetus is particularly vulnerable to exposure due to dynamic changes in gene expression that must be tightly regulated to promote fetal growth. iAs crosses the placental barrier and is associated with lower birth weight and transcriptomic alterations underlying oxidative stress, inflammation, and other growth-related signaling pathways in fetal cells. Fortunately, iAs metabolism is influenced by modifiable factors that may also protect the developing fetus. Specifically, as part of metabolism, iAs is sequentially methylated in a process facilitated by the one-carbon metabolism (OCM) pathway, with incomplete methylation (e.g., higher %MMAs) a risk factor for iAs-related health outcomes including lower birth weight. Among adults, OCM factors (e.g., folate, B12, homocysteine) influence iAs metabolism and the risk of iAs-associated diseases.

METHODS: We explore maternal serum concentrations of OCM factors as modifiers of iAs-associated changes in gene expression in cord blood using data from the Biomarkers of Exposure to ARsenic (BEAR) cohort (overall N=200; subcohort N=38). Genome-wide expression levels were quantified using microarray technology. Drinking water, maternal urine, and infant cord serum arsenicals were previously measured using HG-AAS and ICP-MS.

RESULTS: To test our hypothesis, genes underlying oxidative stress and inflammation will be selected a priori and evaluated in relation to iAs exposure using linear regression modeling. Genes differentially expressed ($p < 0.05$) in relation to iAs exposure will be evaluated further for effect measure modification. Specifically, effect measure modification on the additive scale will be assessed using a likelihood ratio test (LRT) of nested linear regression models (e.g., model0=interaction, model1=main effects).

CONCLUSIONS: Given widespread contamination of drinking water by iAs, the work has global implications and could present maternal diet as a preventative intervention for fetal susceptibility to iAs-associated decreases in birth weight.



ABSTRACT E-BOOK

Keywords: arsenic, gene expression, birth weight, intervention

P-166

Omics Technologies » The microbiome

Bacterial modification of the association between arsenic and autism-related social behavior scores

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BACKGROUND AND AIM: The relationship between environmental exposures and neurodevelopmental outcomes has been characterized, but the modifying role of microbiome is unknown. We probed prior evidence in the New Hampshire Birth Cohort Study (NHBCS) suggesting relationships between arsenic and neurobehavioral development, which were both associated with the infant gut microbiome in separate studies.

METHODS: Total arsenic was quantified in six-week-old toenail clippings of NHBCS participants. Three years postpartum, parents completed the Social Responsiveness Scale (SRS-2), which measures autism-related social behaviors on a continuous scale standardized to a mean of 50 (standard deviation 10) with higher scores indicating more maladaptive behavior. Metagenomic sequencing was performed on infant stools collected at six weeks and one year of age. The ten bacterial species and functions with the highest relative abundances at each time were dichotomized at the median. Separate linear models including interaction terms between exposure and each dichotomous microbiome feature were constructed to examine the modifying role of the microbiome on the arsenic-SRS-2 relationship, adjusting for five other trace elements (copper, manganese, lead, selenium, zinc) and sociodemographic characteristics.

RESULTS: The 78 participants with exposure, outcome, and microbiome data, rated better on the SRS-2 than the normative population (mean=44, SD=5). The relative abundances of several functional pathways identified in six-week stool samples appeared to modify the arsenic-SRS-2 association, including the S-adenosyl-L-methionine (SAM) cycle; among infants with high relative abundance of SAM genes there was no association [β =-0.66, 95%CI (-2.41,1.08)], whereas among infants with low relative abundance there was suggestive evidence of an adverse association [β =2.24, 95%CI (-0.04,4.51)], pinteraction=0.046]. Effect modification by individual species in six-week stool samples and features of the one-year-old microbiome was also identified in preliminary analyses.

CONCLUSIONS: Our findings indicate that the infant gut microbiome may alter neurodevelopmental susceptibility to environmental exposures. Potential effect modification by SAM genes suggests the gut microbiome may contribute to arsenic methylation/excretion.



ABSTRACT E-BOOK

Keywords: Microbiome, Children's environmental health, Neurodevelopmental outcomes, Chemical exposures

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Omics Technologies » The microbiome

Human Microbiome Mixture Analysis using Weighted Quantile Sum Regression

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BACKGROUND AND AIM: Studies of the health effects of the microbiome often measure overall associations by using diversity metrics, and individual taxa associations in separate analyses, and do not consider the correlated relationships between taxa in the microbiome. The aim of this study was to test the use of random subset weighted quantile sum regression (WQSRS) on microbiome data to identify mixture effects.

METHODS: We applied WQSRS, a mixture method successfully applied to 'omic data to account for relationships between many predictors, to processed amplicon sequencing data from the Human Microbiome Project. We simulated a binary variable associated with 20 operational taxonomic units (OTUs), 2 strong, 8 medium and 10 weak, which were chosen based on previously identified links to health outcomes. All other OTUs were assigned no association. WQSRS was used to test for the association between the microbiome and the simulated variable, adjusted for sex, and sensitivity and specificity were calculated. The WQSRS method was also compared to other standard methods for microbiome analysis.

RESULTS: WQSRS predicted the correct directionality of association between the microbiome and the simulated variable, with a sensitivity and specificity of 75% and 60%, respectively, in identifying the 20 associated OTUs. Regression analysis using alpha diversity as the outcome identified an association with the simulated binary variable in the correct direction, however permutational analysis of variance (PERMANOVA) analysis using Bray-Curtis distances did not identify an association with the simulated binary variable. Similarity percentage analysis identified the associated OTUs with a sensitivity of 40% and specificity of 78%, and performed the same when tested with a random variable.

CONCLUSIONS: The application of WQSRS to the microbiome allows for analysis of the mixture effect of all the taxa in the microbiome, while simultaneously identifying the most important taxa in the mixture, and allowing for covariate adjustment.

Keywords: Microbiome, mixtures analysis, modeling



ABSTRACT E-BOOK

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Exposures » Microbes/Microbiome

Associations of urinary microbiome profiles with gestational diabetes mellitus in an Oklahoma case-control study

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BACKGROUND AND AIM: Previous research has demonstrated associations between the human placental, gut, and vaginal microbiome and gestational diabetes mellitus (GDM). Recent findings suggest urine is a biomarker for integrated profiling of the genitourinary and amniotic microbiome. However, little is known about how urinary microbiome disturbances may relate to GDM. The present study aims to characterize and compare the urinary microbial profiles among pregnant women with and without GDM.

METHODS: Bacterial DNA was extracted from mid-pregnancy urine obtained from a prevalence case-control study of 59 GDM cases and 206 controls from the University of Oklahoma Medical Center (August 2009 to May 2010). The taxonomic profile of the urinary microbiome was characterized by high-throughput sequencing of the V4 region of the microbial 16S rRNA gene. Associations between the microbial composition of taxa relative abundance and GDM were evaluated using multivariable logistic regression while controlling for maternal characteristics. Relative abundance (%) was categorized as absent, \leq median or $>$ median values. Alpha diversity (richness and evenness) and beta diversity (community structure) were also compared between cases and controls.

RESULTS: A total of 27 microbial genera were identified in the cases and controls, which were predominated by the genera *Lactobacillus* and *Gardnerella*. The odds of a relative abundance $>$ median was decreased for the genus *Aerococcus* while it was increased for the genus *Veillonella* among the cases compared to the controls in the crude model. After adjusting for age and race, GDM cases had a decreased odds of higher relative abundance ($>$ median vs. absence) of *Aerococcus* compared to the controls, with the upper bound of the confidence interval (CI) marginally crossing 1.0 (adjusted odds ratio: 0.45, 95% CI 0.18, 1.10). No difference was observed in alpha and beta diversity metrics between cases and controls.

CONCLUSIONS: Our hypothesis-generating results suggest the urinary microbiome composition may differ by GDM status.



ABSTRACT E-BOOK

Keywords: Microbiome, Pregnancy outcomes, Molecular epidemiology

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Outcomes » Obesity and metabolic disorders

Exposure to Phthalates May Accelerate Body Fat Gain in Midlife Women: The Study of Women's Health Across the Nation (SWAN)

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BACKGROUND AND AIM: Phthalates may disrupt energy balance in animals, but their effects in humans remain uncertain. We examined whether phthalate exposure was associated with body fat gain in midlife women.

METHODS: We analyzed longitudinal data from 1369 women in the Study of Women's Health Across the Nation Multi-Pollutant Study. Eleven phthalate metabolites measured in spot urine samples at baseline (1999/2000) were standardized with covariate-adjusted creatinine. Body weight (BW), percent body fat (BF%), and waist-to-hip ratio (WHR) were measured near-annually until 2016/2017. For each metabolite, linear mixed effects models with interaction terms between time and $\log_2(\text{metabolite})$ were used to predict outcomes, adjusting for demographic, lifestyle, and menopause-related factors. Analyses were conducted overall and stratified by baseline obesity status due to heterogeneity in outcome trajectories. All analyses were repeated using a second set of metabolites measured in 2002/2003 to evaluate findings' robustness.

RESULTS: In all women, metabolites of di(2-ethylhexyl) phthalate (DEHP), monobenzyl phthalate (MBzP), mono-carboxyoctyl phthalate (MCOP), and mono(3-carboxypropyl) phthalate (MCPP) were associated with faster increases in BF%. The difference in the rate of change per doubling of metabolites ranged from 0.012 percentage point (pp)/year (95% confidence interval (CI): 0.00014, 0.023) for MBzP to 0.019 pp/year (95% CI: 0.0044, 0.033) for MCPP. Stratified analyses revealed that positive associations occurred primarily in women who were normal/underweight at baseline, where mono-ethyl phthalate (MEP), mono-n-butyl phthalate (MnBP), MBzP, and MCPP were associated with faster increases in all outcomes. For instance, each doubling of MnBP was associated with 0.091% (95% CI: 0.0025, 0.18), 0.029 pp/year (95% CI: 0.0083, 0.049), and 0.025% (95% CI: 0.0020, 0.047) faster increases in BW, BF%, and WHR, respectively. Most associations were attenuated and non-significant when using exposure data from 2002/2003.



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CONCLUSIONS: Some phthalate metabolites were associated with fat gains in midlife women, but results may be sensitive to the timing of exposure.

Keywords: Phthalates, Endocrine disrupting chemicals, Obesity and metabolic disorders, Female, Environmental epidemiology

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Outcomes » Microbiome

Ambient Air Pollution Exposure is Associated with the Infant Gut Microbiota

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BACKGROUND AND AIM: Exposure to ambient air pollutants (AAP) has been linked with the gut microbiome in young adults; however, this relationship has not been studied in infancy. This study aimed to examine the relationships between AAP and the infant gut microbiota.

METHODS: This study included 105 infants from the Southern California Mother's Milk Study. Average exposure to particulate matter (PM_{2.5}, PM₁₀) and nitrogen dioxide (NO₂), was examined during the first 6 months of life. The infant gut microbiota was characterized using 16S rRNA sequencing at 6 months. Associations between AAP and the composition of the gut microbiota was examined using a Zero Inflated Poisson Regression (ZIPR), where incidence risk ratios (IRR) and Bonferroni adjusted p-values are reported. Compositionally aware, multinomial models were used to describe associations between AAP and the abundance of each gut microbe, and new methods for visualizing those associations were used to identify an important subset of associated taxa. Based on a directed acyclic graph, models adjusted for sex, breastfeeding frequency, socioeconomic status, birthweight and infant age.

RESULTS: Overall, 26, 16 and 22 gut bacterial taxa were associated with exposure to PM₁₀, PM_{2.5} and NO₂, respectively. For example, PM₁₀ and PM_{2.5} were associated with *Enterococcus* (IRR=1.08, p<0.001) and *Actinomyces* (IRR=1.46, p<0.001) abundances, respectively. Multinomial analysis also revealed that PM₁₀ exposure was associated with the composition of the gut microbiota based on the log-ratio of differentially ranked taxa sub-groups (R²=0.28, p<0.001). For example, all microbial genera positively associated with PM₁₀ via ZIPR were also classified as being in the top 35% of differentially ranked taxa positively associated with PM₁₀ exposure.

CONCLUSIONS: Early postnatal exposure to AAP was associated with the composition of the infant gut microbiota at 6-months of age. These results suggest that early life exposure to AAP may impact the developing gut microbiome, which may have important implications for infant development.

Keywords: Air pollution, Microbiome, Outcomes, Particulate matter, Oxides of nitrogen, Children's



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ABSTRACT E-BOOK

environmental health



ABSTRACT E-BOOK

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Outcomes » Obesity and metabolic disorders

Identifying geographical profiles of nutrition-epidemiological transition in Argentina

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BACKGROUND AND AIM: Latin America has experienced major shifts over the last decades in its demographic, nutritional, and epidemiological profiles. While the global trends and patterns have been widely described, the differences in the process of nutrition-epidemiological transition among and within low- and middle-income countries have been scarcely explained. This work aimed to identify different geographical profiles of nutrition-epidemiological transition within Argentina in the 2005-2019 period.

METHODS: A nationwide ecological study in Argentina was performed, using health statistics and demographic information from official data sources about its 24 geographical units (provinces). Percentages of change (2005-2019) of selected nutritional, epidemiological, and demographic indicators were estimated by geographic unit. Using a Principal Component Analysis coupled with a Hierarchical Cluster Analysis, it was identified geographic clusters representing profiles of nutrition-epidemiological transition (NET) across the Argentinean territory.

RESULTS: Three NET profiles (clusters) were identified: 1) "Reemergence of infectious diseases", mainly characterized by a rising burden of infectious diseases (such as congenital syphilis among others), with a decrease in the years of potential life lost (YPLL) due to cancer and external causes; 2) "Persistence of cardiovascular diseases with improvements in health and lifestyles", with rising arterial hypertension prevalence and decreasing YPLL due to infectious diseases, infant mortality and physical inactivity prevalence; 3) "Consolidation of the obesity-physical inactivity-cardiometabolic diseases triad", characterized by increases in the YPLL due to cardiovascular diseases, in the prevalence of type 2 diabetes and adult obesity, and the proportion of people with a low level of physical activity. These clusters (NET profiles) accounted for 25%, 50%, and 25% of Argentina's provinces, respectively.

CONCLUSIONS: The identification of different epidemiological-nutritional profiles indicates that Argentina is facing different transitional processes. Macro-contextual factors may play a major role in shaping these profiles.

Keywords: Obesity and metabolic disorders, Cardiovascular diseases, Infectious diseases, Environmental disparities, Mortality, Epidemiology



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Outcomes » Obesity and metabolic disorders

Prenatal and Early Childhood Lead Exposure and Metabolic Syndrome Risk Indicators in 6 to 8 year-old Children

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BACKGROUND AND AIM: Exposure to lead (Pb) during early life stages has been associated with the development of metabolic syndrome (MS). Longitudinal studies in children are limited. We aimed to examine the association between prenatal and early childhood exposure to Pb and risk indicators of MS between 6 and 8 years of age.

METHODS: Our study included 601 mother-child dyads participating in the PROGRESS birth cohort, children included were full term. Blood lead levels (BLLs) were assessed prenatally, during the second and third trimesters, in cord blood at delivery, and postnatally in early childhood at ages 1, 2 and 4 years of age. To account for cumulative exposure, we created scores (prenatal, postnatal, and overall) dichotomizing BLLs at each stage visit and categorized as: always above if BLLs was above the median (AA), never above if all BLLs was below the median (NA), and sometimes above otherwise (SA). We analyzed fasting glucose, HbA1c, triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol, body mass index, waist circumference, body fat percentage, systolic and diastolic blood pressure at 72 and 96 months of age. Mixed-effects models were used to analyze each outcome longitudinally for prenatal, postnatal, and overall BLLs scores, adjusting for socioeconomic status, sex, size for gestational age, parity, maternal and children's age.

RESULTS: We observed associations for total cholesterol with SA prenatally (β : -6.13, 95% CI: -11.0, -1.23), postnatally (β : -6.16, 95% CI: -11.8, -0.46) and overall (β : -6.66, 95% CI: -11.2, -2.10); LDL cholesterol and prenatal SA (β : -4.901, 95% CI: -9.13, -0.66); systolic blood pressure and overall AA (β : -1.851, 95% CI: -3.60, -0.09); HbA1c and postnatal SA (β : -0.10, 95% CI: -0.20, -0.001).

CONCLUSIONS: Early life exposure to Pb may alter early indicators of MS. Follow-up of these children will allow for more definition on the longer-term impact of exposure.

Keywords: Lead Exposure, Prenatal Exposure, Metabolic Syndrome, Early Childhood



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Exposures » Microbes/Microbiome

Association between mid-childhood gut microbiome and neurocognitive outcomes in GESTE, a Canadian cohort Study

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BACKGROUND AND AIM: The microbiome is a dynamic ecosystem that may modulate neurodevelopment through the gut-brain axis. Altered microbial gut composition has been linked to childhood temperament and autism, however, to date, no studies estimate the association between the gut microbiome and neurocognitive function in a healthy mid-childhood population

METHODS: Participants were 80 Caucasian children from the GESTation and the Environment, GESTE, a longitudinal birth cohort based in Sherbrooke, Canada. At the 6-8 years follow-up visit stool samples were analyzed with 16S rRNA sequencing. Intra-individual (alpha) microbiome diversity was computed using diversity (Shannon and Gini-Simpson) and dominance indices (Simpson and McNaughton's). Inter-individual microbiome (beta) diversity was calculated using weighted and unweighted UniFrac, Bray-Curtis and Jaccard distances. Furthermore, bacterial phylum and family levels associations were examined. At the same follow-up visit, the children completed the WISC-IV (Wechsler Intelligence Scale for Children) questionnaire which includes seven subtests (block design, coding, total, forward and reverse digit span, information, and vocabulary). The associations between microbiome diversity, bacterial phyla and families and cognitive scores were assessed using generalized linear regression models adjusted for confounders, e.g., sociodemographic characteristics, breastfeeding and mode of delivery. Missing data points were imputed. The results were corrected using FDR method.

RESULTS: Among the study cohort, 52% boys, 80% breastfed and 80% born vaginally with mean age, 6.5 years \pm 0.5 at follow-up. Lower Shannon (β = -1.05, 95%CI: -1.71-0.39, p =0.02) and Gini-Simpson (β = 1.04, 95%CI: -1.77-0.41, p =0.02) indices were associated with better long-term memory. No associations were observed for beta diversity. Higher total digit span was marginally associated with lower Desulfobacterota phylum abundance (β = -0.23, SE:0.09, p =0.09).

CONCLUSIONS: Our findings suggest that while a healthier gut as measured by indices of microbial diversity was not associated with improved long-term memory, lower level of Desulfobacterota phylum bacterial taxa may be beneficial for the development of auditory working memory.

Keywords: Microbiome, Neurodevelopmental outcomes, Epidemiology.



ABSTRACT E-BOOK

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Outcomes » Childrens environmental health

Gestational and early childhood phthalate exposures and adolescent body composition: The HOME Study

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BACKGROUND AND AIM: Early life phthalate exposures may cause metabolic disruption. However, results from human studies are inconsistent and few have examined body composition during adolescence. We investigated associations of urinary phthalate metabolite concentrations during gestation and childhood with body composition at age 12 years to identify periods of heightened susceptibility.

METHODS: We used data from 206 mother-child pairs in a prospective pregnancy and birth cohort enrolled in Cincinnati, OH from 2003-2006. We measured nine phthalate metabolites in spot urine samples collected twice from mothers during pregnancy and up to six times from children at 1, 2, 3, 4, 5 and 8 years. At age 12 years, we assessed whole body fat and lean mass, android, gynoid, and visceral fat mass with dual x-ray absorptiometry, and calculated android to gynoid %fat ratio and age- and sex-standardized fat and lean mass index Z-scores. Using a multiple informant model, we estimated the covariate-adjusted associations between urinary phthalate metabolite concentrations at each time period and adiposity Z-scores at age 12 years. We assessed effect measure modification by child sex using stratified models.

RESULTS: Associations of urinary mono-n-butyl, mono-isobutyl, and mono-benzyl phthalate concentrations with 12-year body composition outcomes differed by time period, with stronger associations for exposures during gestation and later childhood. For example, each 10-fold increase in urinary mono-benzyl phthalate concentrations during gestation at ages 5 and 8 years was associated with a -0.34 (95%CI: -0.72,0.05), -0.44 (95%CI: -0.83,-0.05), and -0.35 (95%CI:-0.71,0.00) Z-score difference in whole body lean mass at age 12 years, respectively, but not for exposure in in early childhood. Slightly weaker but similar patterns of association were found with other body composition measures; associations did not differ by child sex.

CONCLUSIONS: Exposure to certain phthalates during gestation and late childhood may be associated with adolescent body composition, particularly lean mass.

Keywords: Children's environmental health, Endocrine disrupting chemicals, Obesity and metabolic disorders, Phthalates



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Outcomes » Childrens environmental health

Association between placental metal exposure and NICU Network Neurobehavioral Scales (NNNS) profiles in the Rhode Island Child Health Study (RICHS)

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BACKGROUND AND AIM: Exposure to even low levels of toxic metals has been linked to cognitive and behavioral deficits in children. Our prior work has demonstrated the placenta's role in programming newborn health, and that placenta function can be affected by metals exposures. In this study, we hypothesized that placental trace metals can lead to poor neurobehavioral performance and so assessed the associations between placental toxic trace metals, cadmium, manganese, and lead, and neurobehavioral performance indicated through the NNNS in newborns.

METHODS: A hospital-based birth cohort, RICHS enrolled infants >37 weeks gestation and oversampled for infants born either small or large for gestational age (n= 840). Placental tissue was collected within 2 hours of birth, and 24 metals', metalloids', and nutrient elements' concentrations were determined using inductively couple plasma mass spectrometry. NNNS assessment was carried out by certified psychometrists from 24-72 hours after birth (n=625). Latent profile analysis (LPA) was used to define neurobehavior profiles based on 12 NNNS summary scales. Multinomial regression was used to examine the association between placental metals concentrations and neurobehavioral profile membership controlled for confounders (infant sex, maternal age, race, BMI, education status and tobacco smoking during pregnancy).

RESULTS: The optimal LPA fit was a 5-profile model. The 12 NNNS summary scores were significantly different across the five profiles. Adjusted models showed that a doubling of placental cadmium concentration was associated with a 2.4 fold increased odds of newborns belonging to the atypical neurobehavioral profile compared to the typical performing profile (95%CI: [1.4, 3.4]). Participants with detectable placental lead levels also had increased odds of belonging to the atypical profile (OR: 3.4, 95%CI: [2.1, 4.8]).

CONCLUSIONS: Placental toxic heavy metals including cadmium and lead were associated with atypical neurobehavioral performance at birth and provided additional evidence of the importance of the placenta in newborn health.

Keywords: heavy metals, children's environmental health, neurodevelopmental outcomes, environmental epidemiology



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Chemical exposures » Heavy metals

Residential Proximity to Metal-Containing Superfund Sites and Toenail Metal Concentrations in a Nationwide Study of US Women

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BACKGROUND AND AIM: Superfund sites in the United States contain hazardous substances, including toxic metals, which could potentially expose those living nearby. However, it is unclear whether residential proximity to sites may increase body burden of toxic metals. We aimed to evaluate the association between residential proximity to metal-containing Superfund sites and toenail metal concentrations.

METHODS: Metal concentrations (aluminum, antimony, arsenic, cadmium, and lead, ng/g) were measured in toenail clippings collected between 2003-2009 in 2,998 women with a family history of breast cancer. Residential proximity to Superfund sites was measured by living ≤ 5 or 10 miles of a site (yes/no), site density (sites/mile²) and an inverse-weighted sum distance measure (sites/mile). Linear regression was used to estimate the difference in toenail metal concentrations and 95% confidence intervals (CIs) per unit change in residential proximity measures (β). We evaluated whether associations varied by race/ethnicity.

RESULTS: Women who lived closer to, or had a higher residential density of, Superfund sites reporting contamination of lead or antimony had higher toenail concentrations of the corresponding metals. For example, living ≤ 5 -miles of a lead site was associated with 0.37 ng/g higher lead concentrations (95% CI: 0.18-0.57), and an increase in 1 additional lead-containing site/mile² was associated with 2.9 ng/g higher lead concentrations (95% CI: 1.8-4.0). Negligible associations were observed for sites containing arsenic or aluminum for any distance metric. For cadmium, associations were only evident in non-Hispanic Black women living near Superfund sites (N=744) but not non-Hispanic White women (N=2,244, e.g., living ≤ 5 -miles of a cadmium site, β Non-Hispanic Black= 0.69, CI: 0.37-1.0; β Non-Hispanic white = -0.04, CI: -0.3-0.23; p-heterogeneity=0.02).

CONCLUSIONS: Increased residential proximity to Superfund sites was associated with higher toenail concentrations of certain metals. Results for cadmium suggest important racial/ethnic differences in exposure that warrant follow-up for potential issues of environmental justice.

Keywords: chemical exposures, hazardous waste, heavy metals



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Chemical exposures » Heavy metals

Comparative sensitivity of children and adults to neurological effects of inhaled manganese

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BACKGROUND AND AIM: Manganese (Mn) is an essential nutrient but a neurotoxicant at elevated concentrations. Inhalation exposure can bypass homeostatic regulations and enter the brain. The U.S. EPA's 1993 inhalation reference concentration and ATSDR's 2011 minimal risk level are based on neurological outcomes in adults. To understand whether more recent data could provide information on potential lifestage-based variations in susceptibility, we compared sensitivities to neurotoxicity in children and adults using Mn biomarker data.

METHODS: We developed a literature search strategy and a Population, Exposures, Comparators, and Outcomes statement. The search covered 2011-2020, with supplemental backwards reference searching. Screening was performed using SWIFT and DistillerSR. Paired studies were identified based on concordant Mn source, biomarker, and outcome. Comparisons were made based on slope of the observed dose-response (children:adults).

RESULTS: We identified five studies evaluating seven pairings of hair Mn and neurological outcomes in child and adult populations with environmental Mn inhalation exposure. Two Brazilian studies of children (ages 6-12) and one of adults reported effects on IQ; effects in both comparisons were stronger in children (203% and 121%). A paired study of children and adults in Ohio reported effects on five metrics of postural sway; children exhibited both stronger and weaker effects compared to adults (175% to 69%).

CONCLUSIONS: Preliminary results from a small database of well-matched studies suggest that variability in neurological effects by lifestage is less than 10-fold. This conclusion should be interpreted with caution, given the limited available paired studies. Future work will consider the impact of study quality on these conclusions. Additional studies on Mn-exposed children with direct measurement of air concentrations would provide further understanding of the toxicity of inhaled Mn among susceptible lifestages.

*The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

Keywords: Children's environmental health, Heavy metals, Risk assessment, Neurodevelopmental outcomes



ABSTRACT E-BOOK

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Chemical exposures » Heavy metals

Correlates of whole blood metal concentrations among reproductive-aged Black women

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BACKGROUND AND AIM: Metals may adversely affect reproductive health, motivating the need for data on correlates of metal concentrations among reproductive-aged women.

METHODS: We analyzed cross-sectional data from a cohort of 1,693 Black women aged 23-35 years in Detroit, Michigan. We collected whole blood samples and questionnaire data from 1,664 (98%) participants at baseline (2010-2012). We measured concentrations of 17 elements using inductively coupled plasma–mass spectrometer–triple quadrupole and total mercury using Direct Mercury Analyzer (DMA)-80. We used multivariable linear regression models (adjusted for all hypothesized correlates) to identify demographic, nutritional, lifestyle, occupational, and reproductive correlates of metal concentrations.

RESULTS: Median concentrations of select metals included: arsenic (0.33 µg/L), cadmium (0.20 µg/L), lead (0.47 µg/dL), and mercury (0.56 µg/L). The largest correlations were observed between cadmium–lead (0.49), cobalt–manganese (0.45), mercury–arsenic (0.44), and chromium–vanadium (0.42). Alcohol intake (≥14 vs. 0 drinks/week) was positively associated with mercury (102.4% increase [95% confidence interval (CI) 30.3, 214.6]), arsenic (36.0% [12.4, 64.6]), lead (27.0% [15.6, 39.6]), copper (7.4% [2.4, 12.7]), and zinc (6.7% [1.9, 11.7]). Fish intake (≥8 vs. <4 ounces/week) was positively associated with mercury (215.4% [141.7, 311.4]), arsenic (100.3% [78.6, 124.7]), and cesium (5.8% [1.3, 10.5]). Water intake (≥5 vs. < 2 glasses/day) was positively associated with lead (6.8% [1.3, 12.6]). Current smoking (≥10 cigarettes/day vs. never) was positively associated with cadmium (466.8% [385.9, 561.1]) and lead (59.0% [43.7, 76.1]), and inversely associated with mercury (-58.0% [-73.8, -32.6]). Having ever worked in an auto repair shop/gas station was positively associated with nickel (71.4% [22.2, 140.3]), chromium (49.5% [17.6, 90.2]), arsenic (28.5% [-2.9, 70.1]), lead (11.4% [-3.1, 28.0]), and antimony (9.8% [-0.3, 20.8]).

CONCLUSIONS: We observed associations between dietary, lifestyle, and occupational factors and metal concentrations. Future analyses will examine correlates of metal mixtures and associations between metal concentrations and reproductive health outcomes.

Keywords: Chemical exposures, female, heavy metals



ABSTRACT E-BOOK

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Chemical exposures » Heavy metals

A State-of-the-Science Review on Metal Biomarkers Used in Epidemiological Mixtures Analyses: Best Practices and Common Pitfalls

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BACKGROUND AND AIM: Researchers are increasingly using innovative statistical methods to understand how exposure to real-world metal mixtures may affect human health. Although these new statistical approaches, such as Bayesian Kernel Machine Regression and Weighted Quantile Sums Regression, allow for researchers to include a wide panel of metals in their analysis, metals have unique sources and routes of exposure, different adsorption and elimination pathways and not all biomarkers are effective measures of exposure. This review aims to move the field of metal epidemiology forward by summarizing the most up-to-date research available on several metals, particularly highlighting the strengths and limitations of metal biomarkers and discussing potential existing evidence of interactions with other metals and environmental exposures.

METHODS: We reviewed observational and experimental studies from database searches and citations regarding exposure to 12 different metals, including 8 non-essential elements (arsenic, barium, cadmium, lead, mercury, nickel, tin, uranium) and 4 essential trace elements (manganese, molybdenum, selenium, and zinc). We included more than 500 studies.

RESULTS: In this review, we discuss in depth major environmental sources of exposure, biotransformation and elimination, biomarkers of exposure, and known interactions with other metals and environmental exposures for 12 metals increasingly used in metal-mixtures analyses.

CONCLUSIONS: As metal epidemiology moves towards embracing a multi-metal approach it is important for researchers to have a strong knowledge base about the metals they are including in their analysis. This review provides researchers with sufficient background knowledge on several metals to appropriately inform their analysis planning, statistical approach, and interpretation of results.

Keywords: Heavy metals, Chemical exposures, Biomarkers of exposure, Mixtures, Toxicology



ABSTRACT E-BOOK

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Outcomes » Other (to be specified with keywords in the keywords section)

Exposure to non-essential metals and albuminuria: exploring causal associations under a Mendelian randomization framework

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BACKGROUND AND AIM: Arsenic, cadmium and lead exposures are known nephrotoxicants at high exposure levels. However, there is scarce information for other non-essential metals, especially in low-moderate chronic exposure. Mendelian randomization (MR) is an interesting tool to disentangle causal associations where randomized controlled trials are not feasible. Our objective was to assess the observational and causal association of non-essential metals with albuminuria, a well-established marker of renal function decline.

METHODS: 1410 participants from the Hortega Study, a representative sample of a general Spanish population, had available albumin and inorganic arsenic (iAs), barium (Ba), cadmium (Cd), chromium (Cr), antimony (Sb) and vanadium (V) urinary determinations. Observational associations were assessed using traditional adjusted regression models. Causal associations were estimated with a 2-stage least squares (2SLS) adjusted MR approach and tested for consistency applying robust MR methods, including the inverse variance weighted and MR-Egger.

RESULTS: Median levels were 3.8 mg/g for albumin, and 6.6, 51.9, 0.4, 3.5, 0.08, 2.1 µg/g for iAs, Ba, Cd, Cr, Sb and V, respectively. The geometric mean ratio (95% confidence interval) of albuminuria by increased iAs, Ba, Cd, Cr, Sb and V in observational models was 1.72 (1.55, 1.91), 1.57 (1.43, 1.73), 2.06 (1.87, 2.27), 2.18 (2.00, 2.39), 1.58 (1.45, 1.73) and 2.17 (1.99, 2.37), respectively. Genetically-elevated urine levels (number of associated single-nucleotide polymorphisms) of iAs (82), Ba (69), Cd (70), Cr (68), Sb (65) and V (75) showed a positive causal association with albuminuria in the 2SLS-MR approach and were consistent with the robust MR methods, except for Sb, for which the MR-Egger suggested presence of pleiotropy among the SNPs and showed inconsistent results.



ABSTRACT E-BOOK

CONCLUSIONS: Our results support that non-essential metals are causally related with kidney damage at exposure levels relevant for the general population. Replication of findings in other populations would add robustness to these findings.

Keywords: Heavy metals, Causal inference, Epidemiology, Outcomes



ABSTRACT E-BOOK

P-181

Chemical exposures » Heavy metals

Iron deficiency and blood cadmium concentrations in a cohort of reproductive-age women

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BACKGROUND AND AIM: In reproductive-age women, iron deficiency is common. When iron stores are low, gut metal ion transporters are upregulated to increase intestinal absorption of dietary iron. However, this mechanism can also increase absorption of cadmium in the diet.

METHODS: We investigated the association between iron deficiency and blood cadmium concentrations using enrollment data (years 2010-2012) from the Study of Environment, Lifestyle & Fibroids, a cohort of 1,693 Black women ages 23-35 years who reside in the Detroit, Michigan area. Since cadmium exposure from cigarette smoking occurs via inhalation and not intestinal absorption, we restricted the study population to non-pregnant, never-smokers (n=1242). Cadmium and ferritin concentrations were measured in whole blood and serum samples, respectively, from 1120 participants. We adjusted the serum ferritin concentrations using high-sensitivity C-reactive protein and the Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) internal regression correction approach to account for inflammation. We defined iron deficiency as adjusted serum ferritin concentrations <15 µg/L. Multivariable linear regression was conducted to estimate the percent difference in blood cadmium concentrations in relation to iron deficiency, adjusting for age, education, and passive cigarette smoke exposure.

RESULTS: The geometric mean (GM) blood cadmium concentration in our sample was 0.22 µg/L (95% CI: 0.21-0.23), similar to that reported in NHANES 2011-2012 among Black women of the same age who never smoked (GM 0.24, 95% CI: 0.22-0.27). In the study sample, 19% of participants were iron deficient (n=210). Iron deficient participants had blood cadmium concentrations that were 51% higher than those who were not iron deficient (95% CI: 39%, 64%).

CONCLUSIONS: Our data suggest that iron deficiency increases cadmium body burden. The observed association aligns with our previous finding that heavy menstrual bleeding, a substantial contributor to iron deficiency, was associated with higher blood cadmium concentrations in this cohort.



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ABSTRACT E-BOOK

Keywords: Heavy metals, Female, Epidemiology



ABSTRACT E-BOOK

P-182

Chemical exposures » Heavy metals

Blood total mercury levels of Brazilian preschool children and associated risk factors: preliminary results

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BACKGROUND AND AIM: Environmental exposure to mercury in preschool children can impact their health by increasing its blood levels, which can cause negative health outcomes. This study aimed to set the reference value for blood mercury in preschool children from a megacity in Brazil, and investigating associated risk factors.

METHODS: Blood samples were collected of 2,463 children and the present study reports preliminary results from 1,020 1-4-year-old children attending 29 daycare centers (DCC) located in São Paulo, Brazil, 2013. Guardians answered sociodemographic and potential risk factors questionnaires. DCC and metal contaminated-sites (MCS) were georeferenced (QGIS™). Blood total mercury levels (BTM) were determined by Cold Vapor Atomic Absorption Spectrophotometry (CV-AAS). BTM was dichotomized (low/high levels) in a cut-off point of 1.06 µg.L⁻¹, which represents the 95th percentile reference value for total mercury established by the U.S. Centers for Disease Control and Prevention (CDC). Summary data and multiple logistic regression were performed (p<0.05).

RESULTS: The geometric mean for BTM was 1.71 µg.L⁻¹ (95%CI: 1.64-1.78 µg.L⁻¹) and the 95th percentile was 5.43 µg.L⁻¹ (95%CI: 4.89-6.26 µg.L⁻¹). DCCs located in the Northwest geographic zone were associated with high BTM when the model was adjusted for fish intake, age, sex, geographic zone, mother schooling, and amalgam (p=0.018). No associations were found between high BTM and fish consumption, amalgam teeth fillings, and georeferenced vicinity of the DCC to MCS.

CONCLUSIONS: BTM in Brazilian preschoolers (95th percentile) was more than five times higher than U.S. children's levels. Even the Brazilian geometric mean was higher than the U.S. BTM 95th percentile. More studies are necessary to identify potential mercury exposure sources for preschool children. Nevertheless, these results showed the need to formulate public health policies, intending to better understand and eliminate mercury sources.

Funded by Fapesp (2011/13076-0, 2011/23272-0, 2012/21840-4) and Capes.

Keywords: Mercury, Preschool children, Environmental exposure, Public Health, Blood, Potentially Toxic Elements



ABSTRACT E-BOOK

P-183

Outcomes » Cardiovascular diseases

Chelation Therapy in Patients with Cardiovascular Disease: A Systematic Review

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BACKGROUND AND AIM: Ethylenediaminetetraacetic acid (EDTA) is an intravenous chelating agent with high affinity to divalent cations (e.g. lead, cadmium, calcium) that may be beneficial in the treatment of cardiovascular disease (CVD). While a large randomized clinical trial (RCT) funded by the National Institutes of Health showed benefit, other smaller studies were inconsistent. We performed a systematic review of published studies to examine if EDTA improves clinical outcomes in adults with CVD.

METHODS: We conducted a systematic search of 3 databases (MEDLINE, Embase and Cochrane) from database inception to November 5, 2019 to identify all studies involving EDTA chelation treatment in patients with CVD. Predetermined outcomes included mortality, disease severity, plasma biomarkers of disease chronicity, and quality of life.

RESULTS: We found 23 studies (4 RCTs and 19 before/after studies) that assessed the use of repeated EDTA chelation treatment in patients with pre-existent CVD. Of these, 16 studies (1 RCT) found improvement in their respective outcomes following EDTA treatment. The largest improvements were observed in studies with high prevalence of participants with diabetes and/or severe occlusive arterial disease, including peripheral artery disease (PAD).

CONCLUSIONS: Repeated EDTA for CVD treatment may provide more benefit to patients with diabetes and severe PAD. EDTA excretes metals from the body that are known to induce inflammatory and oxidative processes involved in the progression of diabetes and atherosclerosis. Research is necessary to confirm these findings and to evaluate the potential mediating role of metals.

Keywords: Cardiovascular Diseases, Heavy Metals



ABSTRACT E-BOOK

P-184

Chemical exposures » Heavy metals

Metal concentrations in cereals are not related to the Chronic Kidney Disease of unknown cause (CKDu) in Sri Lanka

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BACKGROUND AND AIM: Exposure to nephrotoxic metals (As, Pb, and Cd), as well as Se deficiency has been hypothesized as a possible cause of Chronic Kidney Disease of unknown cause (CKDu) in Sri Lanka; however, evidence is inconclusive. Here, we determined the concentrations of these elements in rice and other grains consumed in endemic and non-endemic regions of CKDu.

METHODS: Dried and fine ground cereals were digested completely with trace metal grade nitric and hydrochloric acids and hydrogen peroxide. The clear completely digested solutions were analyzed using inductively coupled plasma mass spectrometry (ICP-MS).

RESULTS: Our results showed comparable mean concentrations (in µg/kg) of 23±17, 7.4±6.7, and 15.1±15.2 for As, Pb, and Cd, respectively, in rice from endemic regions, and 26±14, 10.5±6.3, and 12.3±15 in rice from non-endemic regions. Selenium concentrations (in mg/kg) were 0.05±0.02 and 0.04±0.02 in rice cultivated in endemic and non-endemic regions, respectively. Arsenic and Cd concentrations were significantly higher in rice compared to other grains, which themselves had higher Se than rice. All samples were below the Codex standards established for Cd (400 µg/kg for rice; 100 µg/kg for cereal grains), Pb (200 µg/kg), and total As (300 µg/kg).

Our findings show that dietary exposure to low levels of As, Pb, Cd, and inadequate Se in staple grains cannot be linked to CKDu, suggesting that the disease could be multifactorial. Our previous water quality evaluation in the study area similarly does not appear to be implicated, which further highlights the lack of strong evidence on nephrotoxic metals exposure from food and water in the study area.

CONCLUSIONS: More research is needed to understand the contribution of additional food materials among other risk factors to identify preventive strategies and minimize CKDu health cases in Sri Lanka and affected regions globally.

Keywords: CKDu, Nephrotoxic metals, Selenium deficiency, CKDu endemic and non-endemic regions, Sri Lanka.



ABSTRACT E-BOOK

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Chemical exposures » Heavy metals

EVALUATION OF THE PHYTOREMEDIATION POTENTIAL OF *Lemna minor* AND *Eichhornia crassipes* IN WATERS CONTAMINATION WITH NICKEL (II)

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BACKGROUND AND AIM: At present, human activities related to the consumption of energy and minerals have generated a negative environmental impact on aquatic ecosystems, with the nickel industry being one of those with the greatest impact on the environment. Phytoremediation is presented as a convenient technology for the stabilization of heavy metals and the improvement of water conditions, since aquatic plants can accumulate pollutants through different physical and biochemical pathways.

METHODS: In this study, the bioremediation capacity of two types of aquatic macrophytes was evaluated: *Lemna minor* and *Eichhornia crassipes* upon contact with synthetic nickel sulfate solutions at a concentration of 0.5, 1.5, and 2.5 mg/L of nickel ion. Their phytoremediation effect was evaluated by calculating the bioconcentration factor, the percentage of removal, the kinetics of the removal capacity and their physical development during the process.

RESULTS: The results showed that these species had a great phytoremediation potential. In addition, *L. minor* presented a maximum removal rate of 68%, compared to *E. crassipes*, which did not exceed 50% at the three concentrations studied. However, the latter macrophyte showed greater resistance to nickel affectations and obtained a higher removal capacity during the phytoremediation process, which was performed for 10 days.

CONCLUSIONS: It can be concluded that the two macrophytes are presented as a good alternative for nickel removal in water body.

Keywords: Heavy metals, Water quality, Exposures



ABSTRACT E-BOOK

P-186

Outcomes » Other (to be specified with keywords in the keywords section)

Association between blood and urine manganese levels and cardiorenal outcomes in adolescents: NHANES 2013-2018

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BACKGROUND AND AIM: Manganese (Mn), an essential mineral, is naturally present in many foods; however, deficiency or excess exposure may have potential adverse health effects. The kidneys are a major organ of Mn site-specific toxicity because of their unique role in filtration, metabolism, and excretion of xenobiotics. Limited evidence has identified the effects of Mn on renal or cardiovascular dysfunction, especially in adolescents. We hypothesized that Mn concentrations were associated with poorer cardiorenal outcomes such as estimated glomerular filtration rate (eGFR), blood pressure (BP), and blood urea nitrogen (BUN).

METHODS: We conducted a cross-sectional analysis of 2,002 US adolescents aged 10-19 years participating in NHANES cycles 2013-2014, 2015-2016, and 2017-2018. Blood Mn concentrations were measured using inductively coupled plasma mass spectrometry. Systolic (SBP) and diastolic (DBP) BP was calculated as the average of available readings. eGFR was calculated from serum creatinine using the Bedside Schwartz equation. We performed multiple linear regression, adjusted for race, age, gender, BMI, race/ethnicity, and poverty income ratio.

RESULTS: The average age of participants was 15.4 years. Median blood Mn concentration was 10.4 ug/L (IQR: 8.4, 13.1 ug/L). We observed that a log₁₀-unit increase in blood Mn ug/L was marginally associated with a 6.41 mL/min higher eGFR (95% CI: -0.32, 13.14). We observed null relationships for BP and BUN outcomes. There were no significant differences when stratified by sex.

CONCLUSIONS: Our findings suggest that Mn exposure may have implications for kidney health reflecting potential hyperfiltration. Additional analyses will examine non-linear relationships. We cautiously interpret these findings, as reverse causality cannot be ruled out. These findings warrant further investigation in longitudinal studies.

Keywords: Environmental Epidemiology, Heavy Metals, Cardiovascular Disease, Outcomes



ABSTRACT E-BOOK

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Outcomes » Cardiovascular diseases

Decline in blood lead and blood pressure: the Strong Heart Family Study

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BACKGROUND AND AIM: Chronic Pb exposure is associated with subclinical and clinical cardiovascular disease. American Indian (AI) participants in the Strong Heart Family Study (SHFS) experienced a 39% decline in blood Pb concentrations in recent decades. We evaluated if declines in blood Pb were associated with changes in systolic and diastolic blood pressure (SBP and DBP) in the SHFS. **METHODS:** Pb was measured in whole blood samples from 310 SHFS participants at visit 3 (1997-1999) and visit 5 (2006-2009). SBP and DBP were assessed at visit 4 (2001-2003) and visit 5. We evaluated the association between declines in blood Pb and changes in SBP and DBP via generalized estimating equations a) across tertiles of Pb decline, b) per decline in Pb corresponding to the interquartile range (IQR), and c) in flexible cubic spline models.

RESULTS: Mean change in blood Pb was 0.27 µg/dL for participants in the lowest tertile of Pb decline, and 8.02 µg/dL for participants in the highest tertile. In adjusted models, participants in the highest tertile of blood Pb decline experienced an average decline in SBP of 6.30 mmHg (95% CI 0.46, 12.15) compared to those in the first tertile. The average decline in SBP pressure per decline in blood Pb corresponding to the IQR (-1.03 µg/dL) was 2.33 mmHg (95% CI 0.57, 4.08, p=0.009). Flexible cubic spline models indicate a significant linear association between blood Pb decline and declines in SBP, and a nonsignificant linear association with declines in DBP.

CONCLUSIONS: Despite sample size limitations, recent large reductions in blood Pb were associated with large reductions in SBP in the SHFS, even at low levels of exposure relevant for the general US population. These findings support the importance of further reducing Pb exposures for all US communities.

Keywords: lead, blood pressure, cardiovascular disease, American Indian



ABSTRACT E-BOOK

P-188

Neurologic and Mental Health Outcomes » Other (to be specified with keywords in the keywords section)

Effects of lead, cadmium, and selenium exposures and fish consumptions on cognitive function in older adults

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BACKGROUND AND AIM: In our pilot study, we found blood lead and cadmium concentrations are negatively associated with both immediate and delayed recalls, and the opposite was found for blood selenium concentrations. In this study, we aimed to assess the effects of multiple metal exposures to lead, cadmium, and selenium on cognitive function in older adults to understand whether selenium or lead and cadmium had a greater effect on cognitive function.

METHODS: We used data from the National Health and Nutrition Examination Survey (NHANES) 2011 - 2014. These cycles performed cognitive function modules for the older adults, using the Consortium to Establish a Registry for Alzheimer's Disease (CERAD), and measured environmental metal exposures from participant's blood and urine. In the statistical analysis, data was analyzed using linear regression models, adjusted for sociodemographic characteristics and risky behavior.

RESULTS: In age-stratified linear regression models, blood lead concentrations were associated with significant decrements on CERAD immediate recall performance. Blood selenium concentrations were strongly associated with better CERAD performance. However, blood cadmium concentrations were not statistically associated with CERAD immediate recall scores. Furthermore, participants who ate more than 3 meals of fish in a month had significantly higher scores of CERAD immediate recall. From predicted regression models of CERAD immediate recall scores, participants with higher predicted scores had higher blood selenium concentration and frequent fish consumption. Meanwhile, those with lower scores had higher lead and cadmium concentrations.

CONCLUSIONS: Our results indicated that selenium intake and fish consumption may play important roles to maintain better cognitive functions in older adults.

Keywords: Heavy metals, Environmental epidemiology, Mixtures, Exposure assessment-biomarkers of exposure, Cognitive impairment, NHANES



ABSTRACT E-BOOK

P-189

Chemical exposures » Heavy metals

Drinking water challenges at the nexus of corroding infrastructure, policy, public health and climate change

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BACKGROUND AND AIM: Louisiana faces risks of an oncoming water crisis that will be intensified by both man-made and natural threats. Climate models predict an increase in the frequency and magnitude of storms, precipitation, and flooding in Louisiana in the upcoming decades; while gaps in regulatory oversight and enforcement, weaknesses public health recommendations, and corrosion of drinking water infrastructure threatens delivery of clean water to vulnerable communities.

METHODS: Results are presented from several independent investigations of private well or small community water systems throughout Louisiana.

RESULTS: Several cases of private, small or rural water systems were uncovered which pose public health threats, despite the fact that they have historically complied with regulatory requirements, or conformed to public health recommendations for water system maintenance. In New Orleans, while water lead levels met regulatory requirements, prevailing recommendations for reducing exposures through flushing and partial line replacements were not only inconsistently effective, but could also inadvertently increase exposures. In Louisiana, an estimated 400 water systems have excess iron, a largely unregulated nutrient; but monitoring of two compliant systems with high iron revealed conditions which can impact public health, including mobilization of trace inorganics like lead, depletion of free chlorine residual, interference with disinfection, and propagation of water pathogens. Finally, monitoring of wells in the aftermath of historical floods, revealed water pathogen contamination, despite shock chlorination, and failures in pathogen detection using conventional water testing practices.

CONCLUSIONS: The facts presented, support the need to address vulnerabilities in water regulations, oversight, infrastructure, testing, treatment, and exposure reduction strategies. Ultimately, vulnerable communities that are served by private wells or small rural water systems need lowcost autonomous water treatment solutions in order to prepare for threats they will inevitably face from anticipated climate impacts and infrastructure failures.

Keywords: Drinking water, climate change, iron, lead, water pathogens, infrastructure



ABSTRACT E-BOOK

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Built environment » Green space

Green Space as Environmental Public Policy for COPD Coping Measures: Contributing to Promoting Environmental Health and Equity

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BACKGROUND AND AIM: Chronic Obstructive Pulmonary Disease - COPD remains one of the main chronic respiratory diseases in the world and will likely continue to be a major public health concern due to an aging population and historically high rates of smoking. COPD is responsible for thousands of deaths all over the world. In some countries it already occupies the second place. It is mainly related to tobacco, but also environmental, occupational factors. The actually preventive measures and public policies are not able to completely directly impact mortality, yet. Researchers have been presenting new impactful approaches in COPD such as analyzes of access to green areas and COPD morbidity and mortality. Due to the chronic nature and incurability of COPD, many areas of health care are involved. COPD-related mortality is underreported. Interventions to improve air quality and prevent smoking can help reduce the risk of developing or worsening these diseases. Recent studies show that green space in cities are another important preventive factor in mortality. The objective of this work is to describe studies found that relate COPD and green space.

METHODS: We conducted surveys of studies for the period 2018 to 2021 that analyzed morbidity and mortality from COPD and the relationship with access to green space.

RESULTS: We found 24 studies.40% developed in European countries, 20% in North American countries. and 40% in Asia. 80% of them showed positive results regarding the reduction of morbidity or mortality due to COPD generated by access to green areas. We did not find related studies in Latin America and low-income countries.

CONCLUSIONS: Considering that COPD has no cure, it affects the population in all countries, it is essential to expand this discussion involving social and environmental indicators to all countries, considering a viable implementation of public policies to contributing to Promoting Environmental Health and Equity.

Keywords: Green space,Built environment,Policy,Science communication,Respiratory outcomes



ABSTRACT E-BOOK

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Built environment » Green space

Is it important to visit greenspace to keep your mental health good during a pandemic? - a cross-sectional online survey

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BACKGROUND AND AIM: Along with multiple stressors of COVID-19, access to greenspace may be altered and it would adversely affect health. We suggested mechanisms how a pandemic affects associations between greenspace and mental health and assessed the associations between decreased visits to greenspace and prevalence of depression and anxiety during the pandemic. **METHODS:** We conducted an online survey recruiting Korean adult participants from social media during September – December 2020 and collected data on basic information, patterns of using greenspace, and mental health symptoms during the past 2 weeks from the time of survey. The Patient Health Questionnaire (PHQ-9) and the Generalized Anxiety Disorder 2-item (GAD-2) were applied to identify probable cases of depression and anxiety. Multivariable logistic regression models assessed the impact of a categorical variable of decreased visits to greenspace after the outbreak compared to 2019 on depression and anxiety.

RESULTS: Among the total 322 survey participants, prevalence of probable cases was 19.3% for depression and 14.9% for anxiety. A higher rate of depression (23.3%) and anxiety (19.4%) was found among persons currently having job-related and financial issues. Of the total participants, 64.9% reported decreased visits to greenspace after the COVID-19 outbreak and low-income persons reported significantly higher reduction in visits to greenspace (p -value=0.046). The major reasons for decreased visits to greenspace were fear and worry regarding Coronavirus and the government's stay-at-home orders. In multivariable models, decreased visits to greenspace after the outbreak compared to 2019 was significantly associated with increased risk of depression at the time of the survey (OR=2.06, 95% CI: 0.91, 4.67).

CONCLUSIONS: Not using greenspace may deprive people of mental health benefits and affect mental illnesses during the pandemic; alternatively, those experiencing mental illnesses may be less likely to visit greenspaces during pandemic. Interventions need to adequately guide greenspace uses under an outbreak combined with mitigation measures.

Keywords: Built environment, Mental health outcomes, Green space



ABSTRACT E-BOOK

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Built environment » Green space

Street-View Greenspace Exposure and Objective Sleep Characteristics

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BACKGROUND AND AIM: Epidemiologic studies on the association of residential greenness with children's sleep quality are limited. Furthermore, most studies rely on satellite-derived measures of greenspace, which do not capture ground-level visible exposures. Google Street View (GSV) images offer the opportunity to measure greenspace from a street-based view and capture greenspace that may be most relevant for health.

We aim to examine associations of GSV-based greenspace with objective sleep characteristics in Project Viva, a highly-phenotyped cohort in eastern Massachusetts participating in the Environmental influences on Child Health Outcomes (ECHO) consortium.

METHODS: We applied the PSPNET deep learning segmentation algorithm to GSV images from 2007-2010 (mid-childhood visit) and 2012-2016 (early adolescence visit) to derive novel metrics of greenspace (e.g. % trees, %grass within each 360 degree image) at a 250m radius around participant's residential addresses (N=717). In early adolescence (mean[SD] age 13.0[0.7] years), participants completed >5 days of wrist actigraphy recording for >10 hours/day. Sleep duration and efficiency were derived from actigraph data. We used linear regression to examine associations of GSV-based greenness metrics at mid-childhood and early adolescence with sleep at early adolescence, adjusting for child's sex, race/ethnicity, and age, mother's education and marital status, father's education, household income, neighborhood median income, and population density.

RESULTS: Among the 500 adolescents, 249 were girls. In unadjusted models, mid-childhood GSV-based total greenness (per interquartile range) was associated with longer sleep duration at early adolescence (9.3 min/day; 95%CI:3.2,15.5). This association was mostly driven by trees (8.2; 95%CI:1.7,14.6). In early adolescence, unadjusted associations were similar. However, in all fully



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adjusted models, the association was no longer present (e.g. 1.1; 95%CI:-5.5,7.7 for mid-childhood greenness). No associations were observed between GSV-based greenness and sleep efficiency.

CONCLUSIONS: GSV-based greenness was not associated with sleep duration and efficiency in early adolescence among Project Viva participants.

Keywords: Built environment, green space, Children's environmental health, Environmental epidemiology



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Built environment » Green space

The influence of urban tree characteristics on environmental noise in Montreal, Canada

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BACKGROUND AND AIM: Vegetation can reduce environmental noise, but limited information exists regarding how specific characteristics of trees of the urban forest influence environmental noise. We investigated the physical characteristics of urban trees that influence environmental noise measurements in Montreal, Canada.

METHODS: We used Light Detection and Ranging (LiDAR) point cloud data from 2015 to extract the characteristics of all trees across the island of Montreal. Needle and broadleaf trees were distinguished with a Random Forest algorithm. Based on individual tree characteristics, we computed the total area of the tree crown footprint, the mean tree crown centroid height, the mean volume of tree crowns, and the percentage of broadleaf trees within various buffers (250 to 1000m) around 87 noise measurement sites across the city. Noise measurements were taken over a two-week period in the spring of 2010. Random Forest regression models were used to estimate the variation in noise around measurement sites related to tree characteristics, the Normalized Difference Vegetation index (NDVI), and distances of the measurement sites to major noise sources (highways, railways, and roads).

RESULTS: The 24-hour equivalent noise levels averaged across the 87 monitoring sites were 57.5 + 5.1 dBA. The mean crown centroid tree height (5.2 + 0.4m) and the total area of crown footprint (130.7k + 63.4m²) within 500m of each site location were the strongest predictors of measured noise levels. The percentage increased mean squared errors indicated that in 500m buffers, the total area of the



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crown footprint (29.2%) and the mean crown centroid height (12.6%) were associated with a stronger noise decrease than NDVI (3.2%); similar patterns were observed with other buffers.

CONCLUSIONS: Our findings suggest that tree crown footprint and centroid height, and not just the overall amount of vegetation, may play a vital role in reducing urban noise levels.

Keywords: Built environment, Green space, Noise



ABSTRACT E-BOOK

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Built environment » Green space

Associations between Residential Green Space and Fertility in a North American Preconception Cohort Study

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BACKGROUND AND AIM: A growing body of epidemiological literature shows that exposure to green space (natural vegetation) may have positive effects on human health, including reproductive outcomes. Residential green space may improve health via reduced exposure to traffic-related air pollution, reduced depressive symptoms or stress levels, and increased physical activity. We hypothesize that increased exposure to green space may promote fecundability, a sensitive marker of fertility.

METHODS: In a North American preconception cohort study (Pregnancy Study Online, PRESTO), we prospectively examined associations between residential green space (measured by satellite normalized difference vegetation index [NDVI] at a 30m resolution) and fecundability (per-cycle probability of conception) (n=8,790). From 2013 through 2019, women aged 21-45 years who were trying to conceive without fertility treatment completed online questionnaires every 8 weeks for up to 12 months. We followed participants until reported pregnancy or a censoring event (loss to follow-up, end of pregnancy attempt, initiation of fertility treatment, or 12 menstrual cycles), whichever event was first. Using geocoded residential addresses, we calculated annual maximum NDVI for 50m, 100m, 250m, and 500m buffers around each residence to quantify green space. We used proportional probabilities regression models to estimate fecundability ratios (FR), adjusting for sociodemographic and lifestyle characteristics.

RESULTS: Using life table methods, 67.7% of participants conceived who were in the highest NDVI group for the 250m buffer (NDVI: 0.8-1.0; n=874), compared to only 62.0% of participants with the lowest NDVI group (NDVI: 0.0-0.2; n=162). When comparing participants with the highest to lowest NDVI values in the 250m buffer, adjusted models show an FR of 1.43 (95% CI: 1.04, 1.95). Restricted cubic splines show a nonlinear trend. Results are similar for other distance buffers.

CONCLUSIONS: We present the first epidemiologic evidence that residential greenness is positively associated with fecundability. Future work will examine the role of key pathways that may mediate this relationship.

Keywords: Green space, Reproductive Outcomes, Female, Built environment, Environmental disparities



ABSTRACT E-BOOK

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Built environment » Green space

The association between forest cover and depressive symptoms in Pennsylvania adolescents

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BACKGROUND AND AIM: Exposure to green space, especially dense tree cover, can be beneficial for mental health, but most studies have been conducted with adults. We investigated associations between percent forest cover and depressive symptoms in adolescents in Pennsylvania.

METHODS: We assessed depressive symptoms via Public Health Questionnaire-9 scores in 24,985 Geisinger subjects aged 11-18 years (52% females; 93% white; 44% on Medical Assistance) with electronic health records in 2014-16. Percent forest was calculated within a circular residential buffer of radius 463-m (which was converted to a 1250 x 1250 m² square buffer using “Feature Envelope to Polygon” in ArcGIS) using the most recent release of data (2011) from the U.S. National Land Cover Database with land classes for deciduous, evergreen, and mixed forest and modeled in quartiles. We assessed associations with negative binomial regression models using generalized estimating equations to account for clustering of subjects within communities, adjusted for individual- and community-level covariates. We also used multinomial logistic regression models using generalized estimating equations to evaluate the association between percent forest and clinical depressive score categories of the PHQ-9.

RESULTS: The highest quartile percent forest (vs. lowest) was associated with decreased depression symptoms (adjusted exponentiated coefficient = 0.89, 95% confidence interval: 0.83 – 0.96). In categorized models, the highest quartile of percent forest (vs. lowest) was associated with an adjusted odds ratio of 0.80 (95% confidence interval: 0.64, 0.98) for moderately severe to severe depressive symptoms vs. no to minimal depressive symptoms.

CONCLUSIONS: Surrounding forest was associated with lower depressive symptoms in a large sample of adolescents. Forest cover could reduce depressive symptoms through promotion of physical activity and reduction of stress. These findings suggest communities should preserve and increase tree cover, a goal that is also consistent with, for example, climate change adaptation for cooling effects and heavy precipitation mitigation.

Keywords: mental health outcomes, children's environmental health, health co-benefits



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Built environment » Green space

Association of neighborhood parks with child health in the United States

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BACKGROUND AND AIM: While there is evidence that parks support pediatric health, there have been no national studies looking at both physical and mental health. We assessed whether the presence of a neighborhood park is associated with pediatric physical or mental health or health behaviors across the wider United States.

METHODS: Hypotheses about child health and neighborhood parks were investigated among respondents to the National Survey of Children's Health (NSCH) 2016, a nationally representative sample of children and adolescents aged 0-17. Caregivers reported on the presence of parks or playgrounds in the neighborhood and diverse outcomes, including child physical activity, screen-time, sleep, weight, and diagnosis of anxiety, depression, or attention deficit/hyperactivity disorder (ADHD). Covariates included child and family socio-demographics and, for 29 states, neighborhood urbanicity.

RESULTS: Caregivers reported on 49,146 children (mean age 9.4 years; 49% female). There were 11,791 (24%) children living in neighborhoods lacking a park; children in non-urban locations (aOR 2.19, 95%CI 1.40–1.67) or below the federal poverty level (aOR = 1.48, 95%CI 1.38–1.58) had higher odds of lacking a park. Irrespective of socio-demographics, children lacking parks were more likely to be physically inactive (aOR 1.36, 95% CI 1.24, 1.48), have excessive screen-time (aOR = 1.19, 95% CI 1.14, 1.25), or obtain inadequate sleep (aOR = 1.23, 95% CI 1.18, 1.29). Children without parks were more likely obese (aOR = 1.32, 95% CI 1.21, 1.43), overweight (aOR 1.25, 95%CI 1.17, 1.33), or diagnosed with ADHD (aOR 1.20, 95% CI 1.12, 1.29), but not more anxious or depressed (aOR = 1.04, 95%CI 0.97, 1.11).

CONCLUSIONS: Associations between parks and pediatric physical and mental health and health behaviors suggests that the provision of neighborhood parks could represent a low-cost childhood health intervention.

Keywords: Built environment, Green space, Children's environmental health, Mental health outcomes, Environmental disparities



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Built environment » Green space

Urban Greenness and Mental health among participants of the Canadian Longitudinal Study of Aging (CLSA)

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BACKGROUND AND AIM: In Canada, an estimated 6.7 million people suffer from mental health disorders in any given year. An increasing number of recent studies have suggested links between greenspaces and improved health. Few Canadian studies, however, have examined greenness-mental health relationships.

METHODS: We used cross-sectional data from the Canadian Longitudinal Study on Aging (CLSA) to characterize associations between greenness and prevalent mental health outcomes. Our analyses are based on 26,765 adults, 45 to 85 years of age, who lived in urban areas. The Normalized Difference Vegetation Index was used as a residential measure of greenness and we modelled exposures based on a series of buffer intervals (250m, 500m, 1000m). Four self-reported measures of mental health were assessed, and these included: i) the Center for Epidemiologic Studies Depression Scale (CES-D-10; short scale), ii) Perceptions of Mental health on the Likert scale, iii) Perceptions of General health on the Likert scale iv), and the Satisfaction With Life Scale (SWLS). We used multivariable logistic regression models to characterize associations between greenness and mental health. The resulting odds ratios, and their 95% confidence intervals, were adjusted for several important risk factors.

RESULTS: Overall, 5.6% of the participants reported fair/poor mental health, 9.3% fair/poor general health, 12.2% were dissatisfied on the SWLS, and 15.9% reported moderate/serious depression. Greenness at 500m around the residential postal code was inversely associated with all four measures of mental health. Specifically, interquartile range increases in greenness significantly reduced the odds of moderate/serious depression by 12% [OR=0.88, (95% CI=0.83-0.93)], the odds of dissatisfaction by 13% [OR=0.87, (95% CI=0.81-0.92)], the odds of fair/poor mental health by 19% [OR=0.81, (95% CI=0.74-0.88)], and the odds of fair/poor general health by 10% [OR = 0.90, (95% CI =0.83-0.98)].

CONCLUSIONS: Our findings suggest that urban greenness confers mental health benefits, and provide some support for local initiatives to green neighbourhoods as a means to improve population health.

Keywords: Mental health, Depression, Adults, Greenness, CLSA



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Built environment » Green space

Street-View Greenspace Exposure and Objective Daily Rest-Activity Patterns

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BACKGROUND AND AIM: Rest-activity patterns (sleep and physical activity) are modifiable risk factors for obesity. The sparse research on greenspace and sleep or physical activity in children is dominated by satellite-derived measures of greenspace, which do not capture ground-level exposures. Google Street View (GSV) images measure greenspace exposures as participants experience them and may be most relevant for health. We aimed to examine GSV-based greenspace and objective rest-activity patterns in adolescents in Project Viva, a cohort in eastern Massachusetts participating in the Environmental influences on Child Health Outcomes (ECHO) consortium.

METHODS: We applied deep learning algorithms to GSV images from 2012-2016 to derive metrics of greenspace (e.g., % trees, %grass within each image) within 250m of participant's residential addresses. We derived rest-activity metrics from the early adolescence visit (2012-2016; median age 12.7), when participants completed >5 days of wrist actigraphy for >10 hours/day. We used linear regression to examine associations between GSV-based greenspace and rest-activity patterns, adjusting for child's sex, race/ethnicity, and age; mother's education and marital status; father's education; household income; neighborhood median income and population density.

RESULTS: In unadjusted cross-sectional analyses (N=505), higher %grass, %trees, %plants, %fields, and %flowers combined (%total greenspace) was associated with lower activity in the least active 5-hour period (L5) in the 24-hour cycle, suggesting more consolidated sleep (L5 difference per IQR [24%] increase in %greenspace: -10.3 [95%CI -16.4,-4.2]), and slightly higher relative amplitude (RA),



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reflecting both higher activity during wakefulness and more restful sleep at night (RA difference per IQR increase in %greenspace: 0.01 (95%CI 0.01, 0.02)). These associations were consistent for both %grass and %trees. However, in multivariable models, these associations were no longer present. No associations were observed between GSV-based %greenspace exposure and moderate-vigorous nor light physical activity.

CONCLUSIONS: GSV-based greenspace exposure was not associated with objective rest-activity patterns among participants in early adolescence.

Keywords: Greenspace, Google Street View, Deep Learning, Accelerometry, Rest Activity, Children



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Built environment » Green space

Exposure to green and blue areas and children's lung function growth: results from the RESPOZE study

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BACKGROUND AND AIM: Although there is evidence on the effects of air pollution on children's respiratory health, few studies have reported results on exposure to green and blue spaces. We aimed to evaluate the association between indicators of green and blue areas and lung function growth in 10-11-year old children.

METHODS: We used data from the "Respiratory Effects of Ozone Exposure in children (RESPOZE)" panel study of 186 students residing in the two largest cities in Greece (Athens and Thessaloniki). Data was collected through questionnaires, weekly spirometry measurements and time-activity diaries, while home addresses were geocoded. Residential surrounding urban green spaces in different buffers, blue spaces in a buffer of 1000 meters and satellite-derived Normalised Difference Vegetation Index (NDVI) averaged over a buffer of 150 meters were used as exposure indices. The associations between lung function growth and exposure metrics in quartiles were assessed by applying multiple regression models with adjustment for confounders and clustering at neighborhood level.

RESULTS: Lung function growth was positively associated with green space surface around 500 meters of children's homes in single exposure models. A 0.050% [95% CI: 0.003, 0.097] increase in FVC and 0.030% [95% CI: -0.017, 0.077] increase in FEV1 for green space surface of more than 45,000 m² versus less than 5,250 m² was found, while the associations with NDVI were modest and insignificant. Children residing in areas with a blue space within a buffer of 1000m had increased lung function growth by 0.046% [95% CI: 0.003, 0.089] in FVC and 0.028% [95% CI: -0.010, 0.066] in FEV1 in relation to children residing in areas without blue space within a buffer of 1000m. Observed associations remained after controlling for residential distance from major roads.

CONCLUSIONS: This study indicates the beneficial role of residential green and blue spaces environment in children's respiratory health.

Keywords: Green space, Blue space, Children's environmental health, Respiratory outcomes, Epidemiology



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Built environment » Green space

Urban nature exposure in the time of COVID-19: associations between visitation patterns, mental health and perceived value

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BACKGROUND AND AIM: The COVID-19 pandemic has posed challenges for people worldwide experiencing restrictions and social isolation. The present study focuses on the exploration of the health benefits from visits to urban green (UGS) and urban blue spaces (UBS) during the third wave of COVID-19, as well as practices and perceptions towards urban nature in pre- and post-lockdown Greece.

METHODS: In February 2021 we conducted an online survey among 925 participants (18-65 years old, 30% male) on the engagement with UGS and UBS (proximity, ease of access, frequency, duration, motivation and types of UGS/UBS visited, as well as view of UGS and UBS from home) pre- and post-lockdown. Anxiety and depression were measured with the Patient Health Questionnaire-4 (PHQ-4) and subjective questions were used to determine the value participants attach to urban nature.

RESULTS: Lockdown measures resulted in a reduction of visitation and availability of different types of UGS and UBS, while the time spent in nature was either unchanged or slightly increased. The main motivation for using urban nature was walking and relaxing both pre- and post-lockdown. Participants' wellbeing was negatively affected during lockdown; however, access and view of UGS and/or UBS were perceived as helpful for coping with negative emotions, while visitation was associated with lower levels of depression and anxiety. The presence of UGS and/or UBS within the urban fabric was perceived as highly important by 89% of participants, who attached a higher value to urban nature after having experienced social isolation at home. Finally, a clear preference for continuing visiting UGS and UBS after the lifting of the lockdown was observed.

CONCLUSIONS: Our findings show the positive association between UGS and/or UBS exposure and mental health improvement in times of social isolation, highlighting the need to integrate ecosystem services into urban design.

Keywords: built environment, green space, blue space, COVID-19, mental health outcomes



ABSTRACT E-BOOK

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Built environment » Green space

Examining the influence of greenspace on youth development: a systematic review and research agenda

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BACKGROUND AND AIM: Evidence to date suggests that youth growing up in places with more greenspace have better developmental outcomes. However, most studies of greenspace and youth development are cross-sectional, limiting causal inference. We evaluated the current state of longitudinal evidence assessing the relationship between greenspace exposure and youth development.

METHODS: We searched six databases with unrestricted publication dates using the following search string: ("green space" OR greenspace OR (green space)) AND (youth OR child* OR adolescent* OR pediatric) AND development. We included prospective, longitudinal studies on greenspace and youth development (ages 2-18). Data on study design, study population, greenspace measurement, outcome assessment and key findings were extracted from studies meeting selection criteria. Study quality was assessed using a ten-item checklist adapted from a published review on greenspace and obesity by Lachowycz and Jones. Studies were classified into thematic categories using structured review.

RESULTS: Twenty-eight studies met criteria for review. Developmental outcomes were coded into five thematic groups: cognitive and brain, mental health and wellbeing, attention and behavior, allergy and respiratory, and obesity and weight. Most studies found that higher levels of greenspace exposure were associated with optimal youth development. The overall quality of studies ranged from moderate to good, with most studies failing to collect data on distance, frequency, use, and type of greenspace.

CONCLUSIONS: Findings indicate that green space promotes healthy development in youth. However, our review identified relatively few longitudinal studies, most of which were concentrated in wealthy, Western European countries, limiting generalizability of findings. Key challenges for the field include (1) lack of uniform standards for measurement of greenspace, (2) inadequate measures to account for large latency periods between greenspace exposure and developmental outcomes, and (3) a need to diversify study settings and populations.

Keywords: Green space, Children's environmental health, Built environment



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Built environment » Green space

Residential greenness and lower stress during pregnancy: hair cortisol levels as a chronic stress biomarker among pregnant women in Israel

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BACKGROUND AND AIM: Residential surrounding greenness has been associated with reduced stress and most of the studies used self-reported stress measures. Hair cortisol concentration (HCC) is a non-invasive biomarker of chronic stress. Our aim was to evaluate the associations between maternal exposure to greenness and first trimester HCC among pregnant women in Israel.

METHODS: Women were recruited during third trimester. Hair samples (3 cm) were taken from the scalp and HCC during the first trimester were determined for 216 women. HCC were natural log transformed and outliers were excluded. Based on geocoded birth address, small area sociodemographic status (SES) and mean residential surrounding greenness were calculated using high-resolution satellite-based Normalised Difference Vegetation Index (NDVI) data at 100m, 300m and 500m buffers in a cross-sectional approach. In addition, longitudinal exposure to mean of greenness during the two weeks preconception and first trimester were calculated. Linearity of the associations were evaluated and generalized linear models were used to estimate the crude and adjusted associations controlled for the relevant covariates. Missing covariates were imputed.

RESULTS: After exclusion of outliers, for 211 women, crude and adjusted beneficial associations between exposure to higher mean NDVI and HCC were observed for all the exposure measures. An increase in 1 interquartile range greenness (100 m buffer) was associated with a statistically significant decrease in natural log hair cortisol (-0.27 95% CI: -0.44; -0.11). The associations were robust to adjustment for covariates. The findings were consistent for different buffers, for the longitudinal approach and for all HCC observations. For most of the exposure measures, stronger associations were observed among those of lower socioeconomic status.

CONCLUSIONS: Our findings that more greenness might reduce chronic stress measured by cortisol level in the hair, adds to the limited information and require confirmation in other populations.

Keywords: Green space, Birth and pregnancy outcomes, Hair Cortisol, Normalised Difference Vegetation Index (NDVI), greenness, Hypothalamic-pituitary-adrenal axis



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Built environment » Green space

Exploring the Nature of Associations Between SES and Greenness in the Green Heart Louisville Study

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BACKGROUND AND AIM: Residential area greenness is often associated with socioeconomic status (SES) of nearby residents. However, the nature of this association has not been thoroughly explored at the individual level, or by greenness types at various scales. We conducted an in-depth assessment of associations between SES and greenness in Louisville, Kentucky, in a study area similar to many urban residential neighborhoods in the eastern United States.

METHODS: As part of the Green Heart Louisville Study, we collected data on SES: income, education, employment, property ownership status, for 730 participants residing in a neighborhood study area of 3.5 sq miles with high variability of SES and greenness. We collected aerial-based high-resolution indices of greenness - NDVI, biomass, leaf surface area, leaf area index, and canopy cover. We used multiple linear regression and random forest models to examine associations between SES and surrounding greenness estimated at parcels of participant homes, spatial radii around homes, and census units, and we compared the relationship between SES and greenness at the parcel, area, and neighborhood scales.

RESULTS: We found that surrounding greenness was significantly associated with income, population density, and distance to major roads and that these factors explain a significant percentage of greenness variability in both parcel and area-level models. Much stronger associations were observed among non-renters. The associations varied with the spatial unit examined, but less so with different measures of greenness. Adjusted multiple linear regression models showed high consistency across local-level greenness, while parcel-level models evince greater variability.

CONCLUSIONS: We observed significant associations between SES and greenness in our study area, with results varying based on the spatial context and participant characteristics. While not representative of all urban areas, these results could help inform statistical adjustments of future work when examining associations between greenness and health outcomes and better enable sustainable and culturally competent greenness intervention strategies.

Keywords: Greenness, SES, remote sensing, trees, built environment



ABSTRACT E-BOOK

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Built environment » Green space

Association between urban greenness and sleep measures in Canadian adults: Findings from the Canadian Longitudinal Study of Aging

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BACKGROUND AND AIM: A series of epidemiological studies have found that urban greenness may confer several health benefits, including improved sleep quality. In this study we explore the association between greenness and sleep quality among middle-age adults in a national Canadian cohort.

METHODS: We conducted a cross-sectional analysis of 30,089 urban dwelling participants, 45 to 69 years of age, of the Canadian Longitudinal Study of Aging. We investigated the relationship between urban greenness (NDVI) and the three sleep measures – sleep quality satisfaction, sleep duration, and difficulty falling asleep. We included individual data on levels of physical activity, health status, and connection to their local neighbourhood, as well as contextual measures including air pollution, favourability of the neighbourhood for active living, and socioeconomic status. We conducted multinomial logistic regression to derive adjusted odds ratios and their 95% confidence intervals to describe associations between greenness at sleep measures.

RESULTS: The analytic cohort included 27,276 participants, the majority of who were married or common-law, well educated, self-identified as white, and were born in Canada, which is in agreement with the demographic profile of the full CLSA cohort. Greenness exposure was higher among participants who were married/common-law, higher income and education, ethnically white, better general and mental health, never smokers, and a stronger connection to their neighbourhood. Multinomial logistic regression models adjusted for a set of a priori covariates according to each sleep outcome, based on socio-demographic characteristics, lifestyle factors, chronic disease, connection to neighbourhood, and stress. Multinomial logit models revealed greenness had a protective effect on sleep quality satisfaction and difficulty falling asleep (OR>1); however, results were not statistically significant.

CONCLUSIONS: Creating new green areas, as well as protecting and restoring current spaces, could have beneficial impacts on the sleep behaviour of middle-to-older aged adults residing in urban areas.

Keywords: Sleep, green space, NDVI, cross-sectional study, Canada, adults



ABSTRACT E-BOOK

P-205

Built environment » Green space

School greenness and student-level academic performance in Santiago, Chile

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BACKGROUND AND AIM: Previous research suggests greenness exposure might foster children's learning and improve academic performance. However, evidence on the association between school greenness and academic outcomes is mixed, with most studies looking at school-level associations in developed countries of the northern hemisphere. We present preliminary results from an observational study evaluating the association between school greenness and student-level academic performance in Chile

METHODS: Satellite-derived school greenness estimates were linked to administrative data on academic outcomes and contextual student and school information. We included all 4th grade students (n=246,774) enrolled in 1,398 public, charter, and private schools within the Greater Santiago Area (GSA) between 2014 and 2018. Academic performance was measured as individual-level scores in mathematics and reading standardized tests. Greenness in a 100m buffer around schools for each year was estimated using Normalized Difference Vegetation Index (NDVI) derived from Landsat 8 reflectance data. We fit linear multilevel mixed effects models to evaluate associations between school greenness and mathematics and reading scores, adjusting for students' sex, age, maternal education, paternal education, household income, and attendance, and for schools' SES, size, student-to-teacher ratio, and school type.

RESULTS: We found that a 0.1 increase in school NDVI was associated with a 3.1 point increase (95%CI: 1.8-4.4) in mathematics scores, equivalent to an increase of 1.2% (95%CI: 0.4%-1.7%) in mean mathematics scores for the study population. For reading, a 0.1 increase in school NDVI was associated with a 0.8 point increase (95%CI: -0.4-2.0) in test scores, equivalent to an increase of 0.3% (95%CI: -0.1%-0.7%) in mean reading scores for the study population. Stratified analyses by school type showed that the impact of NDVI was more significant in public versus private and charter schools.

CONCLUSIONS: Increased greenness was linked to improved standardized mathematics scores among elementary-aged students in a capital city in South America, with higher impact in public schools.

Keywords: Greenspace, Academic Performance, School Environment, Normalized Difference Vegetation Index (NDVI)



ABSTRACT E-BOOK

P-206

Chemical exposures » Endocrine disrupting chemicals

Maternal bisphenol urine concentrations, fetal growth and adverse birth outcomes. A population-based prospective cohort

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BACKGROUND AND AIM: Exposure to bisphenols may affect fetal growth and development. The trimester-specific effects of bisphenols on repeated measures of fetal growth remain unknown. Our objective was to assess the associations of maternal bisphenol urine concentrations with fetal growth measures and birth outcomes and identify potential critical exposure periods.

METHODS: In a population-based prospective cohort study among 1,379 pregnant women, we measured maternal bisphenol A, S and F urine concentrations in the first, second and third trimester. Fetal head circumference, length and weight were measured in the second and third trimester by ultrasound and at birth.

RESULTS: An interquartile range increase in maternal pregnancy-averaged bisphenol S concentrations was associated with larger fetal head circumference (difference 0.18 (95% confidence interval (CI) 0.01 to 0.34) standard deviation scores (SDS), p-value<0.05) across pregnancy. When focusing on specific critical exposure periods, an interquartile range increase in maternal first trimester bisphenol S concentrations was associated with 0.10 (95% CI 0.03 to 0.17, p-value<0.020) SDS larger fetal head circumference in the second trimester and 0.07 (95% CI 0.01 to 0.14, p-value<0.05) and 0.07 (95% CI 0.00 to 0.14, p-value<0.05) SDS higher fetal weight in the second and third trimester, respectively. An interquartile range increase in maternal first trimester bisphenol S concentrations was associated with a lower risk of small size for gestational age at birth (Odds Ratio 0.72 (95% CI 0.54 to 0.96), p-value<0.05). Maternal bisphenol S concentrations were not associated with fetal length or risk of preterm birth. None of the other bisphenols were consistently associated with fetal growth outcomes.



ABSTRACT E-BOOK

CONCLUSIONS: Higher maternal bisphenol S urine concentrations, especially in the first trimester, seem to be related with larger fetal head circumference, higher weight and a lower risk of being small size for gestational age at birth.

Keywords: Chemical exposures, Endocrine disrupting chemicals, Phenols, Phthalates, Birth outcomes



ABSTRACT E-BOOK

P-207

Chemical exposures » Endocrine disrupting chemicals

Gestational organophosphate ester exposures and bone mineral density in early adolescence: The HOME Study

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BACKGROUND AND AIM: Optimizing bone mineral density (BMD) in adolescence is critical for life-long bone health. Organophosphate esters (OPEs) are synthetic flame retardants and plasticizers that may have osteotoxic effects via endocrine disruption or nuclear receptor agonism. Animal studies suggest that gestation may be a critical period of susceptibility for the impact of OPEs on bone health, but human studies are lacking. We assessed the relation of maternal urinary OPE metabolite concentrations during pregnancy with early adolescent BMD in a prospective birth cohort study.

METHODS: We used data from 223 mother-child dyads enrolled in the HOME Study from Cincinnati, OH area, 2003-2006. We measured bis-2-chloroethyl phosphate (BCEP), bis-(1,3-dichloro-2-propyl) phosphate (BDCIPP), di-n-butyl phosphate (DnBP), and diphenyl phosphate (DPHP) in maternal urine collected at 16- and 26-weeks gestation, and calculated the average of creatinine-adjusted concentrations. We performed dual x-ray absorptiometry in children at age 12 years and calculated height-, age-, sex-, and population ancestry-specific Z-scores for whole body (excluding head), total hip, femoral neck, distal radius, and ultradistal radius areal BMD (aBMD) and spine bone mineral apparent density (BMAD). We estimated covariate-adjusted associations per 2-fold increase in maternal urinary OPE concentrations and assessed effect measure modification by child sex.

RESULTS: In adjusted analyses, BDCIPP concentrations were positively associated with aBMD and BMAD Z-scores at most skeletal sites. Z-score differences were between 0.11 and 0.15 and greatest for total hip ($\beta = 0.15$, 95% CI: 0.02, 0.29). Associations of DPHP with femoral neck and total hip aBMD differed by child sex. Associations among males were null while DPHP concentrations were inversely associated with femoral neck ($\beta = -0.15$, 95% CI: -0.29, -0.02) and total hip ($\beta = -0.15$, 95% CI: -0.29, 0.00) aBMD Z-scores among females.

CONCLUSIONS: Maternal OPE exposures during gestation may affect early adolescent BMD in a metabolite-, sex-, and bone site-specific manner.



ABSTRACT E-BOOK

Keywords: Chemical exposures, Children's environmental health, Endocrine disrupting chemicals

P-208

Chemical exposures » Endocrine disrupting chemicals

Variability of urinary organophosphate esters (OPEs) during childhood: The HOME Study

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BACKGROUND AND AIM: Organophosphate esters (OPEs) are widely used as flame retardants and plasticizers. Previous research has shown that gestational exposure to OPEs is variable, but no studies have examined the patterns and variability of postnatal exposure to our best knowledge.

METHODS: In a prospective birth cohort (HOME Study, Cincinnati, OH, USA), we measured urinary OPE metabolite concentrations three times (16 and 26 weeks of gestation, at delivery) during pregnancy and five times (ages 1, 2, 3, 5, 8 years) during childhood. We log₁₀-transformed creatinine-standardized OPE metabolite concentrations. We calculated Spearman correlation coefficients between postnatal OPE metabolites at each time point. We then used linear mixed models to calculate intraclass correlation coefficients (ICCs) for metabolite concentrations across the five postnatal time points. We further examined the association between three prenatal measures and early childhood (ages 1, 2, 3 years) exposure and subsequent metabolite concentrations at ages 5 and 8 years, including the main effect and the interaction term with the subsequent time points of metabolite measurement using linear mixed models.

RESULTS: We detected (2-chloroethyl) phosphate (BCEP), bis(1,3-dichloro-2-propyl) phosphate (BDCIPP), and diphenyl phosphate (DPHP) in 79 to 100% of children. The median concentrations (µg/g creatinine) were 0.78-4.76 for BCEP, 4.02-7.42 for BDCIPP, and 2.57-11.48 for DPHP. We found moderate correlations between BCEP and BDCIPP (rs: 0.28-0.49, p < 0.001) at all time points. ICCs for metabolites across five postnatal time points, however, indicated poor within-person correlation (0.09-0.25). Prenatal urinary DPHP concentrations were positively associated with postnatal DPHP concentrations at some time points. Positive associations between early (1-3 years) and late childhood concentrations (age 8 years) were found for BCEP and BDCIPP.



ABSTRACT E-BOOK

CONCLUSIONS: We found high within-person variability of OPE exposure within children across the first 8 years of life, suggesting that multiple urine samples are needed to characterize children's exposures to OPEs.

Keywords: Chemical exposures, Endocrine disrupting chemicals, Children's environmental health, Environmental epidemiology



ABSTRACT E-BOOK

P-209

Chemical exposures » Endocrine disrupting chemicals

Gestational Exposure to Polybrominated Diphenyl Ethers and Social Skills and Problem Behaviors in Adolescents: The HOME Study

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BACKGROUND AND AIM: Polybrominated diphenyl ethers (PBDEs) are persistent environmental pollutants used as flame retardants in consumer products. Gestational PBDE exposure has been associated with a variety of behavior problems in children, but little is known about its impact into adolescence, particularly on social skills, which are important for achieving social competence, establishing identity, and forming lasting relationships.

We investigated the association between gestational exposure to PBDEs and social skills and problem behaviors in adolescence in a longitudinal pregnancy and birth cohort in Cincinnati, Ohio (recruited 2003-2006).

METHODS: We measured maternal serum concentrations of PBDE congeners, creating a summary exposure variable during pregnancy ($\sum 5\text{PBDE}$: the sum of PBDEs 28, 47, 99, 100, and 153). At age 12, we collected self-reported and caregiver-reported social skills and problem behaviors for 243 adolescents using the Social Skills Improvement System (SSiS). Higher scores on the SSiS indicate better social skills and more problem behaviors. We used multivariable linear regression models to estimate associations between maternal PBDE concentrations and SSiS outcomes, controlling for potential covariates.

RESULTS: We found sex-specific associations of $\sum 5\text{PBDE}$ concentrations with adolescent-reported Problem Behaviors ($\sum 5\text{PBDE} \times \text{sex } p\text{-int}=0.02$) and caregiver-reported Social Skills ($\sum 5\text{PBDE} \times \text{sex } p\text{-int}=0.02$) despite similar $\sum 5\text{PBDE}$ exposures (Male GM=4.70, GSE=1.04; Female GM=4.97, GSE=1.04). In sex-stratified models, a 10-fold increase in maternal $\sum 5\text{PBDE}$ concentration among males was associated with decreased caregiver-reported Social Skills composite score ($\beta=10.2$, 95% CI: -19.5, -1.0), increased adolescent-reported Problem Behaviors composite score ($\beta=12.1$, 95% CI: 5.4, 18.8), and increased caregiver-reported Problem Behaviors composite score ($\beta=6$, 95% CI: 0.1, 11.7). Further analysis on SSiS subscales revealed similar patterns in significant associations among males. There were no statistically significant associations in stratified models among females.

CONCLUSIONS: Exposure to PBDEs during gestation was associated with decreased social skills and increased problem behaviors among adolescent males in this cohort.

Keywords: Chemical Exposures, Children's Environmental Health, Endocrine Disrupting Chemicals, Male, Neurodevelopmental Outcomes



ABSTRACT E-BOOK

P-210

Chemical exposures » Endocrine disrupting chemicals

Predictors of phthalate metabolites exposure among healthy pregnant women in the United States

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BACKGROUND AND AIM: Phthalate exposure varies by geographic region, race, sex, product use, and other factors. Exposure is associated with detrimental reproductive and developmental outcomes. Few studies consider sociodemographic differences in exposure through the course of pregnancy. We examined determinants of phthalate metabolites during pregnancy in a cohort of diverse nulliparous pregnant women.

METHODS: We report on urinary metabolites of 4 parent phthalates: Butyl benzyl phthalate (BBzP - MBzP), Di-isobutyl phthalate (DiBP - MiBP), Diethyl phthalate (DEP - MEP), Di-(2-ethylhexyl) phthalate (Σ DEHP) from urine collected up to three times (e.g. once in each trimester) from 960 women enrolled in the Nulliparous Mothers To Be Study. Phthalate metabolites were adjusted for specific gravity; concentrations below the limit of detection (LOD) were replaced with LOD/ $\sqrt{2}$. We calculated the geometric mean of concentrations in each trimester for each metabolite. Generalized linear models examined characteristics that predicted average levels of phthalate metabolites.

RESULTS: In the prediction model, maternal race and clinical site were significant predictors (p -value $< .0.05$) for MiBP and MEP. Compared to non-Hispanic White women, higher concentrations of MiBP were found in Hispanic and Asian women, and higher concentrations of MEP was found in Asian women respectively. Metabolite concentration varied throughout the US. Women who received care at in sites in Illinois, California and Pennsylvania had lower MBzP concentration in comparison to women who received care in sites in Ohio. Women who received care in Illinois had higher MEP levels on average when compared to women who received care in Ohio. Lastly, women who received care in New York and Pennsylvania had higher DEHP concentration in comparison to women receiving care in Ohio.

CONCLUSIONS: These findings suggest differences in exposure among heterogeneous groups of women and indicate independent exposure patterns that may imply the need for interventions targeted toward specific groups to reduce exposure.

Keywords: Phthalates, predictors, environmental epidemiology



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-211

Chemical exposures » Endocrine disrupting chemicals

A Review of Health Effects of Polybrominated Biphenyls Five Decades after Michigan Agricultural Contamination

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BACKGROUND AND AIM: The Michigan Polybrominated Biphenyl (PBB) cohort was created after a 1973 manufacturing mistake mixed the flame retardant PBB into animal feed. PBB was distributed to Michigan farms for nearly a year, exposing Michigan farmers, chemical workers, and consumers of animal products to high PBB levels. The PBB cohort has been continuously followed since 1976 and has provided insights into health impacts of an endocrine disrupting chemical (EDC) during specific windows throughout the lifecourse.

METHODS: We conducted a systematic literature review using the MEDLINE and Thompson Reuters (ISI) Web of Science databases for PBB research published since the 1973-1974 incident. We identified 60 publications resulting from the PBB cohort that researched the first-generation cohort members (F0), the second (F1) and third (F2) generation cohort members.

RESULTS: The literature review highlighted the adverse human health effects of PBB exposure since 1975. Early studies (1975-1984) did not find many associations with PBB; however, methodological limitations might account for these results. More recent work revealed an increased risk of breast cancer, accelerated pubertal development and earlier menarche for girls exposed in utero, urogenital problems and slower pubertal development in boys exposed in utero, altered hormone levels among women exposed in childhood, and increased risk of miscarriage among daughters of exposed women. Emerging epigenetic and metabolomic research has supported evidence of altered pathways related to estrogenic effects and immune function. Research has also shown PBB levels alter the epigenome of spermatogenic cells. This work has begun to elucidate biological mechanisms of endocrine disruption.

CONCLUSIONS: The PBB cohort is a unique population to research the multigenerational impacts of exposure to an EDC. The PBB cohort adds to the growing evidence that the effects of endocrine disruptors depend not only on dose but also on the timing, with the most damaging effects during fetal development and before puberty.

Keywords: Endocrine-disrupting chemicals, Exposome, Epigenomics, Reproductive Outcomes, Long-



ABSTRACT E-BOOK

term exposure

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Chemical exposures » Endocrine disrupting chemicals

Comparison by Race and Ethnicity of Endocrine Disrupting Chemical levels in the U.S. Military

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BACKGROUND AND AIM: Prior studies reported racial/ethnic (R/E) differences in serum concentrations of polyhalogenated aromatic hydrocarbons (PHAHs), an endocrine disrupting chemical class including polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), polybrominated biphenyls (PBBs), and organochlorine pesticides (OCPs). We investigated R/E differences in PHAH serum concentrations in members of the U.S. military.

METHODS: Serum samples, obtained 1994-2010, for 742 active-duty military personnel were analyzed by ICP mass-spectrometry. We compared serum concentration levels of 14 PCBs, 4 PBDEs, 1 PBB, and 5 OCPs, for which at least 40% of samples had detectable values. We used a multiple imputation method to replace values below the detection limit. Age-adjusted geometric means (aaGMs) of serum concentrations (ng/g-lipid) of these analytes were compared by R/E between the 467 (66.0%) non-Hispanic (NH) whites (reference), 132 (18.6%) NH blacks, 68 (9.6%) Hispanics, and 41 Asians/Pacific Islanders (APIs) (5.8%) using generalized linear models.

RESULTS: The mean participant age was 27.3 (SD=7.4) years. Compared to NH whites, NH blacks had higher aaGMs for all PCBs, while Hispanics had lower aaGMs. PBDE aaGMs were generally higher among NH blacks and Hispanics than NH whites; APIs also had lower levels. For OCPs, APIs had the highest levels of dichloro-diphenyl-trichloroethane (DDT). Yet, Hispanics had the highest levels of DDT's major metabolite, dichlorodiphenyldichloroethylene (DDE). NH blacks had the highest levels of trans-nonachlor and oxychlorane, while NH whites had the highest levels of hexachlorobenzene. Most differences in aaGMs by R/E were statistically significant ($p < 0.05$).

CONCLUSIONS: This study found differences in serum concentrations of several endocrine disrupting chemicals by R/E among military personnel. Studies are needed to investigate if these differences exist at entry into the military or are associated with military exposures.

Disclaimer: The opinions here are the authors' and do not reflect the official views of the Uniformed Services University or the Department of Defense.

Keywords: Endocrine disrupting chemicals, Pesticides, Chemical exposures, Occupational exposures



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-213

Chemical exposures » Endocrine disrupting chemicals

Prenatal exposure to phthalates and phenols and pre-clinical cardiovascular health during early adolescence

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BACKGROUND AND AIM: Exposure to endocrine-disrupting chemicals may increase cardiovascular risk from early life, but studies in children have shown inconsistent results, most focused on analysis of single chemicals, and none included measures of micro-vascularization as early pre-clinical markers. This study aimed to evaluate the association between prenatal exposure to phthalates and phenols and macro- and microvascular health during early adolescence.

METHODS: Using data from a Spanish birth cohort (n=416), prenatal exposure to phthalate metabolites and phenols (bisphenol A, parabens, benzophenone-3, triclosan) was assessed using first and third trimester spot-urine concentrations. Macrovascular health (systolic and diastolic blood pressure (SBP and DBP, mmHg), pulse wave velocity (PWV, m/s)) and microvascular health (central retinal artery/vein equivalent (CRAE/CRVE, μm)), were measured at 11 years old. Linear regression models assessed associations for individual chemicals and Bayesian weighted quantile sum regression (BWQS) evaluated the overall association of each chemical group with cardiovascular health.

RESULTS: In individual exposure models, BPA was associated with decreased PWV (β per doubling of exposure = -0.06 ; 95% CI: $-0.10, -0.01$). One phthalate, MiBP was associated with an increase in CRAE ($\beta = 1.89$; 95% CI: $0.34, 3.44$). Two parabens, MEPA and BUPA were associated with a decrease in CRVE ($\beta = -0.71$; 95% CI: $-1.41, -0.01$) and ($\beta = -0.96$; 95% CI: $-1.57, -0.35$), respectively. No significant associations were observed between any of the exposures and SBP or DBP. In models using BWQS there was no evidence of associations between the phthalates or phenols mixture and any of the outcomes.

CONCLUSIONS: Our results provide little evidence to suggest that prenatal exposure to phthalates and phenols is associated with macro or microvascular health during early adolescence, except a few associations with certain compounds. Errors in exposure measurement and reduced variability in cardiovascular measures at this early age limit our ability to draw strong conclusions.

Keywords: Phenols, phthalates, cardiovascular diseases, chemical exposures, Endocrine disrupting chemicals, mixtures analysis



ABSTRACT E-BOOK

P-214

Chemical exposures » Endocrine disrupting chemicals

Low and high molecular weight metabolite concentrations in relationship to adiposity in a multi-site, multi-racial cohort of children

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BACKGROUND AND AIM: Low molecular weight (LMW) and high molecular weight (HMW) phthalates are used in multiple everyday products, many of which are bioavailable to children. Evidence concerning the effects of these phthalates on child adiposity remain inconsistent.

METHODS: Analyses included 540 racial/ethnically diverse children ages 4-8 in the Environmental Influences on Child Health Outcomes (ECHO) study, a follow-up of the NICHD Fetal Growth Studies. Urinary oxidative metabolites of three LMW and eleven HMW phthalates were determined using liquid chromatography tandem-mass spectrometry. Values were divided by molecular weight and summed to obtain composite LMW and HMW group values (nmol/ml) and natural log transformed. Outcomes were child's body mass index (BMI) z-score, waist circumference z-score, and percent body fat. Linear regression models were adjusted for urine specific gravity, gender, age, race/ethnicity, birth weight, prolonged exclusive breastfeeding, physical activity, fast-food consumption, smoke exposure, neighborhood traffic, mother's education and pre-pregnancy BMI.

RESULTS: All children had LMW and HMW phthalate group levels at or above the limit of detection. LMW levels were not associated with BMI z-score (β [95% CI]: 0.010 [-0.037, 0.057]), waist circumference z-score (β [95% CI]: -0.002 [-0.046, 0.042]) or percent body fat (β [95% CI]: -0.009 [-0.025, -0.007]). There was evidence of a possible interaction with race ($p=0.09$), with increased LMW levels in Black children being positively associated with percent body fat (β [95% CI]: 0.005 [0.001, 0.010]). HMW levels were not associated with BMI z-score (β [95% CI]: -0.003 [-0.084, 0.078]), waist circumference z-score (β [95% CI]: 0.021 [-0.055, 0.097]) or percent body fat (β [95% CI]: 0.0003 [-0.008, 0.008]).

CONCLUSIONS: In this largely null cross-sectional analysis only LMW phthalates in Black children were associated with percent body fat. Additional research is needed to identify possible interactions between LMW phthalates, HMW phthalates and joint exposure to related chemicals.

Keywords: Phthalates, Obesity and metabolic disorders, Children's environmental health



ABSTRACT E-BOOK

P-215

Chemical exposures » Endocrine disrupting chemicals

***In utero* paraben exposure and evidence of obesogenic effects - Associations between placental ethyl paraben and cord blood metabolic biomarkers**

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BACKGROUND AND AIM: Parabens are used as antimicrobial preservatives in personal care products. Few studies had dealt with adverse health outcome, transplacental transfer, and obesogenic effects of exposure to parabens. We investigated potential obesogenic effects of *in utero* paraben exposure of the fetus by assessing the association between placental paraben levels and cord blood metabolic biomarkers, considering modulating effects of maternal pre-pregnancy BMI.

METHODS: Placental concentrations of four parabens [methyl (MeP), ethyl (EtP), propyl (PrP), and butyl (BuP)] were measured by ultra-performance liquid chromatography/tandem mass spectrometry in 229 placentas of the ENVIRONAGE birth cohort. The association between placental parabens and cord blood metabolic biomarkers [glucose, insulin, γ -glutamyltransferase (GGT), high-density and low-density lipoprotein (HDL and LDL)] was analyzed in multiple regression models with two different sets of, *a priori* selected potential confounders, and additionally stratified for different maternal BMI groups.

RESULTS: The geometric means of placental MeP, EtP, PrP, and BuP levels above the limit of detection (LOD) were 4.42, 1.32, 1.51, and 0.35 ng/g respectively, with only EtP showing sufficient (88%) measurements above LOD for further analyses. An interquartile ratio (IQR) increase in placental EtP was associated with an increase of 12.61 % (95% CI: 1.80, 24.57) in the geometric mean of cord GGT activity, and with a decrease of -3.64 % (95% CI: -6.80, -0.39) in the geometric mean of cord glucose. Maternal pre-pregnancy BMI was inversely correlated with cord blood GGT ($r = -0.14$, $p = 0.045$).

CONCLUSIONS: Prenatal EtP exposure could contribute to adverse health outcomes later in life by modifying metabolic processes *in utero*. The association of placental EtP with cord blood GGT and glucose levels provides a starting point for further research aiming to unravel the mechanism of action of paraben-related metabolic effects.

Keywords: Endocrine disrupting chemicals, Obesity and metabolic disorders, Children's environmental health, Environmental epidemiology



ABSTRACT E-BOOK

P-216

Air pollution » Particulate matter

PM_{2.5} effect on health in the city of Korhogo (Côte d'Ivoire, West africa)

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BACKGROUND AND AIM: Air quality and its impacts capture more attention of governments and public opinion. Indeed, air pollution has consequences on the health of populations. Epidemiological studies contributed much to the understanding of the effects. In order to understand this, an epidemiological study was done in the regional hospital of Korhogo in regards to the PM_{2.5} concentration levels in the city.

The objective of this study was to assess the impact of PM_{2.5} concentration on health in Korhogo, with special attention to cardiorespiratory and skin diseases.

METHODS: All subjects coming to consultation in the regional hospital of Korhogo were selected in relation to the lungs, skin, and heart symptoms for 3 months beginning from December 2018 to March 2019. Patients to include were identified by a Medical Doctor through a questionnaire after their informed consent.

The relationship between exposure to air pollution and health was done through time series. The main outcomes of the study were the incidence of cardiorespiratory and skin diseases (95% CI) and the indicator of health impact. An existence of a significant relationship between exposure to air pollution and health outcomes was done.

RESULTS: The preliminary results showed that 3410 patients consulted a physician during the 3 months visits in the regional hospital of Korhogo. Within those patients, 527 (17.46%) were recruited for pollution issues. More than 95% of the patients had cardiopulmonary diseases in the city of Korhogo. The average of PM_{2.5} concentration was higher than the daily recommended by WHO. A strong relationship was seen to be associated to cardiopulmonary disease in that regional hospital

CONCLUSIONS: The average of PM_{2.5} concentration was higher than the daily recommended by WHO. A strong relationship was seen to be associated to cardiopulmonary disease in that regional hospital. Where a special attention should be taken for patients

Keywords: PM_{2.5} concentration; Health impact, Korhogo



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Particulate matter pollution at traffic hotspots of Accra: levels, exposure experiences of street traders, and associated respiratory and cardiovascular symptoms

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BACKGROUND AND AIM: There is limited studies on health effects of street trading in spite of common knowledge that individuals engaged in the trade are exposed to high levels of traffic-related air pollution per their mode of operation, and also the fact that the venture is a dominant occupation in cities of Sub-Saharan Africa and other developing regions. We characterized particulate matter (PM) pollution levels at traffic hotspots of Accra, Ghana during the dry and wet seasons, and assessed exposure experiences of street traders.

METHODS: A cross-sectional study was conducted among 236 street traders operating along six selected traffic routes of Accra and a comparison group of 186 office workers. PurpleAir PA-II monitors was used to measure PM levels at the selected traffic routes. We estimated annual PM exposure of street traders using assigned seasonal PM_{2.5} and PM₁₀ levels, and information collected in a structured questionnaire on activity patterns of the street traders.

RESULTS: PM levels at Accra traffic hotspots were high in both seasons. 1 μ g/m³ increase in PM_{2.5} exposure increased respiratory, cardiovascular and overall symptoms by a score of 0.0001 (95% CI: 0.00004, 0.0002), 0.00008 (95% CI: 0.00002, 0.0001) and 0.0002 (95% CI: 0.00008, 0.0003), respectively. Compared to office workers, high PM_{2.5} exposure among street traders was statistically associated with increased odds of coughing, catarrh, sneezing, rapid heart beating, sharp chest pains, irregular heartbeat, fainting spells, headaches and dizziness. Low and medium PM_{2.5} exposure was also statistically associated with increased odds of dermatitis and rapid heart beating, and sharp chest pains, respectively.

CONCLUSIONS: We found consistent evidence that PM_{2.5} exposure among street traders increases occurrence of self-reported respiratory and cardiovascular symptoms. We also provide indicative measurements of PM levels at traffic hotspots of a rapidly growing SSA city with heavy vehicular traffic and yet, limited air quality monitoring capacity.

Keywords: Street trader, Traffic-related air pollution, Particulate matter, Respiratory symptoms, Cardiovascular symptoms



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Which specific urban policies should be implemented by local authorities to achieve a health objective seeking reducing air pollution-attributable mortality?

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BACKGROUND AND AIM: Public policies aiming at decreasing air pollutants such as fine particulate matter (PM_{2.5}) are often designed without targeting an explicit health benefit and without carrying out cost-benefit analyses, therefore possibly limiting their adoption. We therefore developed a transdisciplinary backward and forward approach.

METHODS: We first defined health objectives (corresponding to decreases by 33%, 50% and 67% in PM_{2.5}-attributable mortality in 2030 compared to 2016), then identified which PM_{2.5} reductions and urban policies allowed to meet the health targets (backward approach), and finally conducted health impact and cost-benefit analyses of these policies (forward approach). The urban policies were related to wood heating and traffic, the two main emitting sectors in the considered area (Grenoble conurbation, France). The forward approach also considered the health and economic impacts related to changes in physical activity and carbon dioxide emissions.

RESULTS: We showed that the most ambitious health target (-67%) could be achieved in 2030 by replacing all inefficient wood heating equipment by pellet stoves and by reducing by 36% the traffic of private motorized vehicles. Such a reduction in traffic requires to increase active modes share (walking, biking...), which would also induce substantial increases in physical activity, and additional health benefits beyond the initial health target. Wood heating system replacement and the strategies maximizing active mobility, which are those that did not require massive investment in public transport, were the most cost-effective policies. Many benefits would be linked to the increase in physical activity: annual net benefits were between  468 and  615 per capita for policies with report on active modes, compared to between  151 and  258 for those without.

CONCLUSIONS: Urban policies strongly reducing air pollution-attributable mortality can be identified by backward transdisciplinary approaches, and they can be cost-efficient. To our knowledge, such approach has not previously been carried out at the city or national level.

Keywords: Dispersion model, economic analysis, fine particulate matter (PM_{2.5}), health impact assessment, transportation modal shift



ABSTRACT E-BOOK

P-219

Air pollution » Oxides of nitrogen

Copula-Based Semiparametric Spatial Modelling of Antenatal Exposure to Ambient Oxides of Nitrogen on Joint Adverse Preterm and Low Birthweight Outcomes

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BACKGROUND AND AIM: The adverse effects of ambient air pollution on preterm birth and low birthweight are complex, and a nonlinear dependency between the covariates and the adverse birth outcomes is more realistic in addition to linear relationships. Preterm birth and low birthweight cause several adverse maternal and infant outcomes. The aim of our study was to investigate the impact of maternal antenatal exposure to ambient oxides of nitrogen during pregnancy on joint adverse birth outcomes of preterm birth and low birthweight.

METHODS: Six hundred and fifty-six mother-newborn pairs from the Mother and Child in the Environment birth cohort from the city of Durban, South Africa, participated in this study. A copula-based geospatial bivariate probit model was used. Despite the geospatial bivariate probit model being computationally intensive, a potential advantage is that the effect of air pollution can be detected with higher power under a plausible joint model.

RESULTS: The results showed that the observed co-occurrence of preterm birth and low birthweight was found to occur in 7.5% of cases. After adjusting for potential confounding factors such as socio-economic, demographic, clinical, and behavioural factors, exposure levels to oxides of nitrogen and spatial variation were found to have a non-linear effect on joint adverse birth outcomes of interest in this study. In addition, maternal smoking was further found to increase the risk of co-occurrence of preterm birth and low birthweight.

CONCLUSIONS: The study suggested that the spatial identification of high-risk areas for the joint occurrence of preterm birth and low birthweight, gives decision-makers the advantage of early identification of air pollution in residential communities that are of concern, so that interventions can be put in place timely, to lower the risk of the adverse birth outcomes of interest to this study.

Keywords: Cohort study, Gaussian copula, NO_x exposure, Semiparametric model, Spatial effect



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Ambient particulate matter exposure and red blood cell distribution width (RDW): results from a cross-sectional linkage study in Portugal

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BACKGROUND AND AIM: Ambient particulate matter (PM) is now a well-established risk factor to develop cardiovascular diseases. Multiple studies have linked PM exposure to cardiovascular events, but the pathophysiologic mechanisms linking the occurrence of these events with PM exposure are still an area of intensive debate. red blood cell distribution width (RDW), a blood parameter used to measure the variability sizes of the red blood cells, has been associated with a vast array of human pathologies, including cardiovascular diseases. The present study aims to estimate the long-term effect of PM₁₀ exposure on RDW, in the adult Portuguese mainland population.

METHODS: Our study was based on 2211 participants of the 1st Portuguese Health Examination Survey (INSEF, 2015) with available data on RDW parameter and living within a 30km radius of an air quality monitoring station from the air quality monitoring network of the Portuguese Environment Agency with available PM₁₀ measurements. Generalized linear models were used to assess the effect of 1-year PM₁₀ exposure on RDW values.

RESULTS: We found an association between long-term exposure to PM₁₀ and RDW values (2.82% RDW increase per each 10 µg/m³ PM₁₀ increment, 95% CI: 0.62%; 5.02%), particularly among males (2.96% RDW increase per each 10 µg/m³ PM₁₀ increment, 95% CI: 0.80–5.12), which is well supported by the sensitivity analysis.

CONCLUSIONS: To the best of our knowledge, this is the first study describing an association between ambient PM₁₀ exposure and RDW values. It is uncertain whether changes in RDW due to PM₁₀ exposure constitute an adverse health outcome. However, RDW has been identified as an independent prognostic biomarker of multiple cardiovascular diseases, therefore we consider this result to be of special relevance in particular to explain the effect of PM₁₀ in triggering cardiovascular events.

Keywords: Particulate Matter, RDW, INSEF, Portugal



ABSTRACT E-BOOK

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Air pollution » Particulate matter

The positive impact of the first-wave COVID-19 lockdown on urban air quality in Greece

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BACKGROUND AND AIM: Following the first confirmed cases of COVID-19 during the first wave of the pandemic, the Government of Greece imposed a nationwide lockdown on March 23rd 2019, one of the first in Europe. Our study assesses the impact of this lockdown on the air quality of Greece's two largest cities, Athens and Thessaloniki.

METHODS: The average monthly concentrations of particulate matter (PM₁₀ and PM_{2.5}) and nitrogen oxides (NO and NO₂) measured on a 24-hour basis were obtained from the Greek Ministry of the Environment and Energy. In order to assess the impact of the lockdown on air quality, data were divided into three periods: (a) pre-lockdown (1 September 2019 – 22 March 2020), (b) during lockdown (23 March 2020 – 3 May 2020), and (c) post-lockdown (4 May 2020 – 6 November 2020), which overlapped with the beginning of the second wave COVID-19.

RESULTS: Nitrogen oxide showed the most striking decrease in Athens, ranging from 6 to 84% (during lockdown) and from 12 to 66% (post lockdown), respectively, and was most prominent at the urban traffic stations. Compared to the pre-lockdown period, Athens also experienced significant reductions in PM₁₀ (13–38%), PM_{2.5} (1–40%) and NO₂ (9–65%) concentrations. In Thessaloniki the most marked decrease was observed at the urban traffic stations for PM₁₀ and PM_{2.5}, where a 39% and 31% decrease was respectively observed when comparing the lockdown and post-lockdown periods.

CONCLUSIONS: Our results indicate that there is a relationship between air pollution and lockdown measures. The time series of the 24-hour data for PM₁₀, PM_{2.5}, NO and NO₂ concentrations showed a decrease during the six weeks of lockdown in both cities. The observed changes could be attributed to lower traffic volumes, working remotely and temporary suspension of industrial activities.

Keywords: air pollution, particulate matter, oxides of nitrogen



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Constructing clean cookstove stack in Ghana

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BACKGROUND AND AIM: Transition to cleaner cooking technologies has the ability to increase economic and environmental benefits, studies have shown that adoption of improved cooking stoves is very low and those who adopt clean cooking stove/ fuels are likely to stack with biomass fuel. The aim of this study was to identify promising “clean stacks” of stoves and fuels that are relevant to household energy needs in middle belt of Ghana.

METHODS: A mixed method approach was used in data collection. Ten households who were exclusive users of biomass fuel were randomly selected from the Kintampo Health Demography Surveillance Survey. We used questionnaires to collect information on sociodemographic characteristics, household energy needs, stove use, and acceptability of stoves. The stoves that were given to participants were Mimi motos (a forced draft pellet biomass stove), Electric induction, Ethanol stoves and LPG stoves. Fuel was provided at no cost to participants. Each stove was assigned to the households for a period of two weeks, one after the other. After the single technology assessment, two most preferred stoves were given back to participants to use simultaneously for a period of one month. During this one-month period, participants exposure to PM_{2.5} were assessed.

RESULTS: LPG and Ethanol stoves were the two most preferred stoves. The participants noted inconveniences and numerous mechanical and operational difficulties with the mimi moto and the electric stove. Induction electric stove recorded a mean reading of 0.10 volts Forty-eight-hour personal PM_{2.5} assessed during the clean stack period was slightly higher with mean concentration of 10.82 µg/m³ (0.54) compared to WHO guideline (10 µg/m³), but was substantially lower than baseline.

CONCLUSIONS: Of the four stoves tested, participants expressed satisfaction with LPG stove and Ethanol stove as it met their daily energy needs. Adoption and acceptability of the improved stoves varied with different dishes or cooking tasks.

Keywords: clean fuel stack, exposure assessment, Ghana



ABSTRACT E-BOOK

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Air pollution » Oxides of nitrogen

Air quality changed disproportionately across the world urban agglomerations, countries, and regions due to COVID-19 lockdown measures

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BACKGROUND AND AIM: The COVID-19 response policies had a major impact on air quality (AQ) worldwide. However, limited data availability, diverse political responses, and multiple-factor interactions made the analysis challenging. We aimed to quantify the effect of various COVID-19 response policies on concentration of ambient nitrogen dioxide (NO₂) in major world urban agglomerations (UAs), countries, and regions.

METHODS: Daily mean NO₂ concentrations from January 01, 2019 to July 31, 2020 were collected from 1) 1,267 publicly available ground monitoring sites at 496 UAs across 29 countries, and 2) Sentinel-5P satellite at 1,851 UAs across 143 countries. Eight daily national COVID-19 response actions were retrieved from Oxford's COVID-19 Government Response Tracker for countries of the world. COVID-19 response action implementations were clustered into three groups: stringent, moderate, and mild policy. Using UA-specific linear regression models, we assessed the association between different policy implementations and NO₂ concentrations, adjusting for meteorological variables and time trends. Finally, meta-regression models were applied to aggregate global, regional, and country-specific results. In addition, we examined the effect modification of the association by UA population size.

RESULTS: Ground-monitored data suggested that NO₂ concentrations decreased by 32% in countries with a stringent policy and by 26% in countries with a moderate policy. No substantial changes occurred in countries with a mild policy. Satellite observations of NO₂ were highly correlated with ground-monitored data, and demonstrated that the greatest AQ improvements occurred in the Eastern Mediterranean and Western Pacific regions, but not in Europe or North America. The greatest AQ improvements were observed in more populated areas, especially in UAs with ≥5 million population.

CONCLUSIONS: Our study suggests that COVID-19 response policies taken in 2020 led to global reductions in NO₂ concentrations. These AQ improvements were most pronounced in countries with more stringent COVID-19 containment policies and in more populated areas.

Keywords: COVID-19, Air pollution, Policy, Exposures, Oxides of Nitrogen



ABSTRACT E-BOOK

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Air pollution » Oxides of nitrogen

Exposure to long-term nitrogen dioxide air pollution and breast cancer risk: A nested case-control within the French E3N cohort study

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BACKGROUND AND AIM: Nitrogen dioxide (NO₂) is one of an important air pollutant due to its adverse effects on human health, however whether it is consistently associated with the risk of breast cancer (BC) is limited. In this study, we investigated the association between long term exposure to NO₂ and risk of BC.

METHODS: A total of 5,222 BC cases identified over the follow up period and 5,222 matched controls of a nested case-control study within a French E3N cohort study were examined. Mean exposure estimates to NO₂ were estimated by CHIMERE and land use regression (LUR) models and assigned to the geocoded residential postal codes of participants for each year from recruitment 1990 through 2011. Multivariable conditional logistic regression models were used to compute odds ratios (ORs) and 95% confidence intervals (CIs).

RESULTS: Overall, in all women, for each 1 interquartile range (IQR) increase in NO₂ levels (CHIMERE: 11.1 ug/m³, LUR: 17.8 ug/m³), the ORs of the model adjusted for confounders were 1.16(95% CI: 1.06-1.26) and 1.09(95% CI: 1.01-1.18) according to CHIMERE and LUR measures, respectively. The corresponding ORs in the fully model additionally adjusted for established BC risk factors = 1.13(95% CI: 1.03-1.24) for CHIMERE and 1.07(95% CI: 0.99-1.16) for LUR measures. Comparable results were found for postmenopausal women. Substantial heterogeneity in the ORs was observed by hormone receptor status, using NO₂ measured by CHIMERE the ORs of the model 3 was 1.17 (95% CI: 1.04-1.31) for ER. With LUR NO₂, the OR of ER+BC in the fully model = 1.08 (95% CI: 0.98-1.19).

CONCLUSIONS: We provide an evidence of an increase BC risk in association with long term exposure to NO₂ air pollution according to CHIMERE and LUR measures, with risks being higher for CHIMERE



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model. Subgroup analyses suggested stronger effects especially in postmenopausal women and for hormone dependent BC.

Keywords: Nitrogen dioxide, breast cancer, residential history, menopausal status, hormone receptor status, epidemiology

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Air pollution » Particulate matter

Assessment of Ambient concentrations of Particulates (PM_{2.5} and PM₁₀) and Occurrence of Non-Communicable Diseases in Ogbomoso Metropolis Southwestern Nigeria

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BACKGROUND AND AIM: Air pollution has become a serious threat especially in fast developing urban areas. Significant adverse health effects such as lung cancer, aggravation of respiratory and cardiovascular diseases are linked to particulate matter. This study assessed the association between particulates and occurrence of non-communicable diseases in Ogbomoso Metropolis, Oyo state, Nigeria.

METHODS: Twenty selected cells from the gridded map of Ogbomoso metropolis were investigated. The concentrations of PM_{2.5} and PM₁₀ were monitored in each cell using Aeroqual gas meter. Meteorological parameters such as ambient temperature, relative humidity, air pressure and wind speed were monitored using wind mate (WM-350). Information on recorded cases of non-communicable diseases was retrieved from the state hospital in the study area.

RESULTS: The values of PM_{2.5} and PM₁₀ ranged from 27.79±45.62 to 151.50±188.93 mg/m³ and 109.83±31.98 to 576.67±943.44 µg/m³ respectively during the dry season and from 14.38±3.87 to 72.79±42.46 mg/m³ and 33.67±20.11 µg/m³ to 73.54±34.89 µg/m³ respectively during the wet season. Concentrations of PM_{2.5} and PM₁₀ were relatively high and above the WHO permissible limit in the dry season. The values of PM_{2.5} in cell 1, 2, 5, 8, 16, 18 and 19; and PM₁₀ in cell 1, 5, 6, 8, 19 and 20 were within the WHO permissible limit in wet season while others exceeded it. Wet season, PM_{2.5} concentration shows positive significant (p<0.05) associations with chronic respiratory diseases, diabetes and high blood pressure (r= 0.559, 0.516, 0.487) while during dry season, there was a positive significant (p<0.05) association between PM_{2.5} and chronic respiratory diseases. PM₁₀ showed a positive significant association with hypotension in dry season (r= 0.639; p<0.05).

CONCLUSIONS: This study concluded that exposure to PM_{2.5} contributes significantly to the occurrence of chronic respiratory disease, diabetes and high blood pressure in both dry and wet seasons while PM₁₀ contributes significantly to only hypotension in the dry season.

Keywords: Air pollution, Particulate matter Cardiovascular diseases, Cancer and cancer pre cursors, Temperature



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P-226

Air pollution » Oxides of nitrogen

Nitrogen dioxide (NO₂) long-term exposure and breast cancer incidence: a meta-analysis followed by a health impact assessment

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BACKGROUND AND AIM: The epidemiological literature about the relationship of nitrogen dioxide (NO₂) long-term exposure to breast cancer incidence has recently strongly evolved. We aimed to perform i) a meta-analysis of the studies considering this association, and, ii) using the dose-response function established, an assessment of the corresponding number of attributable cases in France and of the related economic costs.

METHODS: We conducted a literature review and a random-effects meta-analysis corrected for publication bias of the epidemiological studies examining the association of NO₂ long-term exposure with breast cancer incidence. Additional meta-analyses were stratified on menopausal status and on the hormone-receptor status of the tumor. The resulting dose-response function was combined with modeled NO₂ atmospheric levels in 2013 for France to estimate the number of attributable breast cancers in France, and then the related economic costs.

RESULTS: The literature review allowed identifying 11 relevant studies, providing 36 effect estimates, 21 and 8 of which according to menopausal and hormone-receptor status, respectively, and including 121,189 breast cancer cases among nearly 4 million women. The meta-analytical relative risk estimate of breast cancer incidence corrected for publication bias was 1.023 (95% CI, 1.005, 1.041). NO₂ estimated effects appeared higher in premenopausal (1.059, 95% CI, 0.985, 1.138) than postmenopausal women (1.019, 95% CI, 0.993, 1.046), and higher for hormone-receptor positive (ER+/PR+, 1.045, 95% CI, 0.980, 1.114) than negative tumor subtype (ER-/PR-, 0.987, 95% CI, 0.885, 1.101). Assuming a causal effect of NO₂, we estimated that 1,677 (95% CI, 374, 2,914) new breast cancer cases were attributable to NO₂ annually in France, or 3.15% (95% CI, 0.70, 5.48) of the incident cases. The corresponding tangible and intangible costs were estimated to be 825 million Euros (570, 1,080) per year.

CONCLUSIONS: These findings suggest that decreasing NO₂ long-term exposure, or correlated air pollutants exposures, could decrease breast cancer risk.

Keywords: Breast cancer, economic costs, health impact assessment, meta-analysis, nitrogen dioxide (NO₂)



ABSTRACT E-BOOK

P-227

Air pollution » Particulate matter

The potential benefits to cardiovascular health from reduction of air pollution. Krakow example
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BACKGROUND AND AIM: Based on Global Burden of Diseases estimates, in 2019 the air pollution accounted for nearly 6.75 million deaths and 213 million years of healthy life lost. Numerous studies indicate that ambient particulate matter (PM) is strongly associated with increased cardiovascular disease incidence and mortality.

The aim of this study was to assess the potential benefits from reduction of PM_{2.5} and PM₁₀ to the mortality and hospital admissions due to cardiovascular events in Krakow, one of the most polluted cities in Europe.

METHODS: The Environmental Benefits Mapping and Analysis Program was used to estimate changes in cardiovascular health due to changes in the ambient concentration of particulate matter (both PM_{2.5} and PM₁₀) in Krakow, based on data for 2016. The baseline level of pollutants was based on data from air pollution monitoring system operated by Provincial Environmental Protection Inspectorate. The demographic structure as well as the number of deaths were gathered from Statistics Poland, and number of emergency hospital admissions due to cardiovascular causes (ICD-10 codes: I00–I99) was obtained from National Health Fund.

RESULTS: Average daily air pollution levels in Krakow ranged from 2 to 235 µg/m³ for PM_{2.5} and from 8 to 299 µg/m³ for PM₁₀, and it exceeded the daily limit values recommended by European Union Air Quality Directive on about 30% of days for PM_{2.5} and 20% for PM₁₀. The reduction of PM_{2.5} to the limit value results decrease of more than 3% in cardiovascular hospitalizations and 5% in cardiovascular mortality. The reduction of PM₁₀ level to 40 µg/m³ is associated with over 4% and more than 7% decrease in cardiovascular hospitalizations and mortality, respectively.

CONCLUSIONS: Decrease of ambient particulate matter to the limit recommended by Air Quality Directive can provide considerable reduction of cardiovascular events that were attributable to air pollution.

Keywords: Air pollution, particulate matter, cardiovascular disease



ABSTRACT E-BOOK

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Air pollution » General

Short-term Exposure to Air pollution and the Attributable Risk of Emergency Room Visits for Kidney Diseases

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BACKGROUND AND AIM: Several existing studies have shown that long-term exposure to air pollution is associated with reduced kidney function. However, less is known about the effects of short-term exposure to air pollution on kidney disease aggravation and resultant emergency department burden. This study aimed to estimate the excess emergency room (ER) visits attributable to the short-term air pollution and to suggest evidence on better air pollution standards to protect kidney patients. **METHODS:** We conducted a time-series study using the National Health Insurance data covering all persons in South Korea (2003-2013). We collected daily data for air pollutants (particulate matter <10µm [PM10], ozone [O3], carbon monoxide [CO], and sulfur dioxide [SO2]) and ER visits for total kidney disease, acute kidney injury (AKI), and chronic kidney disease (CKD), respectively. We performed a distributed lag model analyses to estimate excess ER visits attributable to air pollution. **RESULTS:** For all kidney disease, excess ER visits attributable to air pollution were statistically significant for all air pollutants. While, for AKI, O3 showed the highest impacts on excess ER visits compared to other pollutants. On the other hand, the impacts of CO and SO2 were the highest for CKD compared to O3 and PM10. We also found that the positive association between air pollution and kidney ER visits existed for days with air pollution concentrations below the current WHO air quality guidelines.

CONCLUSIONS: This study provides estimates of excess ER burdens attributable to air pollution and suggests that stricter air quality standards would benefit kidney disease patients.

Keywords: Kidney disease, Emergency Room Burden, Short term exposure, Air pollution, WHO air quality guideline



ABSTRACT E-BOOK

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Air pollution » Other (to be specified with keywords in the keywords section)

Health and Environmental Impacts of Replacing Kerosene-Based Lighting with Renewable Electricity in Eastern Africa

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BACKGROUND AND AIM: Lighting sources have been overlooked in previous estimates of the health burden attributable to household air pollution (HAP). However, lighting sources can be an important predictor of personal exposure to HAP in countries with limited access to electricity. We modeled the health and environmental impacts of hypothetical intervention scenarios that replace kerosene-based lighting with renewable electricity in Eastern Africa.

METHODS: We used comparative risk assessment methods to quantify the ischemic heart disease-, stroke-, lung cancer-, chronic obstructive pulmonary disease- and lower respiratory infection-related mortality attributable to personal fine particulate matter (PM_{2.5}) exposure due to kerosene-based lighting for residents of Eastern Africa in 2015. We used health and demographic data from the Global Burden of Disease; PM_{2.5} exposure estimates from a previous study replacing kerosene-based lighting with solar lighting; and exposure-response functions from the literature to estimate the number of deaths that could be avoided with increased scaling-up of the lighting source intervention. We estimated avoided black carbon emissions using emission factors from published literature.

RESULTS: We estimated that 6,218, 10,092, 12,723 deaths could be avoided if 33%, 66%, and 100% respectively of households using kerosene-based lighting replaced it with electricity in Eastern Africa in 2015. Including lighting fuel in estimates of deaths due to PM_{2.5} from household air pollution in the region would add a further 9% in addition to those from cooking with solid fuel. Full replacement of kerosene-based lighting with renewable electricity would have reduced black carbon emissions by 4.4 Gg/year or 3,957 CO₂eq Gg in 2015, with the largest emission reductions in Uganda and Kenya.

CONCLUSIONS: Kerosene-based lighting is a non-negligible source of HAP in the region and should be included in assessments of the mortality burden attributable to HAP.

Keywords: Household Air Pollution, Mortality, Particulate Matter.



ABSTRACT E-BOOK

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Air pollution » General

Ambient air pollution exposures and functional decline in a sample of non-demented community-dwelling older adults in Northern Manhattan

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BACKGROUND AND AIM: A growing body of evidence has linked air pollution exposures to indicators of unhealthy aging. The effects of air pollution on functional performance in older adults remain poorly understood. We investigated cross-sectional and longitudinal associations between air pollution exposures and functional performance.

METHODS: From an available pool of 2182 participants enrolled in the Washington Heights-Inwood Aging Project from 1999-2002, 1884 individuals of Hispanic, Non-Hispanic White, or Non-Hispanic Black race-ethnicity who had valid addresses, no diagnosis of probable dementia at study intake, and were not missing data in the outcome measure of interest were selected. Inverse probability of censoring weighted linear mixed-effects models were used to investigate the associations between residential ambient air pollutant concentrations (fine particulate matter [PM_{2.5}] and nitrogen dioxide [NO₂]) at baseline and functional performance as measured by an extended Instrumental Activities of Daily living scale (IADL-x), adjusting for potential confounders.

RESULTS: Participants were followed for a maximum of six study visits, with a median follow-up time of 4.28 years. Higher concentrations of pollutant exposures were associated with lower IADL-x scores at baseline and steeper rates of decline in IADL-x scores over time. In adjusted models, a one IQR increase in PM_{2.5} was associated with a 0.275 standard deviation SD (95 % CI: -0.356, -0.194) lower IADL-x score at baseline and an additional 0.031 SD (95% CI: -0.048, -0.013) decline per year of follow-up. A one IQR increase in NO₂ was associated with a 0.133 SD (95 % CI: -0.180, -0.086) lower IADL-x score at baseline and an additional 0.035 SD (95% CI: -0.046, -0.024) decline per year of follow-up.

CONCLUSIONS: These results contribute to the body of evidence on the deleterious effects of air pollution on healthy aging and point to opportunities for future research on potential pathways linking air pollution exposures to functional decline.

Keywords: air pollution, functional performance, aging.



ABSTRACT E-BOOK

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Air pollution » Particle components

Super-learning and ensemble weighted averaging models to predict hyperlocal long-term exposure to fine particulate matter components in the United States

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BACKGROUND AND AIM: Fine particulate matter (PM_{2.5}) mass is classified as carcinogenic for humans and linked to mortality and morbidity; however, less is known about health risks of PM_{2.5} components. We aimed to predict PM_{2.5} components across the contiguous United States.

METHODS: Daily mean PM_{2.5} component data (EC, OC, NO₃, NH₄, SO₄, Br, Ca, Cu, Fe, Ni, K, Pb, Si, V, and Zn) were obtained from the EPA and several other sources. Annual means were calculated at 987 monitoring sites from 2000 to 2019. About 160 predictor variables were used for modeling, such as traffic counts, distance to OpenStreetMap features, and satellite observations available through Google Earth Engine. After partitioning data into 70% training and 30% testing sets, two separate modeling approaches were developed for non-urban vs urban areas using Microsoft Azure. In non-urban areas, six machine-learning (ML) algorithms were fit on the training set to predict at 1 km spatial resolution and were integrated using six super-learners (SL) and GAM-based ensemble weighted-averaging (ENWA). In 3,535 urban areas, models were trained on a 50 m spatial grid and predictions from three ML algorithms were integrated using four SLs and an ENWA. The trained models were assessed using 10-fold cross validation and externally validated on the test set.

RESULTS: Support vector machines with polynomial kernel SL outperformed other models across most of PM_{2.5} components. The minimum and maximum R² for non-urban areas in unseen test sets were, respectively, 0.826 (Br) and 0.975 (SO₄). In urban areas, these were 0.821 (Br) and 0.973 (SO₄). The median R² value on test sets across all models and components was 0.91.

CONCLUSIONS: Our high resolution and hyperlocal predictions across 20 years will enable new epidemiological studies of the health risks of PM_{2.5} components that were not previously possible in the contiguous United States.



ABSTRACT E-BOOK

Keywords: PM2.5 components, machine-learning, super-learning, ensemble, United States

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Air pollution » Short-term exposure

Sixteen years analysis of PM2.5 and mortality in Kuwait

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BACKGROUND AND AIM: Middle Eastern desert countries like Kuwait are notoriously known for dramatic dust storms and enormous petrochemical industries affecting ambient air pollution. However, local health authorities have not been able to assess health impacts of air pollution due to limited monitoring networks and lack of historical exposure data. We aimed to estimate the relationship between estimated historical fine particulate matter (PM2.5) and mortality in Kuwait stratified by cause, gender and age.

METHODS: We developed a novel approach using machine learning and remote sensing to estimate spatially and temporally resolved daily urban PM2.5 exposures from 2001 to 2016 in the country. We then used over-dispersed generalized additive models to investigate the association with cause-specific, gender- and age-stratified mortality timeseries.

RESULTS: There was a total of 70,321 deaths during the study period of 16 years. The average urban PM2.5 was estimated to be 46.2±19.8 µg/m³. A 10 µg/m³ increase in a 5-day moving average of urban PM2.5 was associated with 1.31% (95% CI: 0.56 to 2.07%) increase in all-cause mortality and a 1.15% (0.13 to 2.18%) increase in daily cardiovascular deaths. The corresponding associations among males and females were 1.23% (0.29 to 2.17%) and 1.44% (0.33 to 2.56%), respectively. For the elderly (above 65 years) there was a 1.23% (0.15 to 2.31%) increase in all-cause mortality. The associations were unchanged after adjusting for dust storm days.

CONCLUSIONS: We leveraged available pollution, weather and remote sensing data to predict historical PM2.5 with high temporal and spatial resolution. Urban PM2.5 concentrations were above the international regulatory limits. Our findings suggest that, PM2.5 is associated with increased mortality across different strata of the Kuwaiti population. The approach we used can be implemented in other countries that lack historical pollution data or those with insufficient monitoring networks.

Keywords: Desert, Dust storm, Kuwait, Middle East, Air Pollution, Machine Learning



ABSTRACT E-BOOK

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Air pollution » Ozone

Chronic obstructive pulmonary disease (COPD) attributable to ozone in Germany: Burden of disease estimates for the years 2007-2016

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BACKGROUND AND AIM: Long-term exposure to ground-level ozone has been associated with the development and exacerbation of chronic obstructive pulmonary disease (COPD) and COPD mortality. We aimed to estimate the COPD burden due to long-term exposure to ozone in Germany from 2007 to 2016. A particular emphasis was on the disease burden based on effect estimates adjusting for fine particulate matter (PM_{2.5}) and nitrogen dioxide (NO₂).

METHODS: We estimated population-weighted average maximum 8-hour ozone concentrations during the summer months (April to September) at a 2 km × 2 km resolution based on a combination of chemical transport models and ground-level measurements. Estimates for the exposure-response function were extracted from recent cohort studies and pooled using random-effects meta-analysis. We calculated the burden of COPD due to ozone using a counterfactual value of 65 µg/m³. We used German data on population, life expectancy, and mortality to reflect the national situation as adequately as possible.

RESULTS: The attributable proportion of the COPD disease burden and the years of life lost (YLL) estimates per 100,000 inhabitants due to summer ozone varied from 6.11% (95% confidence interval [95% CI]: 4.68%-7.36%) (year 2013) to 8.29% (95% CI: 6.36%-9.96%) (year 2015) and 18.33 YLL per 100,000 inhabitants (95% CI: 14.02-22.08) (year 2007) to 35.77 YLL per 100,000 inhabitants (95% CI: 27.45-42.98) (year 2015). Overall, no clear temporal trend in the burden could be observed for the period 2007 to 2016. Results indicated that ozone affects the COPD burden independent of PM_{2.5} and NO₂.



ABSTRACT E-BOOK

CONCLUSIONS: Long-term exposure to summer ozone contributed to the burden of COPD in the German population. Effective emission reduction strategies are needed as ongoing climate change is expected to increase ozone concentrations.

The project was funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (research code 3718 62 208 0).

Keywords: ozone, air pollution, chronic obstructive pulmonary disease (COPD), mortality, environmental burden of disease



ABSTRACT E-BOOK

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Air pollution » Other (to be specified with keywords in the keywords section)

Household air pollution and associated risk factors before and during COVID-19 Hard Lockdown in South Africa

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BACKGROUND AND AIM: Household air pollution (HAP) is associated with adverse human health impacts. During COVID-19 Hard Lockdown Level 5, South Africans remained at home, potentially increasing their exposure risk to HAP. This study was conducted to investigate changes in fuel use behaviours / patterns affecting HAP exposure and associated HAP-related health outcomes during the COVID-19 Hard Lockdown that started 23 March, 2020.

METHODS: This was a cross-sectional online and telephonic survey of participants from an existing database. HAP exposure indicators were considered before and during Hard Lockdown. Participants were also asked about HAP and COVID-19 symptoms/tests before and during this lockdown. Logistic regression and McNemar's test were used to analyse household-level data.

RESULTS: Among 2,505 participants, while electricity was the main energy source for cooking and heating before and during Hard Lockdown, some households used less electricity during Hard Lockdown. A majority of households reported cooking more, cleaning more, and spending more time indoors during the lockdown. Age (older), gender (male), and number of people (an increase) living in the dwelling affected the presence of HAP-related health outcomes. For fuel type used for heating, paraffin had the highest significant odds ratio (1.89 p = 0.015, CI 1.13 - 3.16) compared to electricity (applied as reference category) as the heating fuel type used in a household that reported COVID-19-related health symptoms and / or confirmed COVID-19 cases (combined analysis).

CONCLUSIONS: This study showed that increased number of people living in a dwelling and using paraffin for heating increased the odds of those households having HAP-related health outcomes. Several of these are similar to COVID-19 symptoms. Should South Africa return to Hard Lockdown Level 5, awareness raising about the risks associated with HAP as well as messaging information for prevention of exposure to HAP and adverse health impacts will be necessary to inform the public.



ABSTRACT E-BOOK

Keywords: dirty fuels, environmental health, fuel patterns, household air quality, respiratory health

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Air pollution » Other (to be specified with keywords in the keywords section)

Promoting a better understanding of green infrastructure in urban planning to reduce air pollution exposure

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BACKGROUND AND AIM: Green infrastructure (GI) is seen as a win-win solution to air pollution, reducing pollutant concentrations and thus, improving human health. However, the effects of GI on air quality are still unclear, and questions have been raised about the effectiveness of GI in mitigating air pollution.

Before making generalisations about the benefit of GI to air quality, it is crucial to consider the GI-characteristics that influence air quality. So, to enhance the mitigation of air pollution, a holistic understanding of the effects of GI in cities is essential. This research reviews the academic literature addressing GI-related characteristics in cities, creating a holistic framework.

METHODS: The mechanisms by which GI is considered to influence air quality were identified. A specific literature review was then conducted for each mechanism to extract the associated GI-characteristics. A holistic framework was created to help guide decision-makers in using GI solutions for improved air quality.

RESULTS: Four mechanisms were identified by which GI influences air quality: deposition, dispersion, absorption, and biogenic emissions. Deposition is influenced by leaf form and micromorphological traits. The structure of the street, the meteorological conditions and the shape of the GI influence dispersion. Stomata conductance and chemical properties of the pollutant influence absorption. Plant emissions such as biogenic volatile organic compounds and pollen should be considered and minimised by appropriate species selection. Thus, maximising the positive effect of GI in cities on air quality will be the product of understanding a range of chemical and physical mechanisms in a highly site-specific context.

CONCLUSIONS: Complex interactions between GI and site characteristics should be considered to maximise the benefits of GI in improving air quality. This research contributes to the air pollution mitigation field, explicitly helping to inform decision making for more health-promoting urban settings by optimising the expected benefits of GI through a holistic understanding of their impacts.

Keywords: Air pollution, built environment, and green spaces



ABSTRACT E-BOOK

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Air pollution » Short-term exposure

Short-term Effects of Indoor Air Quality on Schoolchildren's Attention Level: A Pilot Study of Four Primary Schools in Barcelona

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BACKGROUND AND AIM: Despite knowing that children are highly sensitive towards increased pollution values, available evidence on the impact of short-term air quality exposure on children's attention level is limited, and it overlooks indoor exposure at schools, where children spend a considerable amount of time. We aimed to investigate the relationship between short-term indoor air quality exposure at school and attention levels in schoolchildren.

METHODS: A cross-sectional study of 5th grade school children (n=139, aged 9 to 11y) from four schools in Barcelona (Catalonia, Spain) was conducted in 2019, assessing attention levels via the computerized Attention Network Flanker task. Short-term indoor environmental quality was assessed, measuring T^a, relative humidity, black carbon, CO₂, and PM_{2.5}, during the test progress. Explorative linear regression models, analysing the relationship between school short-term indoor air quality exposures and attention levels were performed, adjusted by sex and selected neighbourhood contextual factors.

RESULTS: Statistically significant differences were found among the four schools regarding all indoor environmental quality exposures (p-value<0.001), and two attention level outcomes: impulsivity (p-value 0.048) and selective attention (p-value 0.031). Overall, no significant associations were observed between single short-term indoor quality exposures and attention level outcomes. A trend towards decreased impulsivity [-0.61 (-1.1;-0.12) 95%CI; p-value 0.014] and increased conflict score [2.45 (-7.57;12.47) 95%CI; p-value 0.63] was found with increasing T^a. A reverse trend was observed towards impulsivity [0.1 (-0.08;0.27) 95%CI; p-value 0.282] and conflict score [-1.43 (-5.04;2.18) 95%CI; p-value 0.433] with increasing relative humidity.

CONCLUSIONS: Short-term indoor air quality exposures do not necessarily affect attention levels in primary school children while developing a short task. Increased indoor temperature balanced with low relative humidity could improve attention levels. Next steps will take a longitudinal approach. Including different time point measures will allow to account for temporal changes and to compare the relationship between short-term indoor quality exposures and attention levels across schools.

Keywords: Air pollution, Short-term exposure, Children's environmental health, Built environment, Neurodevelopmental outcomes



ABSTRACT E-BOOK

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Air pollution » Particle components

Exposure to airborne cadmium and lead and cognitive function in an adult population in rural France

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BACKGROUND AND AIM: Air pollution affects cognitive function, but the specific components involved remain poorly understood. In the general population-based cohort CONSTANCES, we aimed to estimate the associations between residential exposures to airborne cadmium (Cd) and lead (Pb) and cognitive function in adults.

METHODS: 39,638 participants aged over 45 years, and enrolled between 2012-2019, responded to the Mini-Mental State Examination (MMSE), a 30-question test evaluating cognitive function. Participants' exposure to airborne Cd and Pb was assessed from metal concentrations obtained by moss biomonitoring in 2011 in rural and semi-urban France and interpolated by ordinary kriging. To estimate the separate associations of each metal with MMSE score while considering potential nonlinearity, we categorized metal exposures in quartiles, and used linear regressions adjusted for age, sex, education, socioeconomic status, smoking, alcohol use, and occupational exposure to metal dust.

RESULTS: The median MMSE score was 28 (IQR: 2); median exposures were 0.17 µg.g⁻¹ dry weight of moss (IQR: 0.09) and 3.2 µg.g⁻¹ (IQR: 2.2) for Cd and Pb, respectively. Using the first quartile as reference, Cd exposure was associated with poorer MMSE scores following a U-shape curve, with betas (95% CI) of -0.28 (-0.33, -0.23), -0.20 (-0.25, -0.15), and -0.05 (-0.10, -0.01) for the second, third, and fourth quartiles, respectively. Pb was associated with poorer MMSE scores only for the third quartile (-0.10 (-0.16, -0.05)), with an unclear nonlinear pattern.

CONCLUSIONS: These first results suggest a cross-sectional association between cognitive function and exposure to airborne Cd, but not as much with airborne Pb. Further analyses will bring more insight, especially using a more recent exposure assessment, and including other metals and urban areas.

Keywords: Heavy metals, Neurodegenerative outcomes, Environmental epidemiology



ABSTRACT E-BOOK

P-238

Air pollution » Particle components

Relationship between particle and metal concentrations in subway workers' personal breath zone (PBZ), exhaled breath condensate (EBC), and urine

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BACKGROUND AND AIM: Subway exposure health effects are still unknown. We analyzed particle and metal exposure in the PBZ, EBC and urine of subway workers

METHODS: PBZ of nine station agents, locomotive operators and security guards was sampled during 6-h shifts over two weeks. Urine and EBC samples were collected pre- and post-shift. Mass concentrations of PM₁₀, PM_{2.5} and their metal constituents were determined in PBZ, urine and EBC, along with ultrafine particle (UFP) number in PBZ and EBC. Urine and EBC metal concentrations were standardized by creatinine and EBC volume, respectively, and log-transformed.

RESULTS: PBZ PM mass concentrations were above the WHO guideline for indoor air but varied significantly between jobs. Locomotive operators had the highest exposure (189 and 137 µg/m³ for PM₁₀ and PM_{2.5}, respectively), while station agents had the highest UFP exposure (1.97x10⁴ #/cm³). Only Al, Fe and Zn in both PM_{2.5} and PM₁₀ and Cu and Mn in PM_{2.5} were above the limit of quantification. By mass fraction, Fe, Cu, Al and Zn were the most abundant. Security guards had the highest Al exposure in both PM_{2.5} and PM₁₀, while locomotive operators had the highest PM₁₀ Fe exposure. In EBC, the pre/post-shift metal concentrations ordered Zn>Cu>Ni>Ba>Mn. Security guards had the highest EBC metal concentrations, particularly Zn and Cu. Urinary concentrations ordered Si>Zn>Mo>Ti>Cu>Ba≈Ni>Co. Station agents and locomotive operators had the highest Si and Zn concentrations, respectively. Post-shift EBC Zn and Cu were associated with Zn and Cu concentrations in PM₁₀ and with post-shift urinary Zn and Cu concentrations. Particle number in EBC was significantly correlated with UFP number in PBZ.

CONCLUSIONS: This is the first study exploring a triple assessment of particle and metal exposure in a subway. The use of EBC in addition to urine seems more informative for individual airborne exposure biomonitoring in subways.

Keywords: particulate matter, ultrafine particles, mass concentration, exposure biomarker



ABSTRACT E-BOOK

P-239

Air pollution » Other (to be specified with keywords in the keywords section)

The Government-led initiative for increased LPG adoption in Rwanda: modelling demand scenarios and corresponding health impacts

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BACKGROUND AND AIM: In 2020, cooking with polluting solid fuels was estimated to be responsible for 3,255 premature deaths and 172,643 DALYs in Rwanda. The Rwandan government has set an ambitious target of halving the proportion of the population using solid fuels in traditional stoves to 40% by 2024, mostly through scaling up adoption of liquefied petroleum gas (LPG) for clean cooking. We report here modelling conducted for the Rwandan government to estimate the health impacts of this transition with different scenarios of LPG household adoption in years 2024 and 2030 (Sustainable Development Goals).

METHODS: Three demand scenarios are modelled: the “Business as Usual” (BAU) scenario, and two interventional scenarios (Low and High Intervention Scenarios). BAU projects current demographic, market and industry trends unabated to 2024 and 2030. LIS adds the effects of policies and measures to improve access to LPG. HIS includes more aggressive assumptions regarding LPG availability and promotion, including increased consumer awareness through campaigns about the advantages of LPG cooking as compared with wood fuels. Health impacts of each scenario are estimated.

RESULTS: In 2020, 5.6% of Rwandan households were estimated to be using LPG. This proportion is projected to increase to 10.4% in 2024 and 24.0% in 2030 under BAU; to 11.7% in 2024 and 31.2% in 2030 under LIS; and to 13.2% in 2024, and 38.5% in 2030 under HIS. Depending on the level of LPG adoption, the cumulative number of averted deaths was estimated to range between 2,590 and 7,656 between 2021 to 2030, and the cumulative number of averted DALYs was estimated to range from 135,716 to 403,664.

CONCLUSIONS: To achieve the Rwandan government’s aspirational target of LPG adoption will require aggressive policies and interventions, but will in turn have significant health gains both in terms of reduced mortality and morbidity through reductions in exposure to household air pollution.

Keywords: household air pollution, LPG adoption, health impacts, Rwanda



ABSTRACT E-BOOK

P-240

Air pollution » Other (to be specified with keywords in the keywords section)

Decrease in airborne PAH concentrations in Krakow after intensified actions aiming to ban use of solid fuels for domestic heating

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BACKGROUND AND AIM: Epidemiological studies have confirmed the harmful effects of high concentrations of airborne polycyclic aromatic hydrocarbons (PAHs) on health. Krakow has been struggling with high levels of these pollutants for many years, but is also a first city in Poland which announced ban of using solid fuels. The act was published in January 2016 with 3-year transition period during with intensified public campaign, subsidies for replacing the individual heating sources, ban on the use of wet wood and coal of poor quality (2017) and shield programs for the poorest after replacing old coal stove were introduced.

The aim of this study was to describe the changes of airborne PAH levels in the heating season (November to March) over two winter seasons (2015/16 and 2018/19).

METHODS: The airborne PAH were monitored outside 60 flats at the same places in two winter seasons as part of the cohort study "Environment and child development". Meteorological parameters such as temperature, humidity and wind speed were additionally considered. Generalized estimation equations were used to verify expected decrease in PAH concentrations between studied seasons adjusting for meteorological conditions

RESULTS: In the analyzed period a decrease in sum of 8 carcinogenic PAHs, as well as most of the individual PAHs and pyrene was observed, also after taking into account meteorological conditions. About 40% decrease was observed in sum of carcinogenic PAHs, benzo(a)pyrene, benzo(g,h,i)pyrene, indeno(1,2,3-cd)pyrene and pyrene when comparing raw concentrations. After adjusting to meteorological conditions observed above effect doubled to a decrease of 80% between 2015/16 and 2018/19, as estimated by marginal means.

CONCLUSIONS: The decrease in PAHs concentrations during heating seasons comparing 2015/16 with 2018/19 likely reflect the actions by local authorities aimed at improving air quality in Krakow.

Keywords: airborne PAHs, b(a)p, b(ghi)p, Krakow, Poland



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-241

Climate » Temperature

Association between ambient temperature and sex offense: A case-crossover study in seven large US cities, 2007–2017

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BACKGROUND AND AIM: Sexual violence is an important global public health concern. Whether it could be affected by temperature rise is attracting increasing attention in the context of climate change. We aimed to evaluate the association between daily mean ambient temperature and sex offenses, and to quantify the fractions of sex offenses that were attributable to temperature.

METHODS: We collected daily crime and weather data from seven large US cities (Chicago, Kansas City, Los Angeles, Louisville, San Francisco, Tucson, and Virginia Beach). We used a time-stratified case-crossover design with conditional logistic regression model and distribute lag models to fit the relationship between daily ambient temperature and sex offenses, adjusting for precipitation, relative humidity and public holiday. The overall odds ratio was used to calculate attributable fractions.

RESULTS: A total of 90,182 sex offense cases was recorded during 2007-2017 in the seven cities. We found a linear temperature-sex offense association. Every 5°C rise in daily mean temperature was associated with a 4.5% [95% confidence interval (CI): 2.8–6.3%] increase in sex offenses during lag 0-8 days. The associations were only significant for certain sex offenses (sodomy, fondling and rape), and cases happened in certain locations (open space, education, street but not residence). The associations were stronger in hot season and days with high relative humidity, light or moderate precipitation. We estimated that 2.6% (95%CI: 1.7-3.6%) sex offenses were attributable to temperatures above city-specific median temperatures, corresponding to 2,551 cases and a mean annual rate of 2.9/100,000 (95%CI: 1.9-4.0/100,000) during the study period.

CONCLUSIONS: Daily ambient temperature was related to a significant proportion of sex offenses in seven US cities, but only for certain types and in certain locations. The association could be modified by season, relative humidity and precipitation. This study highlights the potential rising sexual violence due to temperature rise along with climate change.

Keywords: Temperature, Violent crime, Socio-economic factors (non-chemical stressors)



ABSTRACT E-BOOK

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Birth and Pregnancy Outcomes » Pregnancy outcomes

Maternal urinary organophosphate ester concentrations and blood pressure during pregnancy: The HOME Study

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BACKGROUND AND AIM: Organophosphate esters (OPEs) flame retardants found in various consumer products, may be a risk factor of adverse reproductive health outcomes. No study has examined whether gestational exposure to OPEs alters maternal blood pressure (BP) during pregnancy.

METHODS: We analyzed data from 346 women who had liveborn singletons without congenital abnormalities in the Health Outcomes and Measures of the Environment (HOME) Study, a prospective birth cohort (Cincinnati, OH, USA). The exposure variables were maternal urinary OPE metabolite concentrations at 16 weeks of gestation, standardized by specific gravity. We extracted the first two recorded maternal BP measures (<20 weeks) to assess for chronic hypertension. We also extracted the two highest BP measures (≥20 weeks), and any diagnosis of hypertensive disorders of pregnancy (HDP: gestational hypertension, preeclampsia, and eclampsia) from medical charts. We defined HDP for this analysis as two BP>140/90 or HDP noted in the chart at or after 20 weeks gestation. We used linear mixed models and modified Poisson regression with covariate adjustment to estimate associations between OPE concentrations with maternal BP and the risk of HDP.

RESULTS: Diphenyl phosphate (DPHP) had the highest urinary geometric mean concentration (1.81 µg/L), followed by bis(1,3-dichloro-2-propyl) phosphate (BDCIPP; 0.80 µg/L), bis(2-chloroethyl) phosphate (BCEP; 0.61 µg/L), and di-n-butyl phosphate (DNBP; 0.26 µg/L). Thirty women (8.7%) were diagnosed with HDP. Every 10-fold increase of maternal BCEP concentrations was associated with 1.87 mmHg (95%CI 0.05-3.70) increase in the highest diastolic BP≥20 weeks. No urinary metabolites were associated with an increased risk of HDP (RR=1.17, 95%CI: 0.55-2.50 for DPHP; RR=1.68, 95%CI: 0.62-4.58 for BDCIPP; RR= 0.75, 95%CI 0.37-1.53 for BCEP; RR=2.34, 95% CI:0.88-6.24 for DNBP).



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CONCLUSIONS: Maternal urinary BCEP concentrations may be associated with increased diastolic BP. However, no associations were found between maternal urinary OPE metabolites and an increased risk of HDP.

Keywords: Endocrine disrupting chemicals, Pregnancy outcomes, Environmental epidemiology



ABSTRACT E-BOOK

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Birth and Pregnancy Outcomes » Birth outcomes

Association between prenatal exposure to air pollutants and newborn thyroxine (T4) levels

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BACKGROUND AND AIM: Thyroid hormones play a key role in fetal and child development. Recent studies have linked prenatal exposure to atmospheric contaminants with changes in thyroid hormone levels in newborns, but the data from the few studies that have explored this issue are inconclusive. The present study aims to assess the association of total thyroxine (TT4) levels in newborns with weekly prenatal exposure to PM_{2.5} and NO₂ and to identify sensitivity windows to exposure to air pollution in different developmental stages.

METHODS: This prospective cohort study included 463 mother-child pairs from the INMA-Gipuzkoa project with data on PM_{2.5} and NO₂ exposure and TT4 levels at birth. PM_{2.5} and NO₂ levels were measured by high-volume aerosol samplers and passive samplers respectively during the women's pregnancies. TT4 levels were measured in heel-prick blood samples from infants. Data on maternal and infant covariates were gathered through questionnaires administered in the first and third



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trimesters of pregnancy and review of clinical records. Potential associations of PM_{2.5} and NO₂ with TT4 levels over the entire pregnancy was assessed by linear regression models and DLMs were used to identify susceptibility windows.

RESULTS: PM_{2.5} exposure during pregnancy was positively associated with infant TT4 level at birth (β [95% CI]= 0.198 [0.091, 0.305]). DLMs identified three different sensitivity windows, one in the periconceptual period with a negative association between PM_{2.5} exposure and TT4 levels at birth, and a second (weeks 12-17) and a third one (weeks 31-37) with a positive association. In addition, the later the exposure, the stronger the association. In contrast, no association was observed between NO₂ exposure and TT4 levels.

CONCLUSIONS: The results indicate that prenatal exposure to PM_{2.5} could lead to a thyroid function impairment in newborns. Further, they suggest that the effect of PM_{2.5} could be partially mediated by maternal thyroid function.

Keywords: Prenatal exposure, PM_{2.5}, NO₂, TT4 at birth, sensitivity windows



ABSTRACT E-BOOK

P-244

Birth and Pregnancy Outcomes » Pregnancy outcomes

Ambient temperature from satellite-hybrid models and preterm birth: A time-stratified case-crossover analysis of 70,000+ preterm births in Central Mexico

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BACKGROUND AND AIM: Increasing evidence demonstrates that high ambient temperatures (T_a) and fine particulate matter ($PM_{2.5}$) are associated with preterm birth (PTB), but few have studied this relationship in low-and-middle income countries using satellite-based spatiotemporal exposure models. Further, new evidence suggests that studies using the time-stratified case-crossover (TSCCO) may yield biased results if strata are not short enough to account for the changing probability of birth over gestation.

METHODS: Preliminary analyses focused on warm season temperatures. We conducted TSCCOs to associate same-day minimum daily temperatures (T_a minimum) with PTB, matched on day of the week, between 2008-2017 in Central Mexico (including Mexico City). Daily exposures were derived from a satellite-hybrid model at a 1-km² resolution, and were assigned using population-weighted centroids of the sub-county locality of residence. Birth data was derived from a national birth registry, restricted to singletons from 20-36 weeks gestation during warm months (May-September). Results compared 14-day and 28-day TSCCOs. Associations were estimated using conditional logistic regressions.

RESULTS: Analyses included 70,263 PTBs across 497 sub-counties. The median T_a minimum was 13.1°C (IQR: 12.3-14.2°C, 95th percentile: 15.3°C). Both 14-day and 28-day TSCCOs estimated a positive association between T_a minimum and PTB, with a 1.2% increased odds of PTB for each °C increase (OR: 1.01, 95%CI: 1.00-1.02) with the 14-day TSCCO and a 5.2% increased odds (OR: 1.05, 95%CI: 1.04-1.06) with the 28-day TSCCO.

CONCLUSIONS: Our analyses identified an association between the T_a minimum and PTB in Central Mexico, with markedly higher effect estimates for the 28-day TSCCO. This supports our previous simulations that month-long time-strata may yield biased results. Future analyses will assess: 1) interactions with $PM_{2.5}$; 2) full calendar years to assess potential nonlinear relationships; 3) lagged relationships between ambient exposures and PTB; and 4) effect modification by individual-level and community-level factors.

Keywords: preterm birth, ambient temperature, particulate matter, short-term exposure, study design and methods



ABSTRACT E-BOOK

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Birth and Pregnancy Outcomes » Pregnancy outcomes

Blood lead level and pressoric levels in pregnant women

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BACKGROUND AND AIM: INTRODUCTION: Human exposure to lead has been linked to several health problems, including hypertension, which during pregnancy is the main cause of maternal mortality in Brazil and in developed countries. Although the pathophysiology of hypertension during pregnancy is not completely known, the importance of the immune system is known, and in this arm the lead's ability to act in this pathophysiology.

OBJECTIVE: To evaluate the relationship between Blood Lead Level(BLL) and Blood Pressure(BP) levels of pregnant women participating in the Pilot Study of the PIPA project.

METHODS: METHOD: 97 pregnant women participating in the study (PIPA) who had serum lead levels obtained in the third trimester were selected. His blood pressures were categorized into 2 groups: altered BP or normal BP, and compared with serum levels of maternal lead, which were also categorized as: Blood Lead Level > 5 µg / dL or Blood Lead Level <5 µg / dL.

RESULTS: RESULTS: Among the 97 patients: 20 patients had their BP altered, and 34 patients had Blood Lead Level > 5 µg / dL. From this relationship, a Prevalence Ratio of 1.51 was found (CI 95%; 0.69-3.29).

CONCLUSIONS: CONCLUSION: The present study found a positive relationship between Blood Lead Level in the mother's bloodstream and her blood pressure, corroborating with the literature. The small number of patients does not allow us to guarantee statistical significance, requiring more studies to find consistent results.

Keywords: Lead, Hypertension, pregnancy



ABSTRACT E-BOOK

P-247

Birth and Pregnancy Outcomes » Pregnancy outcomes

Vitamin D intake modifies the association of household air pollution exposure with maternal disorders of pregnancy

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BACKGROUND AND AIM: To date only two studies conducted in India have investigated the association of household air pollution (HAP) exposure from cooking with pregnancy disorders. The role of garbage burning at home, an important contributor to HAP has never been investigated. The ameliorating role of diet and nutrition in the association of HAP with pregnancy disorders also remains unexplored. We investigated the association of HAP with hypertensive disorders of pregnancy (HDP) and gestational diabetes mellitus (GDM), and examined the effect modifying role of vitamin D (vitD) intake.

METHODS: We conducted a population-based cross-sectional study among 799 nursing mothers in Cape Coast Metropolis, Ghana. We assessed HAP exposure from cooking and garbage burning at home using a structured questionnaire through the collection of several types of information. A semi-quantitative food frequency questionnaire was used to assess vitD intake. Double-selection lasso logit regression was used to investigate the association between HAP exposure and pregnancy disorders. We performed stratification analysis according to quartiles of vitD intake.

RESULTS: HAP exposure due to cooking and garbage burning was associated with 74% (OR=1.74; 95% CI: 0.99, 3.07) and 287% (OR=3.87; 95% CI: 1.86, 8.04) increased odds of GDM and HDP, respectively. Mothers exposed to both HAP exposures had 256% (OR=4.56; 95%: 1.49, 8.49) increased odds of pregnancy disorders compared to mothers cooking with clean fuels. In the stratified analysis, mothers classified in the fourth quartile of vitD intake had reduced odds of pregnancy disorders compared to their counterparts classified in the first to third quartile. All the interaction p values were greater than 0.05.

CONCLUSIONS: We provide the first evidence on the ameliorating role of vitD intake on the effect of HAP exposure on pregnancy disorders. The study findings will help to better tailor intervention strategies for addressing the burden of pregnancy disorders in developing countries.

Keywords: Vitamin D, Household air pollution, Gestational diabetes mellitus, Hypertensive disorders of pregnancy, Ghana



ABSTRACT E-BOOK

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Birth and Pregnancy Outcomes » Pregnancy outcomes

Exposure to environmental pollutants in perinatology

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BACKGROUND AND AIM: INTRODUCTION: The urban population is exposed to different sources of chemical pollutants, such as food, industrialization, heavy car traffic, water, air pollution and cosmetics, in small daily doses and on a continuous and gradual basis. Exposure to environmental pollutants during pregnancy has been associated with complications for the mother and baby. OBJECTIVE: To investigate food as a source of exposure to chemical pollutants in a group of pregnant women who participated in the PIPA project (Childhood and Environmental Pollutants Project) pilot study.

METHODS: METHOD: 139 pregnant women were part of the cross-sectional study, carried out in the 3rd trimester of pregnancy, which analyzed blood and urine to measure the concentrations of pollutants and interviewed the population to obtain information on the sources of exposure. The variables being considered: kitchen utensils, water source and food. The following pollutants were analyzed: lead, mercury, cadmium, arsenic, organochlorines and perfluorooctanoic acid, measured in the blood, and the metabolites of pyrethroids 3BPA and 4FPBA, in the urine.

RESULTS: RESULTS: When associating food consumption with the concentration of pollutants, OR = 0.778 (CI = 0.31-1.97) was found when comparing the group that reported the lowest consumption of beef and pork with the group with the highest consumption. OR = 0.741 (CI = 0.306-1.795) when comparing the group that reported lower consumption of teas with the group with higher consumption.

CONCLUSIONS: CONCLUSION: Further studies are needed to evidence such associations. The longitudinal study of the PIPA project will start in 2021 and foresees the participation of 2000 pregnant women.

Keywords: Long-term exposure, Pregnancy outcomes, Exposure assessment, Food/nutrition



ABSTRACT E-BOOK

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Birth and Pregnancy Outcomes » Birth outcomes

Prenatal exposure to greenspace and cord blood lipid levels: a cross-sectional study

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BACKGROUND AND AIM: A growing body of evidence has been focused on the health benefits of exposure to greenspace; however, less is known about its health effects for the developing fetus in the prenatal period, although this period of life is the most vulnerable for environmental exposures. With the present study, we aimed to investigate for the first time the associations between maternal greenspace exposure during pregnancy and cord blood lipid levels.

METHODS: This study was based on 150 pregnant women residing in Sabzevar, Iran (2018). For each participant, we characterized exposure to residential surrounding greenspace, residential proximity to green space, time spent in green spaces, and the number of plant pots at home. We measured triglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and TC/HDL-C and TG/HDL-C ratios in the cord blood samples to characterize the lipid levels. We developed linear regression models adjusted for relevant covariates to estimate the associations of each indicator of greenspace exposure with each cord blood lipid.

RESULTS: We found higher residential surrounding greenspace across a 100m buffer, residential proximity to green space, and time spent in green spaces were associated with lower cord blood lipid levels. Our findings for the residential surrounding greenspace across 300m and 500m buffers and the number of plant pots were not conclusive. We observed some suggestions for stronger associations among parents pertaining to the lowest SES group. A potential mediatory role by air pollution was observed.

CONCLUSIONS: This study suggests a beneficial association between exposure to greenspace during pregnancy and cord blood lipid levels.

Keywords: Prenatal exposure, newborn, natural environments



ABSTRACT E-BOOK

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Birth and Pregnancy Outcomes » Birth outcomes

Oxidative stress and inflammation on neonatal outcomes. The role of smoke, traffic exposure and BMI

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BACKGROUND AND AIM: Oxidative stress (OS) is known to play a role in pregnancy and neonatal outcomes, but the pathophysiology underlying such relationship is mostly unknown. Studies have confirmed this significant impact on pregnancy and neonatal life and the consequently adverse outcomes. The aim of this study is to evaluate how the living environment and some important maternal and obstetric risk factors (smoke, overweight, type of delivery) influence Oxidative Stress (OS) and inflammation in pregnancy and newborns.

METHODS: Mothers and newborns were recruited at the Sant'Anna Hospital (Turin, Italy), strictly following these inclusion criteria: (1) full-term pregnancy; (2) uncomplicated pregnancy; (3) no pharmacological treatment during pregnancy; (4) no twin delivery; (5) healthy babies (APGAR score 1'/5'). Environmental and lifestyle information was obtained through a standardized questionnaire (PRAMS). OS and inflammation markers (Isoprostane, IL-1 and IL-6) were analysed in urine samples.

RESULTS: Overall, 134 were recruited. Mothers and newborns OS and inflammation levels resulted to positively correlate (Spearman $p < 0.01$). Active and passive tobacco smoke during pregnancy (Spearman $p < 0.01$ and 0.02 , respectively), traffic exposure (Spearman $p: 0.02$), and higher BMI (Spearman $p: 0.05$) resulted to significantly shape this relationship. Currently, we are calculating greenness and urbanization to analyse their association with OS and inflammation status.

CONCLUSIONS: Our preliminary findings suggest that neonatal OS and inflammation are strongly influenced by 3 major risk factors: tobacco smoke exposure, high urbanization levels, and high BMI. Further analysis of each of those factors role is mandatory in order to understand the mechanisms underlying OS and neonatal outcomes relationship. Nevertheless, correct management and monitoring of these factors must be considered by preventive Public Health strategies, in order to improve neonatal health and outcomes.

Keywords: birth outcomes, oxidative stress imbalance, neonatal risk factors



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Parental Preconception and Prenatal Environmental Exposures and Child Neurobehavioral Outcomes

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BACKGROUND AND AIM: There are limited studies quantifying the effects of paternal and maternal preconception environmental exposures on children's health. The Preconception Environmental exposure And Childhood health Effects (PEACE) Study includes children (age 6-13 years) who were born to couples in the Environment and Reproductive Health (EARTH) Study and aims to determine the extent to which maternal and paternal preconception phthalate exposures are associated with neurobehavioral outcomes.

METHODS: The PEACE study began in 2019 and is ongoing. A total of 478 eligible children (includes multiples) were born to 451 mothers who participated in the EARTH study (2005-2017). Study staff collected multiple maternal and paternal preconception urine samples before pregnancy and prenatal maternal urine samples during each trimester of pregnancy. We quantified 10 urinary phthalate metabolites in these samples. Children's behavior, executive function, and reciprocal social behaviors are being assessed via parent-report using the Behavior Assessment System for Children-3 (BASC-3), Behavior Rating Inventory of Executive Function (BRIEF), and Social Responsiveness Scale-2 (SRS-2), respectively. Trained staff collected additional information about diet, sleep, physical activity, product use, and COVID-19 stress.

RESULTS: As of March 2021, we enrolled 95 mothers, 57 fathers, and 120 children in the PEACE Study who completed visits either in person or virtually. Of children who completed the study, 64 (53%) were boys and 97 (81%) were White. Mean BASC-3 total behavior problem scores were 48.7 (SD: 7.6). Ten percent of children had scores indicative of being at-risk for behavioral problems (T-score>60). Average BRIEF and SRS-2 scores were 48.2 (SD: 9.5) and 46.9 (SD:6.1), respectively.

CONCLUSIONS: The PEACE Study will provide new information about the potential impact of parental preconception environmental chemical exposures on children's health. In addition, the PEACE study will be able to leverage the rich data repository that includes parental chemical, built environment, and dietary exposures.

Keywords: Children's environmental health, Neurodevelopmental outcomes, Phthalates, Male, Chemical exposures, Endocrine disrupting chemicals, Female



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Ambient Air Pollution (PM_{2.5} & O₃) in Relation to ADHD in NYC Children Age 3-13 Years

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BACKGROUND AND AIM: Recent studies have investigated the relationship between air pollution and Attention Deficit/Hyperactivity Disorder (ADHD) with inconsistent results. The specific causes of ADHD remain unknown; however, there is biologic plausibility for etiologic mechanisms linking air pollution exposure and neurodevelopmental outcomes, such as ADHD.

METHODS: We included 5,032 children ages 3-13 years from the 2017 New York City KIDS survey on children's health provided by New York City Department of Health & Mental Hygiene, of which 303 had a parent report of ADHD diagnosed by a mental health professional. Using the child's date of birth and residential neighborhood (sub-borough) during the survey, we linked to daily air pollution data from U.S. Environmental Protection Agency fused air quality using surface downscaling (FAQSD) model, focusing on particulate matter <2.5 micrometers in diameter (PM_{2.5}) and ozone (O₃). We estimated odds ratios (aOR) adjusting for child's sex, child's race/ethnicity, highest parental education, household income, and indoor tobacco use.

RESULTS: One-year postnatal PM_{2.5} and O₃ mean, standard deviations and correlation: 11.1±1.5 (ug/m³); 66.3±4.4 (ppb); -0.67 correlation. ADHD was associated with PM_{2.5}, with aOR and 95% confidence interval (CI) per ug/m³ increase in PM_{2.5}: prenatal=1.13(1.01,1.27); postnatal=1.19(1.07,1.31); combined prenatal and postnatal=1.18(1.07,1.31). In contrast, ozone exhibited inverse associations, with aOR and 95%CI per ppb increase in O₃ exposures for prenatal=0.92 (0.87,0.98), postnatal=0.85(0.78,0.94), and combined prenatal and postnatal=0.87(0.79,0.94).

CONCLUSIONS: Despite air pollution measurement error resulting from geographic aggregation at the neighborhood-level, we observed links between PM_{2.5} and ADHD that align with prior studies. Our observed inverse associations between O₃ and ADHD are unlikely to reflect beneficial effects of ozone given its known harmful impacts and may be artifacts of the negative correlation between ozone and PM_{2.5}. These results provide further support for the adverse impact of air pollutants such as PM_{2.5} during pregnancy and infancy on the risk for development of ADHD.

Keywords: ADHD, Air Pollution, Children's Environmental Health, Neurodevelopmental Outcomes, Ozone, Particulate Matter



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Lead contamination of public drinking water and academic achievements among children in Massachusetts: a panel study

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BACKGROUND AND AIM: Public drinking water can be an important source exposure to lead, which can affect children's cognitive development and academic performance. Few studies have looked at the impact of lead exposures from community water supplies or their impact on school achievements. We examined the association between annual community water lead levels (WLLs) and children's academic performances at the school district level.

METHODS: We matched the 90th percentile WLLs with the grade 3-8 standardized test scores from the Stanford Education Data Archive (SEDA) on Geographic School Districts (GSD) by geographic location and year. We used multivariate linear regression and adjusted for urbanicity, race, socioeconomic characteristics, school district, grade, and year. The model resembles a difference-in-difference (DID) approach in a panel data setting and can have a causal interpretation if certain assumptions are met. We also explored potential effect measure modifications and lag effects.

RESULTS: After adjusting for potential confounders, a 5 µg/L increase in 90th percentile WLLs in a GSD was associated with approximately a 0.00684 [0.00021, 0.01348] standard deviation decrease in the average math test score in the same year. No association was found for English/Language Arts.

CONCLUSIONS: Using a DID causal modeling method, we found an association between the annual fluctuation of WLLs and math test scores in Massachusetts school districts, after adjusting for confounding by urbanicity, race, socioeconomic factors, school district, grade and year. The implications of a detectable effect of WLLs on academic performance even at the modest levels evident in Massachusetts are significant and timely. Persistent efforts should be made to further reduce lead in drinking water.

Keywords: Heavy metals, Neurodevelopmental outcomes, Children's environmental health, Environmental epidemiology



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Maternal occupational exposure to chemicals and neurocognitive development at 4-5 years of age

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BACKGROUND AND AIM: Despite evidence that suggests fetal brain development is particularly sensitive to endocrine disrupting chemicals (EDCs), limited data exist regarding childhood neurodevelopment in relation to maternal exposure to EDCs at levels relevant to occupational settings. This study's objective was to examine the association between maternal occupational EDC exposures and childhood neurocognitive function at 4-5 years of age.

METHODS: This analysis included 1,058 mother-child pairs in the *Infancia y Medio Ambiente* (INMA) project (2003-2008). Likelihood of exposure to several EDC groups was estimated using a job-exposure matrix and assigned to each mother based on her self-reported longest held job during her index pregnancy. At her child's 4-5-year follow-up visit, the McCarthy Scales of Children's Abilities was administered by a trained psychologist, yielding a general cognitive index and sub-scales of verbal, perceptible-performance and quantitative reasoning. We imputed missing covariate data and analyzed associations separately for each cohort using linear regression, weighting for inverse probability of attrition and adjusting for covariates informed by a directed acyclic graph: maternal age, education, country of birth, parity, gestational weight gain, pre-pregnancy body mass index, smoking and alcohol



ABSTRACT E-BOOK

use during pregnancy, verbal intelligence, child sex and age at assessment, and the psychologist who administered the assessment. Finally, we combined cohort-specific effect estimates using random-effects meta-analysis.

RESULTS: We observed an association between maternal occupational exposure to organic solvents and decreased quantitative reasoning scores at age 4-5 (-5.8, 95% confidence interval: -11.0, -0.5). Associations of similar magnitude and direction were observed for the same domain in relation to exposure to alkylphenolic compounds, phthalates and miscellaneous chemicals (i.e., benzophenones, parabens and siloxanes), though these were not statistically significant.

CONCLUSIONS: This study found limited evidence for a role of maternal occupational EDC exposures on childhood cognitive function. Further research should consider the combined impact of multiple workplace exposures.

Keywords: neurodevelopmental outcomes, chemical exposures, occupational exposures, endocrine disrupting chemicals, solvents, occupational epidemiology



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Toxicant exposure and the developing brain: A systematic review of the MRI literature

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BACKGROUND AND AIM: Socioeconomic status (SES) impacts the developing brain early, with poorer children already displaying less total gray matter volume—a measure of neuronal density, neuronal number, and overall early brain health—than wealthy children in the first months of life. However, the components of SES responsible for these neural differences remain poorly understood. One possibility is that, because children living in poverty have greater exposure to pollutants, differences in toxicant exposure may partly explain the neural differences observed among children at different social strata. Yet, the pediatric brain-imaging literature on toxicant exposure is limited.

METHODS: This poster describes the design and preliminary results of an on-going project to systematically review the MRI literature on toxicant exposure and brain structure and function from birth through adolescence.

RESULTS: Results will reveal if different toxicant classes impact overlapping brain structures and functions in youth, and if certain toxicant classes are associated with particularly problematic neurologic outcomes. As most MRI studies have only examined the relationship between one brain outcome and a single toxicant class, despite evidence that many children are exposed to multiple toxicants, results will also provide evidence about whether multi-toxicant exposure harms brain development over and above single exposures.

CONCLUSIONS: Findings are expected to identify new research questions and methodological improvements, as well as to inform chemical regulation, public policy, and parental decision-making to limit children's exposure to toxicants with the greatest impact on brain development.

Keywords: MRI, brain development, toxicant exposure, childhood, adolescence



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Early Life Exposure to Ambient Air Pollutants is Associated with Decreased Cognitive Development in Hispanic Infants from Southern California

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BACKGROUND AND AIM: Previous research has established an association between postnatal ambient air pollution (AAP) exposure and cognitive development in preschoolers and school-aged children. However, this association has not been examined during infancy, a critical neurodevelopmental window. The purpose of this study was to explore relationships between postnatal AAP exposure and cognitive development in infants.

METHODS: This study examined 118 Hispanic mother-infant pairs from the longitudinal Mother's Milk Study in Southern California. Average individual residential exposure to AAP, including nitrogen dioxide (NO₂) and particulate matter smaller than 2.5 and 10 microns in diameter (PM_{2.5} and PM₁₀ respectively), in the first month of life was estimated from central site monitors. Infant cognitive outcomes at 24-months were measured using the Bailey-III Scales of Infant and Toddler Development. Multivariate linear regression was used to examine relationships between postnatal AAP exposure and age scaled cognitive scores, adjusting for socioeconomic status, breastfeeding frequency, time of delivery (early/late/on-time) as a proxy for gestational age, pre-pregnancy BMI, birthweight, and sex. Effects are reported for each standard deviation increase in exposure.

RESULTS: NO₂ was negatively associated with fine motor score ($\beta=-0.55$, $p=0.006$), motor score ($\beta=-0.90$, $p=0.007$), and cognitive score ($\beta=-0.55$, $p=0.01$). PM_{2.5} and PM₁₀ were negatively associated with social emotional scores ($\beta=-0.77$, $p=0.009$ and $\beta=-0.66$, $p=0.01$ respectively). The association between NO₂ and cognitive score varied by infant sex (p -interaction = 0.046), where NO₂ was negatively associated with cognitive score among females ($\beta=-0.16$, $p=0.0006$) but not males ($\beta=-0.01$, $p=0.81$).

CONCLUSIONS: Higher postnatal exposure to AAP in the first month of life was inversely associated with scaled motor, cognitive, and social-emotional scores at 24-months of age. Sex-specific findings for scaled cognitive score may suggest differential impacts of AAP exposure among females. These results indicate that AAP may negatively impact neurodevelopment in early life.

Keywords: Air Pollution, Neurodevelopmental Outcomes, Multi-pollutant, Environmental Disparities, Short-term Exposure



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Other (to be specified with keywords in the keywords section)

Neurobehavioral, neuromotor, and neurocognitive effects in agricultural workers and their children exposed to pyrethroids pesticides: A review

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BACKGROUND AND AIM: In recent years, pyrethroids have emerged as a less toxic alternative to eliminate insect pests. However, some studies with animals and others with children show that these pesticides are toxic and lead to neurobehavioral effects similar to other pesticides such as organophosphates. The purpose of this review is to systematize and analyze the epidemiological scientific evidence about the neurobehavioral, neuromotor, and neurocognitive effects in agricultural workers and their children exposed to pyrethroids pesticides.

METHODS: We conducted two searches (with different terms) in PubMed and Scopus databases including articles in Spanish and English language on the effects of occupational exposure to pyrethroid pesticides associated with the neurobehavioral, neuromotor, and neurocognitive functioning of agricultural workers and their children. There were no filters by year, and the search included studies till march 2021. To develop the search, we followed the recommendations contained in the PRISMA guidelines and the PICO strategy.

RESULTS: The results show that in 66.6% of the studies reviewed (8 of 12 studies), agricultural workers or their children occupationally exposed to pyrethroid pesticides have a higher risk of presenting difficulties in their neurocognitive, neuromotor, or neurobehavioral performance, mainly associated with attention, processing speed (linked to hand-eye coordination) and motor coordination.

CONCLUSIONS: There are still few studies about this issue. However, the quality of most of the research conducted (83% intermediate or high quality) confirms the risk for agricultural workers' neurobehavioral health due to occupational exposure to pyrethroids. More research is required evaluating the exposure to pyrethroids including biomarkers and validated neurobehavioral and neuromotor tests, in addition to evaluating the effect of simultaneous exposure to other hazardous pesticides. Assuming that pyrethroids' use is increasing considerably and faster than the scientific evidence, it is suggested as a precautionary principle to regulate more strictly the sale of pyrethroids and other pesticides.

Keywords: Pesticides, Occupational exposures, Neurobehavioral effects



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Other (to be specified with keywords in the keywords section)

Mixed Metals Exposure and Cognitive Function in Bangladeshi Adolescents

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BACKGROUND AND AIM: Over 57 million Bangladeshis face environmental exposure to arsenic (As), cadmium (Cd), manganese (Mn), and lead (Pb). These metals have been linked to adverse neurocognitive outcomes in adults and children, though effects in adolescents are not fully characterized; additionally, previous studies have shown selenium (Se) to have protective effects against these exposures. This study aims to examine the associations between exposure to a metal mixture (As, Cd, Mn, Pb, Se) and the outcome of cognitive function in Bangladeshi adolescents.

METHODS: The Metals, Arsenic, & Nutrition in Adolescents Study (MANAS) is a cross-sectional study of 572 Bangladeshi adolescents aged 14-26 years. Venous blood was collected for measurement of As, Cd, Mn, Pb, and Se levels. An abbreviated Cambridge Neuropsychological Test Automated Battery (CANTAB) was administered, with subtests assessing cognitive function tasks. Linear regression models and Bayesian kernel machine regression (BKMR) were employed to examine associations between individual metals, the overall metals mixture, and cognitive function as measured by CANTAB subtests.

RESULTS: Linear regression revealed As (B=-2.40) and Mn (B=-5.31) to be negatively associated with Spatial Working Memory (p<0.05). Negative associations were seen between Cd and Spatial Recognition Memory (SRM) (B=-2.77, p<0.05), and between Pb and Delayed Match to Sample (DMS), a measure of visual recognition and memory (B=-3.67, p<0.05). A positive association was seen between Se and Spatial Span Length (B=0.92, p<0.05). BKMR showed no overall effect of the metals mixture, but indicated that Pb was negatively associated with DMS and that Cd was negatively associated with SRM. Se was positively associated with Planning, Reaction Time, and Spatial Span. Posterior inclusion probability consistently rated Se as the most important mixture member.

CONCLUSIONS: Overall, Se had a protective effect for cognitive outcomes, whereas Mn and As were linked to poorer working memory and Cd and Pb were linked to poorer visual recognition and memory.

Keywords: Heavy metals, Mixed metal exposures, Cognitive function, Neurotoxicology, Adolescent cognitive neurotoxicology, Mixtures analysis



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Neurologic and Mental Health Outcomes » Other (to be specified with keywords in the keywords section)

Effects of Folate and Vitamin B12 Nutritional Status on Cognitive Function in Bangladeshi Adolescents

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BACKGROUND AND AIM: Deficiencies in folate and vitamin B12 are widespread in Bangladesh. These micronutrients are essential for the synthesis of neurotransmitters and myelin, and for one-carbon metabolism, which supports synthesis of proteins and nucleotides during periods of rapid growth. Micronutrient deficiency has been associated with poorer cognitive function in adults and children, but this association has not been fully characterized in adolescents. This study aims to examine associations between the predictors of red blood cell (RBC) folate, plasma folate, and plasma B12, and the outcome of cognitive function in Bangladeshi adolescents.

METHODS: The Metals, Arsenic, & Nutrition in Adolescents Study (MANAS) is a cross-sectional study of 572 Bangladeshi adolescents aged 14-16 years. Venous blood was collected for measurement of RBC folate, plasma folate, and plasma B12. Participants completed the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV) and an abbreviated Cambridge Neuropsychological Test Automated Battery (CANTAB), with subtests assessing cognitive function. Linear models were employed to assess associations.

RESULTS: For CANTAB outcome measures, positive associations were observed between plasma folate and Spatial Recognition Memory (SRM) ($\beta=1.32$, $p<0.05$), and between B12 and Spatial Working Memory (SWM) ($\beta=2.10$, $p<0.05$). No significant associations were observed between folate and B12 nutritional predictors and the WISC-IV outcome measures.

CONCLUSIONS: The positive associations between folate and SRM and between B12 and SWM are consistent with previous findings linking folate and B12 deficiencies to memory deficits. Mild SRM impairments may include difficulty noticing that an object has been moved, whereas mild SWM impairments might include difficulty recalling where an object was placed. This research suggests that further investigation into the associations between folate and B12 nutritional status and measures of cognitive function in adolescents is needed. Additionally, these findings suggest that nutritional interventions involving B12 and folate supplementation may have a positive impact on overall adolescent health and cognition.

Keywords: Micronutrient deficiencies, Cognitive function, Neurotoxicology, Adolescent cognitive neurotoxicology, Folate and B12 deficiency, Nutritional status



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Early life critical windows of metal exposure associated with whole brain white matter changes in children

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BACKGROUND AND AIM: The brain white matter (WM) connects gray matter regions into functional networks and is critical for human cognition and behavior. Early-life exposure to metals may impact fetal WM development. Most environmental studies consider single exposures, potentially missing the combined effects of mixtures. In addition, the developmental timing of exposure may be as important as the dose. Little is known about critical windows to nutritive and toxicant metal mixtures on the developing brain. In this study, we investigated associations between early life exposure to a mixture of metals and whole brain white matter in children.

METHODS: In preliminary analysis of 30 subjects (6-10 years; 19 females) enrolled in a neuroimaging follow-up visit of the ongoing Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) study, we estimated weekly early life exposure (12th gestation week through one year of age) to 10 nutritive and toxicant metals (Mn, Zn, Pb, Mg, Li, Ca, Cr, Cu, Sr, Ba) in deciduous teeth using laser ablation-inductively coupled plasma-mass spectrometry. Whole brain WM microstructure integrity was estimated using fractional anisotropy (FA) from diffusion tensor imaging (DTI) acquired in a 3T Siemens scanner. We used lagged weighted quantile sum (IWQS) regression to estimate a time-varying mixture effect of multiple metals on whole brain FA. Models were adjusted for age.

RESULTS: We observe a potential critical window to metal exposure during the postnatal period (0 - 13 weeks) showing positive association with whole brain FA. This association is driven mainly by Li, Mg, and Ca. Negative associations were not detected.

CONCLUSIONS: WM microstructure integrity may demonstrate a postnatal critical window to essential elements. These results may help understand the role of exposure timing in driving neurodevelopmental effects, thereby pointing to future optimal, efficient, and properly timed public health interventions.

Keywords: Neurodevelopmental outcomes, Mixtures analysis, Mixtures



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodegenerative outcomes

Chronic exposure to air pollution and cognitive decline in older adults

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BACKGROUND AND AIM: Growing epidemiologic evidence suggests chronic exposure to fine particulate matter (PM_{2.5}) increases risk of dementia in older adults. Despite this, studies of cognitive impairment, a prodromal sign of dementia, report inconsistent results. Studying repeated measures of cognitive function, rather than measures at a single time point, may be a more robust metric of cognitive outcomes because the study design adjusts for time-fixed confounders that affect air pollution exposure and performance on cognitive tests. Therefore, we examined the effect of air pollution on cognitive decline in a U.S. cohort of older adults.

METHODS: This analysis draws from the Ginkgo Evaluation of Memory Study, a clinical trial aimed at understanding dementia prevention. Participants aged 75 years and older were enrolled between 2000 and 2002 and completed a neuropsychological battery of 10 tests repeated annually for up to eight years. Tests examined domains of memory, visuospatial abilities, language, attention, and executive function. Chronic exposure (20 years before baseline) to PM_{2.5} was estimated using annual averages from fine-scale spatiotemporal models and accounted for residential mobility. Trajectories of cognitive function across levels of PM_{2.5} were compared using generalized estimating equation regression models to account for correlations among repeated cognitive scores. Models included demographic and socioeconomic characteristics as covariates.

RESULTS: This study included 2,587 individuals (mean age=78 years) free of mild cognitive impairment at baseline. Chronic exposure to PM_{2.5} was associated with lower overall scores of memory and visuospatial abilities. Increased exposure to PM_{2.5} was not associated with declines in either domain. Associations with language, attention, and executive function will be assessed in future analyses.

CONCLUSIONS: This study provides support for associations between increased exposure to particulate matter and worse memory and visuospatial abilities. However, preliminary findings show no association between increased exposure and cognitive decline.

Keywords: Air pollution, epidemiology, neurodegenerative outcomes



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Prenatal Exposure to Air Pollution and Autism Spectrum Disorder: Sensitive Windows of Exposure and Sex Differences

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BACKGROUND AND AIM: Emerging animal and human data demonstrate sexual dimorphism in the developmental neurotoxicity of PM_{2.5} exposure. However, little is known about the sensitive gestational windows of prenatal PM_{2.5} exposure associated with increased ASD risk.

METHODS: This population-based retrospective birth cohort study included 294,937 mother-child pairs with singleton deliveries in Kaiser Permanente Southern California (KPSC) hospitals between 2001 and 2014. Children were followed using electronic medical records (EMR) until a clinical diagnosis of ASD, non-KPSC membership, death, or December 31, 2019, whichever came first. Weekly mean PM_{2.5}, NO₂, and O₃ exposures during pregnancy were estimated using spatiotemporal (1km x 1km) prediction models. Cox proportional-hazard models with distributed lags were used to estimate the independent associations between weekly pollutant exposures with ASD risk, separately for boys and girls.

RESULTS: 5,694 children (4,636 boys, 1,058 girls) had ASD diagnosis. Significant sensitive windows of exposure associated with PM_{2.5} exposure were found throughout the first two trimesters [1-27 weeks, cumulative HR=1.20 (95%CI=1.09–1.32) per 10 µg/m³ increase], adjusting for maternal race/ethnicity, maternal age at delivery, parity, maternal education, maternal comorbidities, medical center, median household income, birth year, and season. The cumulative hazard ratio (HR) during the entire pregnancy was 1.24 per 10 µg/m³ increase in PM_{2.5} (95%CI=1.10 –1.39). O₃ exposure during 34-37 gestational weeks was also associated with increased ASD risk [cumulative HR=1.03 (1.01–1.06) per 10 ppb increase]. No associations were observed with NO₂. When stratified by sex, early gestational (1-28 weeks) associations of PM_{2.5} were stronger for boys [cumulative HR=1.23 (1.10 –1.36) for boys and 1.10 (0.81 –1.38) for girls]; O₃ associations in later gestation (33-37 weeks) were observed only in boys [boys=1.05 (1.02 –1.08); girls= 0.97 (0.9 –1.03)].

CONCLUSIONS: Exposures to higher levels of PM_{2.5} in the first two trimesters and O₃ in the late 3rd trimester was associated with increased ASD risk, especially among boys.

Keywords: Autism Spectrum Disorder, Air Pollution, Sex Differences, Sensitive Windows



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Prenatal exposure to mixtures of endocrine-disrupting chemicals and autism spectrum disorder

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BACKGROUND AND AIM: Mixtures methods have the potential to address the unclear relationship between prenatal exposure to endocrine-disrupting chemicals (EDCs) and risk of autism spectrum disorder (ASD). However, mixtures studies in this area are currently sparse. This study examines the relationship of prenatal exposure to a mixture of 25 EDCs, representing 4 classes of persistent pollutants, and ASD.

METHODS: We analyzed data from the Early Markers for Autism (EMA) Study, a population-based, case-control study of children born during 2000-2003 in Southern California. Children diagnosed with ASD (n=491) were identified from clinical records of the Department of Developmental Services and were confirmed by expert review. General population (GP) controls (n=373) were randomly sampled from birth certificate files and frequency matched to children with ASD by sex, birth month, and birth year. Eleven polychlorinated biphenyls (PCBs), 6 brominated flame retardants (BFRs), 2 organochlorine pesticides (OCPs), and 6 polyfluoroalkyl substances (PFAS) were detectable in maternal serum samples collected during the second trimester. To examine the relationship between ASD and EDC mixtures, both within each chemical subclass and across all EDCs, we applied two **METHODS:** weighted quantile sums regression (WQSR) with repeated-holdout validation and Bayesian kernel machine regression (BKMR).

RESULTS: In WQSR adjusted for covariates, PCB, PFAS, and BFR mixtures were not associated with ASD when constrained to the positive direction, but BFRs were associated with ASD in the negative direction (aOR: 0.82; 95%CI: 0.71, 0.95 per quartile increase). Results from BKMR were generally consistent with WQSR, with PBDE 153 contributing the most to both BFR mixture models. WQSR and BKMR analyses showed null associations between the aggregate EDC mixture and ASD. BKMR analyses did not indicate interaction between any of the EDC biomarkers.

CONCLUSIONS: Results suggest that prenatal exposure to the mixture of these EDCs is not adversely associated with overall ASD risk.

Keywords: autism, mixtures, endocrine-disrupting compounds, prenatal



ABSTRACT E-BOOK

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Respiratory and Allergic Outcomes » Respiratory outcomes

Association between prenatal metal exposure and respiratory symptoms in childhood

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BACKGROUND AND AIM: Arsenic, manganese, and lead have been cross-sectionally associated with adverse respiratory outcomes in childhood but there is limited data on their combined effects starting in utero. Our aim was to examine associations between prenatal lead, arsenic, and manganese exposure and respiratory symptoms in childhood.

METHODS: We assessed 637 mother-child dyads enrolled in the Programming Research in Obesity, Growth, Environment, and Social Stressors (PROGRESS) birth cohort in Mexico City. Blood manganese (BMn), arsenic (BAs), and lead (BPb) were measured in mothers at 2nd trimester. Ever wheeze and asthma diagnosis was based on the caregiver's answers (yes/no) from the International Study of Asthma and Allergies in Childhood (ISAAC) survey applied at 4-5 and 6-7 years old. Covariates included maternal education, maternal asthma status, maternal age at enrollment, child's sex, and prenatal environmental tobacco smoke exposure. A logistic mixed model regression was generated to simultaneously assess the association between prenatal metals and ever wheeze, current wheeze, and asthma diagnosis longitudinally across both the 4-5 and 6-7 year study visits.

RESULTS: The mean \pm standard deviation for log-transformed BMn, BPb, and BAs at 2nd trimester were 0.14 $\mu\text{g}/\text{dL} \pm 0.15$, 0.48 $\mu\text{g}/\text{dL} \pm 0.27$, and -1.11 $\mu\text{g}/\text{dL} \pm 0.19$, respectively. In the adjusted model, BPb (Odds Ratio (OR): 1.95, 95% CI: 1.04-3.66) and BAs (OR: 3.44, 95% CI: 1.05-11.34) at 2nd trimester were associated with increased odds of ever wheeze and current wheeze, respectively. BMn at 2nd trimester (OR: 0.05, 95% CI: 0.01-0.27) was negatively associated with current wheeze.

CONCLUSIONS: Prenatal exposure to arsenic and lead was associated with higher odds of ever and current wheeze while manganese was negatively associated with odds of current wheeze in childhood. These findings underscore the need to consider prenatal metal exposure, including low levels of exposure, in the study of respiratory diseases.

Keywords: Respiratory outcomes, Heavy metals, Allergies, Asthma, Children's environmental health



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Respiratory and Allergic Outcomes » Respiratory outcomes

Knowledge, Practice and Associated Factors toward COVID-19 Prevention among Rural Communities in Southwest Ethiopia

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BACKGROUND AND AIM: COVID-19 is the newly emerged viral disease that becomes the global burden, and attacks both developed and developing countries. The aim of this study was to assess knowledge, practice, and related factors toward COVID-19 among rural communities in Southwest Ethiopia.

METHODS: Community based cross-sectional study was conducted from May 10 to July 25, 2020, that included a total of 768 randomly selected participants. Data were collected through face-to-face interview using structured questionnaire. Data were entered into Epi-data version 4.4 and exported into SPSS version 20 and analyzed using chi-square, binary logistic, and multivariable logistic regression to identify significant factors with p -value ≤ 0.05 on knowledge and prevention practice toward COVID-19.

RESULTS: A total of 720 participants were completed the questionnaires. The mean knowledge and practice scores were 4.812 (44%) and 1.829 (37%), respectively. More than half of the participants, 398 (55.3%) and 482 (66.9%) had good knowledge and practice to prevent COVID-19, respectively. Good prevention practice (AOR=2.04, 95% CI: (1.50, 2.83) with $p < 0.000$, those family size greater than five (AOR=1.61, 95% CI: (1.11, 2.33) with $p < 0.012$ were significantly associated with good knowledge of COVID-19. Similarly, married participants (AOR=1.81, 95% CI: (1.22, 2.69) $p = 0.003$, secondary education (AOR=1.78, 95% CI: (1.19, 2.98) $p = 0.028$, being student (AOR=2.27, 95% CI: (1.19, 4.36) $p = 0.014$, good knowledge (AOR=2.04, 95% CI: (1.47, 2.83) $p = 0.000$, and family size > 5 (AOR=0.577, 95% CI: (0.388, 0.824) $p = 0.003$ were significantly associated with good preventive practice toward COVID-19.

CONCLUSIONS: More than half of the participants had good knowledge and preventive practice toward COVID-19 pandemic, even though it is not enough to handle the rapid spread of the virus. The government and non-governmental organizations should give attention to the rural communities to promote and create awareness and preventive practices to combat the transmission of COVID-19 pandemic.

Keywords: COVID-19, Knowledge, Practice, Rural Community, Ethiopia.



ABSTRACT E-BOOK

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Other » Other (to be specified with keywords in the keywords section)

Environmental factors and COVID-19 in Benin: a case-control comparison

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BACKGROUND AND AIM: Some studies suggest an influence of environmental factors on the spread of COVID-19. The objective of the present study was to investigate this influence on the occurrence of COVID-19 in Benin.

METHODS: This was a cross-sectional case-control study including 312 individuals (104 cases and 208 controls) recruited on COVID-19 screening sites in several regions of Benin. Data were collected on the socio-demographic characteristics, housing and working conditions of the cases and controls in the study. Simple logistic regression was used to identify factors associated with the occurrence of COVID-19.

RESULTS: Houses with a common courtyard were the most frequent type of housing for 54.81% of cases and 60.10% of controls. There was no hand washing station installed at the houses entrance for 52.88% of cases and 45.67% of controls. Access to drinking water from the Benin national water company was available in 60.58% of cases and 59.13% of controls. The workplace was a closed space for 43.62% of cases and 40.82% of controls. For 74.07% of cases and 68% of controls, their closest colleague was located less than one meter away. These spaces were permanently air-conditioned for 20.19% of cases and 8.17% of controls. Simple logistic regression showed that the absence of a hand-washing station at home (OR=1.72; [1.03-2.85]) or the existence of a station providing only drinking water without soap (OR=4.62; [1.84-11.61]) and permanent air conditioning of the workplace (OR=3.38; [1.63-6.97]) have an influence on the occurrence of COVID-19.

CONCLUSIONS: The consideration of environmental factors in the response to COVID-19 in Benin is essential.

Keywords: COVID-19, environmental factors, case-control, Benin



ABSTRACT E-BOOK

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Respiratory and Allergic Outcomes » Respiratory outcomes

Asthma-like symptoms and oxidative stress in adults from the GEIRD Cohort

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BACKGROUND AND AIM: Oxidative Stress (OS) is an imbalance between reactive oxygen species production and scavenging. This pre-pathological condition could be involved in the perpetuation and amplification of airway inflammation and other chronic diseases. The present study aimed at investigating OS in both healthy and asthma-like-diseased subjects.

METHODS: Overall, 208 subjects were randomly selected from the GEIRD Cohort (Gene Environment Interaction in Respiratory Diseases). Based on the positive response to the Methacholine Challenge Testing or the obstructive impairment tested by spirometry, 124 volunteers were classified as “healthy”, while 84 as suffering from Asthma-Like Symptoms (A-LSs). Subjects participated after providing their informed consent, underwent anthropometric measurements, and provided a urinary sample. Urinary 15-F2t-IsoP and GSSG were quantified (ELISA technique) as biomarkers of OS. Urinary cotinine was measured as biomarker of tobacco smoking exposure. All biomarkers were normalised by creatinine. The association between OS and A-LSs was tested using two Multivariable Linear Regression Models and log(e)-transformed variables.

RESULTS: Subjects were aged from 18 to 64 years and 41.3% were males. Sex, age, height and weight were not significantly affecting parameter estimates of any models, thus they have been excluded. We observed a significant increase of 15-F2t-IsoP in subjects suffering from A-LSs compared to healthy subjects (+1.58 folds, $p < 0.001$), even adjusting for cotinine and GSSG. Similarly, when considering GSSG as dependent variable, we found a GSSG increase of 1.79 folds in symptomatic subjects compared to healthy ones, adjusting for cotinine and 15-F2t-IsoP. Finally, 15-F2t-IsoP levels were redoubled for each unit of increase of urinary cotinine ($p < 0.001$).

CONCLUSIONS: In conclusion, our findings suggest that 15-F2t-IsoP and GSSG are reliable and sensitive monitors of OS in various respiratory diseases, including A-LSs. Additionally, urinary 15-F2t-IsoP is effective to quantify some of the in vivo effects of tobacco smoking exposure.

Keywords: Molecular epidemiology, Respiratory outcomes, Asthma



ABSTRACT E-BOOK

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Respiratory and Allergic Outcomes » Respiratory outcomes

The respiratory health of rural women after the implementation of an improved cookstove program in San Luis Potosí, Mexico

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BACKGROUND AND AIM: Improved cookstove (ICS) programs are an intervention strategy to reduce the burden of disease attributable to household air pollution (HAP). The aim of this study is to report and compare the respiratory health outcomes for treated and non-treated women of San Luis Potosí, Mexico.

METHODS: As part of a comprehensive ICS program evaluation, a health impact assessment was conducted as a panel study comparing treated and non-treated women selected from the list of program beneficiaries. The information was collected during two rounds in 2015-16 in three regions of the state of San Luis Potosí. The outcome variables were obtained through health questionnaires and spirometry tests. The average treatment effect was estimated using the double difference method combined with propensity score matching.

RESULTS: A total of 716 women were evaluated (370 non-treated and 346 treated). The study groups presented significant differences in demographic and socioeconomic characteristics. On average the program showed a significant increase in FEV1 (6%, $p=0.045$) but did not show significant reductions in respiratory and non-respiratory symptoms. The regional impact was heterogeneous with a significant increase in the lung function parameters (FEV1 and FVC), and a significant reduction (49%, CI 95%:26-91%) in the prevalence of headache in treated women from the Huasteca compared to the Altiplano-Centro region.

CONCLUSIONS: The state ICS program showed a significant impact on women's lung function, and a reduction in the prevalence of some non-respiratory symptoms. The results were heterogeneous between the regions of the state and lost validity because of non-comparable groups.

Keywords: Air pollution, Particulate matter, Respiratory outcomes



ABSTRACT E-BOOK

P-270

Respiratory and Allergic Outcomes » Allergies

Air pollution and emergency department visits for urticaria

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BACKGROUND AND AIM: The objective of this work was to investigate correlations between air pollution and emergency department (ED) visits for urticaria in Toronto, Canada.

METHODS: The National Ambulatory Care Reporting System database was used to draw the diagnosed ED visits. The L50 section of the International Classification of Disease 10th Revision was used to extract ED visits whose primary causes of visit was urticaria-related conditions. Statistical models (Poisson regression) using daily counts of ED visits were created for urticaria, ambient air pollution concentrations, and weather factors. We considered two air quality health indexes and six ambient air pollutants for exposure: fine particulate matter PM_{2.5}, O₃, CO, NO₂, SO₂, and maximum 8-hour average ozone.

RESULTS: A total of 176 statistically significant (P-Value <0.05) positive correlations were identified over the 14 day lag period. For ozone, 74 positive correlations were observed with the following relative risks (RR) for one interquartile range (IQR=12.8 ppb) increase: RR=1.361 (95% confidence interval: 1.302, 1.404), 1.359 (1.299, 1.401), 1.351 (1.281, 1.404) in the warm season (April-September), lag 0, and RR=1.019 (1.013, 1.025), 1.023 (1.016, 1.030), 1.014 (1.007, 1.021), lag 1, in the cold period (October-March), for all, females, and males, respectively. 10, 45 and 45 positive correlations were also obtained for sulfur dioxide, fine particulate matter, and daily maximum 8-hour average ozone concentrations, respectively.

CONCLUSIONS: The results indicate that urban ambient air pollution could influence the rates of ED visits for urticaria. Ambient ozone was determined as the main environmental factor contributing to these associations.

Keywords: Ozone, Traffic-related, Short-term exposure, Allergies



ABSTRACT E-BOOK

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Outcomes » Infectious diseases

Wastewater Surveillance in North Carolina: Promoting Environmental Health Across Sectors

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BACKGROUND AND AIM: Wastewater surveillance has emerged during the COVID-19 pandemic as a unique tool that provides a pooled community sample of SARS-CoV-2 infection. This surveillance method is not dependent on access to testing or health care seeking behaviors. Through a multi-disciplinary collaboration between epidemiologists, laboratory scientists, water reclamation managers, and environmental engineers, this strategy has promising applications for large-scale pathogen, pharmaceutical, and chemical exposure monitoring.

METHODS: In collaboration with University of North Carolina (UNC) system researchers, the North Carolina Department of Health and Human Services (NCDHHS) was one of eight state health departments initially funded by the Centers for Disease Control and Prevention (CDC) to participate in the National Wastewater Surveillance System (NWSS) in September 2020. In January 2021, NCDHHS began collecting twice weekly samples at eleven wastewater treatment plants (WWTPs) for digital droplet polymerase chain reaction (ddPCR) analysis at UNC as part of the North Carolina Wastewater Monitoring Network. NC was the first state to operationalize the CDC's analytics pipeline, submitting wastewater data weekly along with geocoded COVID-19 cases from contributing sewersheds to see if wastewater trends are increasing, decreasing, or plateauing. During the summer of 2021, nine additional sites are being added to the network to increase geographic representation and coverage of populations with higher social vulnerability, with 15 additional sites planned for later in 2021.

RESULTS: Peak wastewater levels were observed in January 2021 with gradual declines during spring 2021. Trends mirrored decreases in COVID-19 cases as vaccination efforts expanded and transmission slowed. By June 2021, most sites are in plateau status and several have had repeated nondetects.

CONCLUSIONS: Success in measuring SARS-CoV-2 in wastewater is prompting interest in measuring other pathogens, pharmaceuticals, and chemical exposures at the population level. The NC Wastewater Monitoring Network has built a foundation of partnerships that will continue to expand capacity for wastewater-based epidemiology in NC.

Keywords: wastewater, surveillance, SARS-CoV-2, epidemiology, environment



ABSTRACT E-BOOK

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Outcomes » Infectious diseases

Air pollution exposure increases the probability of SARS-CoV-2 infection and influences the immune response of healthcare workers affected by COVID-19

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BACKGROUND AND AIM: Several studies have so far investigated the potential association between air pollution exposure and SARS-CoV-2 infection. However, many relied on aggregated data and overall results are still controversial. We aim to verify this association in a well-characterized population of healthcare workers (HCWs).

METHODS: We collected occupational and clinical characteristics of all HCWs who performed a nasopharyngeal swab for detection of SARS-CoV-2 at the Policlinico Hospital in Milan (Italy), from February 24 to December 26, 2020. Air pollution data were treated as time-dependent variables, by calculating person-days at risk. Each person-day was assigned daily levels of particulate matter ≤ 2.5 μm (PM_{2.5}) and nitrogen dioxide (NO₂) measured from the air quality monitoring station closest to the residential address. Poisson regression models adjusted for gender, age, and occupation were fit to calculate incidence rate ratios (IRR) of a positive swab and 95% confidence intervals (CI). Only the first positive swab was considered. Among swab-positive workers, multivariable linear regression models were run to assess the association between air pollution and antibody titer (ElecSys[®] Anti-SARS-CoV-2).

RESULTS: Out of 3,712 HCWs included, 635 (17.1%) had a positive nasal swab. A 10 $\mu\text{g}/\text{m}^3$ increase in PM_{2.5} average concentration in the preceding week was associated with an increased risk of testing positive (IRR=1.11, 95% CI: 1.02; 1.21). As regard NO₂, the risk of testing positive increased from 1.04 (0.98; 1.10) at lag0-1 (average of index-day and the day before) to 1.12 (1.04; 1.21) at lag0-10. Among swab-positive subjects, a 10 $\mu\text{g}/\text{m}^3$ increase in average PM_{2.5} concentration in the month preceding the swab was associated with a 48.8% decrease in antibody titer (95%CI: -59.4; -35.4). No clear pattern was apparent for NO₂.

CONCLUSIONS: Although warranting further investigations, our study suggests a potential role of air pollution exposure in influencing the immune response to SARS-CoV-2 infection.

Keywords: air pollution, covid-19, nasopharyngeal swab, serology, healthcare workers



ABSTRACT E-BOOK

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Respiratory and Allergic Outcomes » Respiratory outcomes

Ambient air pollution and respiratory health in sub-Saharan African children: a cross-sectional analysis

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BACKGROUND AND AIM: Ambient air pollution is projected to become a major environmental risk in sub-Saharan Africa (SSA). Research into its health impacts is hindered by limited data on both exposure and health. We aimed to investigate the cross-sectional relationship between particulate matter with a diameter $\leq 2.5\mu\text{m}$ (PM_{2.5}) and prevalence of cough or acute lower respiratory infection (ALRI) among under-5 children in SSA.

METHODS: Data were collected from 31 Demographic and Health Surveys (DHS) in 21 SSA countries between 2005-2018. Prior-month average PM_{2.5} preceding the survey date was assessed based on satellite measurements and chemical transport model. Cough and ALRI symptoms in the past two weeks were reported by mothers. Associations were analysed using conditional logistic regression within each survey, adjusting for child's age, sex, birth size, household wealth, maternal education, maternal age and month of the interview. Individual survey odds ratios (ORs) were pooled using random-effect meta-analysis.

RESULTS: 368,366 and 109,664 children were included for the analysis of cough and ALRI respectively. On average, 20.5% children had reported cough; 6.4% reported ALRI; and 32% of children lived in urban areas. Prior-month average PM_{2.5} ranged from 8.9 to 64.6 $\mu\text{g}/\text{m}^3$. Across surveys, no associations were observed with either outcome in total populations. Sub-group analyses revealed positive associations with both cough (pooled OR: 1.013, 95%CI: 0.996-1.029) and ALRI (pooled OR: 1.037, 95%CI: 1.002-1.075) for every 1 $\mu\text{g}/\text{m}^3$ higher of PM_{2.5}.

CONCLUSIONS: Short-term higher exposure to PM_{2.5} was associated with higher odds of maternally-reported cough or ALRI among SSA urban children.

Keywords: PM_{2.5}, low-middle-income countries, lung health, acute lower respiratory infection



ABSTRACT E-BOOK

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Other » Other (to be specified with keywords in the keywords section)

Open Surveys on COPD and Smoking in Brazil: An analysis between 2016 and 2020 and their contributions to Public Health

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BACKGROUND AND AIM: Smoking is responsible for more than 8 million deaths per year in world and for the highest mortality rates related to COPD, which is already the third leading cause of death in several countries. Identifying national indicators related to smoking and COPD is a relevant to support public policies. Data from Vigitel (Surveillance of Risk and Protection Factors for Chronic Diseases by Telephone Survey) on smoking between the years 2006 (14.1%) and 2019 (9.8%) indicate an overall reduction of 37.8%. In the National Health Survey (PNS /IBGE) data for adults from 2013 (14.9%) and 2019 (12.8%). A study of Brazilians found that 34% of smokers reported increasing cigarette consumption during the pandemic in 2020. The "Google trends" (GT) can be a source of information on trends in these behaviors. AIM: To analyze the behavior of the GT searches and consultations on smoking and COPD together with Vigitel, in all states of Brazil.

METHODS: Descriptive study, in the period from 2006 to 2020. Responses from the Vigitel and GT surveys on smoking and COPD were analyzed. The data obtained were spreadsheeted in Excel® and analyzed using means and Pearson correlation.

RESULTS: Analysis of the GT data with the word COPD found a non-correlated pattern (0.34) and found about smoking (Vigitel). The annual averages of smoking in Vigitel showed a drop, as did the averages of the GT searches. In the statistical analyses found that there was a relationship (-0.64) for non-smokers and GT for the word "smoking". Regarding smokers, a relationship of 0.90 was found between Vigitel and the word smoking in the GT. Common words may indicate strong relationships between a simple search in GT and an event proven by formal research.

CONCLUSIONS: The use of information from a variety of sources about smoking can contribute to broadening data for public health use.

Keywords: Chemical exposures, Long-term exposure, Policy and practice



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

Exposure to Nitrate from Drinking Water and the Risk of Childhood Cancer in Denmark

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BACKGROUND AND AIM: There is limited evidence that nitrate, a common contaminant in drinking water, increases the risk of childhood cancers. Our objective was to examine this association in a large population based case control study in Denmark with high quality estimates of individual exposures to nitrate in drinking water..

METHODS: We conducted a nationwide case-control study based on all singletons liveborn to Danish-born parents from 1991 to 2015 (N=1,219,140) that included 596 leukemias, 180 lymphomas, and 310 central nervous system cancers (CNS) who were <15 years of age at diagnosis and were identified from the Danish Cancer Registry. Approximately 100 controls were randomly selected and matched to each case on date of birth and sex. Nitrate measurements in public water systems were linked with an address registry to estimate individual average nitrate concentrations during preconception, prenatal, and postnatal periods. Odd ratios (OR) and 95% confidence intervals (95%CI) were estimated using conditional logistic regression controlling for the matching variables, and birth order, birthweight, urbanicity, maternal education, employment, income and smoking, and parental age.

RESULTS: There was no evidence of an association of nitrate with leukemia or lymphoma. An association between CNS and the highest category of nitrate exposure (>25 mg/L nitrate) was observed for preconception (OR=1.82, 95%CI=1.09 to 3.04), prenatal (OR=1.65, 95%CI=0.97 to 2.81), and postnatal exposure (OR=1.48, 95%CI=0.82 to 2.68) in fully-adjusted models. There was also some evidence of an exposure-response in models of continuous nitrate exposure and CNS.

CONCLUSIONS: Our findings provide some evidence that exposure to nitrate from drinking water may increase the risk of childhood CNS cancer, but not leukemia or lymphoma. Exposures in this study were generally well below current European and US maximum allowable concentrations, which in addition to previous studies, raises concerns about the adequacy of these standards for protecting children's health.

Keywords: nitrate, drinking water, childhood leukemia, lymphoma and central nervous system cancer



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Other (to be specified with keywords in the keywords section)

Environmental Cadmium Exposure and Odds of Residing in a Breast Cancer Hotspot in Kentucky

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BACKGROUND AND AIM: Breast cancer is the most common invasive cancer diagnosed in US women. Cadmium is a carcinogenic heavy metal pollutant found in cigarettes and as an agricultural and industrial byproduct. Studies of cadmium exposure and breast cancer risk have produced mixed results depending upon methodology. We examined environmental cadmium exposure and risk of residing in a breast cancer hotspot in Kentucky.

METHODS: Invasive breast cancer cases diagnosed between 1995-2018 were identified from the Kentucky Cancer Registry (n=66,413) and 68 of the 1,114 KY census-tracts were identified as breast cancer clusters using Getis-Ord Gi* for age-standardized rates. Census-tract cadmium concentrations from the 2014 National Air Toxics Assessment interpolated estimations were linked to cases' residential addresses. Logistic regression was performed to assess the odds of residing in a hotspot across quartiles of cadmium exposure adjusted for individual-level (demographic, reproductive factors, Appalachian residence, insurance, tobacco use) and neighborhood factors (population density, poverty, and physical inactivity). Effect modification by smoking was assessed.

RESULTS: 4,134 women with breast cancer resided in hotspots (6.2%), which were located in major cities and southeast Kentucky. The mean age was 61 years. Hotspot cases were more likely than other cases to be black, single, uninsured or have public insurance, live in Appalachia, and reside in more densely populated neighborhoods with greater poverty. The odds of living in a hotspot were 4.2-times higher for those who resided in areas with the highest quartile of cadmium exposure compared to those in the lowest (95% CI: 3.6, 4.8; p-trend <0.0001). Results were similar (Q4 vs Q1: OR=4.4 95% CI 3.6, 5.4) among non-smokers.

CONCLUSIONS: The observed associations of environmental cadmium exposure and residing in breast cancer hotspots in Kentucky warrant further research with more appropriate epidemiologic study designs.

Keywords: heavy metals, cancer and cancer precursors, environmental epidemiology, female, hotspot, air pollution



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

Pesticides and the risk of thyroid cancer, 50 years after restricted organochlorine pesticide use

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BACKGROUND AND AIM: The incidence rate of thyroid cancer has increased significantly in recent decades in the United States (US) and worldwide. Exposure to endocrine disruptive chemicals, including pesticides, has been suggested to potentially contribute to this increase. Although many organochlorine pesticides have been restricted or banned in the US since the 1970s, these pesticides are stable and lipophilic, allowing them to remain in tissues for years potentially exerting carcinogenic effects. The objective of present study was therefore to assess time trends of thyroid cancer incidence and pesticide use in the US from 1975 to 2017.

METHODS: Using data from the United States Department of Agriculture (USDA) and Surveillance, Epidemiology, and End Results Program (SEER), trends of pesticides use between years 1975-2008 and incidence of thyroid cancer between years 1975-2017 in the US were assessed. The Mann-Kendall test was used to assess whether there was a significant, monotonic up- or downward trend, expressed as Kendall's Tau b correlation coefficient.

RESULTS: There was a significant increased thyroid cancer incidence rate from 4.85 cases per 100,000 per year in 1975, to 13.68 cases per 100,000 per year in 2017 (correlation coefficient: 0.873; $p < 0.001$). Pesticide use increased significantly from 448.9 million pounds in year 1975 to 631.9 million pounds in year 1981 (correlation coefficient: 0.809; $p = 0.016$). After 1981, pesticide use decreased to 516.1 million pounds in 2008, however this was a non-significant decrease (correlation coefficient: -0.207; $p = 0.128$).

CONCLUSIONS: The simultaneous increase in pesticide use and thyroid cancer incidence rate suggests a potential negative health effect of pesticide exposure, although longitudinal studies are needed to investigate causality. Surveillance of the general population is needed to explore the impact of pesticide exposure in the US as no significant decrease in pesticide use is seen to date.

Keywords: Pesticides, cancer and cancer precursors



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

Circulating vitamin D concentrations and breast cancer incidence among Black/African-American and non-Black Hispanic/Latina women

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BACKGROUND AND AIM: Vitamin D has anti-carcinogenic properties and may protect against breast cancer. Although Black/African American women and Hispanic/Latina women have lower circulating vitamin D levels than non-Hispanic white women, few studies have examined the association between vitamin D and breast cancer within these racial/ethnic groups. Using a case-cohort sample of Black/African American and non-Black Hispanic/Latina women from the US-based Sister Study cohort, we estimated the association between circulating 25-hydroxyvitamin D [25(OH)D] and incident breast cancer.

METHODS: We compared concentrations of circulating 25(OH)D in blood samples collected at baseline from 405 women (281 Black/African American, 124 non-Black Hispanic/Latina) who developed breast cancer to concentrations in 1,511 women (1,061 Black/African American, 450 non-Black Hispanic/Latina) randomly selected from the cohort. Participants were aged 35-74 years and had a sister previously diagnosed with breast cancer but no breast cancer themselves at enrollment (2003-2009). Race/ethnicity was self-identified and 25(OH)D and 24,25(OH)2D, a biomarker of vitamin D catabolism, were assessed using liquid chromatography/tandem mass spectrometry. We used multivariable-adjusted Cox proportional hazards models to estimate hazard ratios (HRs) and 95% confidence intervals (CIs).

RESULTS: Over a mean follow-up period of 9.2 years, women with blood 25(OH)D concentrations greater than the median level for the sub-cohort (22.6 ng/mL) had lower breast cancer rates than women with concentrations <22.6 ng/mL (HR=0.76, 95% CI: 0.59-0.97). The inverse association appeared stronger among non-Black Hispanic/Latina women (HR=0.55, 95% CI: 0.34-0.88) than among Black/African American women (HR=0.88, 95% CI: 0.66-1.17; p-for-heterogeneity=0.08). We did not see clear differences in the association by menopausal status, time since blood draw, or according to tumor characteristics. Neither 24,25(OH)2D nor the 24,25(OH)2D to 25(OH)D ratio were associated with breast cancer risk.

CONCLUSIONS: This prospective study provides further evidence that vitamin D may be inversely associated with breast cancer incidence in non-Black Hispanic/Latina and Black/African American women.

Keywords: Cancer and cancer precursors, Biomarkers of exposure, Environmental epidemiology, Environmental disparities, Molecular epidemiology



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

No increased cancer risk in male hunters in Northern Sweden after radiation exposure from the Chernobyl Nuclear Power Plant accident

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BACKGROUND AND AIM: Male hunters have slightly higher total cancer incidence versus male non-hunters in 9 Swedish counties after the Chernobyl Nuclear Power Plant (NPP) accident in 1986. The aim of this study was to investigate whether the contribution of absorbed dose from the Chernobyl fallout could have influenced the elevated cancer incidence, given that hunters have a higher internal radiation exposure due to consumption of game contaminated with ¹³⁷Cs.

METHODS: An algorithm was developed to calculate the total absorbed colon dose as a sum of external and internal absorbed colon dose. The time-integrated total absorbed colon dose was calculated individually for hunters (n=40 874) 1986-2015. Allowing for a 5-year latency period, the age-adjusted Incidence Rate Ratios (IRR) per milliGray (mGy) with 95% Confidence Intervals (CI) were calculated using Poisson regression for the follow-up period 1991-2015. A total of 8 964 cancer cases occurred in the hunter cohort to 31 December 2015. Pre-Chernobyl total cancer incidence in each of the counties was investigated as a potential confounding factor.

RESULTS: The mean colon dose was 2.39 mGy with more than half of the absorbed colon dose from internal ¹³⁴Cs and ¹³⁷Cs taken together. No specific cancer site showed a significant increased IRR per mGy. For total cancer the IRR per mGy was 0.995 (95% CI 0.988-1.003). The IRR did not change after adjustment for the pre-Chernobyl total cancer incidence.

CONCLUSIONS: Using the total colon dose as proxy for the whole body dose, no dose-dependent increased risk for cancer was observed in hunters, hence the elevated cancer incidence in hunters versus non-hunters could probably not be attributed to intake of ¹³⁷Cs contaminated game after the Chernobyl NPP accident. Future analyses will calculate individual organ absorbed dose and investigate dose-response relationship for those cancer sites.

Keywords: incidence, ionizing radiation, environmental epidemiology, exposure assessment, cancer and cancer precursors



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

Cancer risk following residential exposure to polychlorinated biphenyls in indoor air: A Danish register-based study

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BACKGROUND AND AIM: Polychlorinated biphenyls (PCBs) are biopersistent chemicals classified as human carcinogens, primarily based on evidence on higher-chlorinated PCBs found in food. The carcinogenic potential of lower-chlorinated PCBs (LC-PCBs) in indoor air remains largely unexplored. We investigated overall and site-specific cancers following residential exposure to LC-PCBs in indoor air.

METHODS: Cancer risk was examined in the Health Effects of Indoor Air (HESPAIR) cohort of 41,493 residents of two partly PCB contaminated estates in Greater Copenhagen, identified by nation-wide registries. PCB-exposure was defined by duration of living in a contaminated apartment and PCB measurements in indoor air in subsets of apartments [ng PCB_{total}/m³*year]. Cancer diagnoses were extracted from the Danish Cancer Registry for the follow-up period of 1970–2018. We estimated adjusted hazard ratios with time-varying exposure and a 10-year lag using Cox regression.

RESULTS: Living in a PCB-contaminated apartment was not associated with an elevated overall cancer risk. However, higher risks were seen for four out of 56 site-specific cancers; compared with residents exposed to <300 ng/m³*year, residents exposed to >3000 ng/m³*year had a higher risk of liver cancer (HR 2.91, 95% CI 1.33–6.38), pancreatic cancer (HR 1.59, 95% CI 0.96–2.63) and meningeal tumours (HR 3.89, 95% CI 2.07–7.30). For testis cancer, a higher risk was observed among residents exposed to 300–950 ng/m³*year relative to residents exposed to <300 ng/m³*year (HR 2.56, 95% CI 1.22–5.34), but the risk for testis cancer was not elevated for residents exposed to >950 ng/m³*year.

CONCLUSIONS: In this first population-based cohort study of residential exposure to LC-PCBs in indoor air, living in a PCB-contaminated apartment was not associated with a higher overall cancer risk. However, the results indicate that residents exposed to LC-PCBs indoors in their private homes have a higher risk of cancer of the liver, pancreas, testes and meningeal tumours.

Keywords: Built environment, Cancer and cancer precursors, Environmental epidemiology, Chemical exposures



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

The role of blood DNA methylation in smoking-related cancers

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BACKGROUND AND AIM: Smoking is a well-known carcinogen consistently associated with differential DNA methylation in diverse populations. Dysregulations of DNA methylation have been associated with lung cancer. Smoking and lung cancer are common among many indigenous communities of the United States, leading to health disparities. This study investigated the potential mediating role of DNA methylation changes in the association of smoking with incident smoking-related cancers. **METHODS:** DNA methylation was measured in blood collected at baseline (1989-1991) using the EPIC 850K platform in 2351 American Indian participants of the Strong Heart Study. Cancer incidence was available through 2017 (97 cases for lung cancer, 222 cases for a combined smoking-related cancer endpoint including lung, esophageal, stomach, colorectal, liver, pancreatic and kidney cancers). Iterative Sure Independence Screening paired with adaptive elastic-net was used to select differentially methylated CpGs associated with cancer. Mediation analysis using Aalen additive hazard models was then applied to the selected CpGs.

RESULTS: A total of 71 CpGs were associated with lung cancer and smoking-related cancer. For lung cancer, we found significant mediated effects for seven CpGs for current versus former or never smoking, and for eight CpGs for cumulative smoking. For smoking-related cancers, we found significant mediated associations for eight CpGs for current versus former or never smoking, and for one CpG for cumulative smoking. CpGs annotated to the AHRR and the PRSS23 genes (well-known smoking-related genes in DNA methylation studies), showed up to 70 % and up to 48 % of relative mediated effects, respectively, without accounting for multiple mediation.

CONCLUSIONS: Our study provides strong evidence that a large extent of the association of smoking with smoking-related cancers, especially in lung cancer, can be explained by differential DNA methylation changes in well-known smoking related genes. Replication is ongoing in the Framingham Heart Study and the Rotterdam Study.



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Keywords: Smoking, DNA methylation, cancer, American Indians

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Cancer and Cancer-Precursors » Incidence

Long-term atmospheric exposure to PCB153 and breast cancer risk in a case-control study nested in the French E3N cohort

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BACKGROUND AND AIM: Although the genetic and hormonal risk factors of breast cancer are well identified, they cannot fully explain the occurrence of all cases. Epidemiological and experimental studies have suggested that exposure to environmental pollutants, especially those with potential estrogenic properties, as polychlorinated biphenyls (PCBs) may have a role in breast cancer development. We aimed to estimate the association between cumulative atmospheric exposure to PCB153 and breast cancer risk.

METHODS: We conducted a case-control study of 5,222 cases and 5,222 matched controls nested within the French E3N cohort from 1990 to 2011. Annual atmospheric PCB153 concentrations were simulated with the deterministic chemistry-transport model (CHIMERE) and were assigned to women using their geocoded residential history. Their cumulative PCB153 exposure was calculated for each woman from their cohort inclusion to their index date. Breast cancer odds ratios (ORs) associated with cumulative PCB153 exposure and their 95% confidence intervals (95% CI) were estimated using multivariate conditional logistic regression models.

RESULTS: Overall, our results showed a statistically significant linear increase in breast cancer risk related to cumulative atmospheric exposure to PCB153 as a continuous variable (adjusted OR=1.19;



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95% CI: 1.08-1.31 for an increment of one standard deviation among controls (55 $\mu\text{g}/\text{m}^3$). Among women who became postmenopausal during follow-up, the association remained statistically significant (adjusted OR=1.23; 95% CI: 1.09-1.39). In analyses by hormone receptors status, the positive association remained significant only for ER-positive breast cancer (adjusted OR=1.18; 95% CI: 1.05-1.33).

CONCLUSIONS: This study is the first to have estimated the impact of atmospheric exposure to PCB153 on breast cancer risk. Our results showed a statistically significant increase in breast cancer risk, which may be limited to ER-positive breast cancer. Further studies are needed to confirm these findings.

Keywords: Polychlorinated biphenyls, Air pollution, Breast cancer, Residential history, Nested case-control



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

Traffic-related air pollution and breast cancer risk: a systematic review and a meta-analysis of observational studies

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BACKGROUND AND AIM: Association of breast cancer risk with air pollution exposure, in particular pollution emitted by traffic exhaust has been investigated but current epidemiological evidence remains inconclusive and methodologies of exposure assessment varied. To systematically review the scientific literature on breast cancer risk and indicators of traffic-related air pollution, e.g. distance from roadways or traffic volume of nearby roadways as well as pollutants from motor vehicle emission and provide meta-analytic estimates of the association between breast cancer and exposure to nitrogen oxides (NO_x) and nitrogen dioxides (NO₂), the main markers of traffic.

METHODS: We systematically reviewed the literature on exposure to traffic-related air pollution and breast cancer risk and conducted a random-effects meta-analysis of observational studies investigating the association between exposure to NO₂ and NO_x and breast cancer risk.

RESULTS: We reviewed six case-control and 11 cohort studies that used different exposure assessment methods and time periods of traffic emissions. While, individual studies provided little evidence of an association between different indicators of traffic-related air pollution and breast cancer risk, the meta-analysis on NO₂ (based on three case-control and seven cohort studies) indicated a borderline association (pooled relative risk, RR per 10 µg/m³ of NO₂: 1.01; 95% confidence interval, CI: 1.00, 1.03; p=0.03). No significant association between NO_x and breast cancer was found on the basis of three cohorts (RR: 1.02; 95%CI: 0.99, 1.05; for an increase of 10 µg/m³ of NO_x).

CONCLUSIONS: Since traffic is the major contributor to NO₂ concentration and is responsible for high concentration observed near busy roads, our findings suggest that traffic-related air pollution is likely to increase breast cancer incidence and to provide additional support for the carcinogenicity of air pollution.

Keywords: Breast cancer, epidemiology, air pollution, traffic, nitrogen dioxides, meta-analysis



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

Identifying predictors of cancer prevalence at the neighborhood level in the United States: A Bayesian machine learning approach

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BACKGROUND AND AIM: Cancer is the second leading cause of death in the United States (US). Individual-level factors including utilization of prevention, health behaviors, environmental exposure, and sociodemographic measures have been linked to individual-level cancer risks. However, risk factors of cancer at the neighborhood level remain understudied. To fill this research gap, we identify and rank important predictors of cancer prevalence at the neighborhood level in the US.

METHODS: We developed a new neighborhood dataset by combining data from the Population Level Analysis and Community Estimates (PLACES), a dataset with population health data across all the US census tracts (n=72,337), with environmental exposure data from the Environmental Justice Screening database and sociodemographic factors from the American Community Survey. Our outcome of interest was tract-level adult cancer prevalence. We included 23 tract-level explanatory variables, including unhealthy behaviors (e.g., smoking, no leisure-time physical activity, drinking), prevention measures (e.g., cholesterol screening), environmental exposures (e.g., air toxics, lead paint), and sociodemographic factors (e.g., racial and ethnic composition, poverty, age 65 years and over). We used Bayesian additive regression trees (BART) to identify the most important predictors of cancer prevalence.

RESULTS: The median prevalence of adults diagnosed with cancer was 6.7% (interquartile range: 5.4%-7.7%) across US census tracts. Based on local threshold criteria, we identified the five most important predictors of cancer prevalence: percentage of adults 65 years old or over, prevalence of routine checkup, percentage of non-Hispanic white, percentage of housing built before 1960, and percentage of individuals below the lower poverty level.

CONCLUSIONS: Using an integrated neighborhood dataset with fine geographic resolution and a machine learning approach, we identified several important predictors of cancer prevalence at the neighborhood level in the US. The results may inform public health practitioners and policymakers to prioritize the improvement of environmental and neighborhood factors in reducing cancer burden.

Keywords: Cancer, Neighborhood-level analysis, Environmental exposures, Big data, Bayesian additive regression trees



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

The impact of socio-economic and environmental factors on the spatial patterns of cancer incidence in Israel: A registry-based cohort study

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BACKGROUND AND AIM: Spatial methods usually used to identify geographical health risk differences. Only a few studies used semi-individual latent multi exposure approach, to investigate the socioeconomic and environmental factors that explain cancer risk spatial patterns. Our aim is to evaluate spatial clusters of cancer and to determine the impact of both socioeconomic and environmental factors on the spatial patterns of cancer incidence in Israel by applying generalized additive models (GAMs).

METHODS: The current study is a registry-based cohort study. The data include the 1995 Israeli Central Bureau of statistics census (N=1,066,714) linked to the Israeli Cancer Registry data. In addition, ambient exposures were determined including: particulate matter with a diameter size that is equal to or smaller than 2.5µm, normalized difference vegetation index derived from satellite data, nitrogen oxides. We first used the global and local Morans' I in order to identify cancer incidence clusters.

RESULTS: During 17 years of follow-up (1998-2015) there were 62,049 new cancer cases among 1,022,637 participants in the 1995 census. Cancer incidence were clustered by geographical area (global Moran's I Index =0.054, p-value<0.000). Cancer clusters were located mainly in the northern district of Israel (surrounding Haifa region) and in the center part of Israel (surrounding Tel-Aviv region).

CONCLUSIONS: The spatial clusters of cancer incidence in Israel can be attributed to socioeconomic and environmental risk factors. Further analysis will be conducted to evaluate the spatial associations with the socioeconomic and environmental factors using spatial modeling.

Keywords: socio-economic factors, environmental epidemiology, spatial statistics, particulate matter, cancer incidence, green space



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

Spatial clustering of adult cancer prevalence in the United States

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BACKGROUND AND AIM: Understanding the geographic distribution of cancer prevalence at neighborhood level may help guide cancer control and prevention measures from the perspective of neighborhoods, as opposed to individuals. We examined the spatial heterogeneity of cancer prevalence across census tracts in the contiguous United States.

METHODS: We previously identified predictors of census tract-level cancer prevalence by applying Bayesian additive regression trees to a combined database of tract-level population health, environmental exposure, and socioeconomic data from multiple sources. In this study, we examined the association between the selected predictors (percentage of adults 65 years old or over, prevalence of routine checkup, percentage of non-Hispanic white, percentage of housing built before 1960, and percentage of individuals below poverty) and cancer prevalence using a linear regression model. Spatial clustering were identified based on weighted normal scan statistics (SatScan V9.7) using the tract-level cancer prevalence and the regression residuals, respectively, with the population for aged \geq 65 years as the weight.

RESULTS: The mean cancer prevalence was 6.7% (standard deviation 1.8%). Using cancer prevalence, we identified 4 circular-shaped high-risk clusters in Florida (Latitude Longitude and radius: 27.817765 N 81.396327 W, 216km), Arizona (33.631195 N 112.350663 W, 9km), New Jersey (39.958259 N 74.345696 W, 11km), and a region encompassing parts of Michigan, Ohio, Pennsylvania, and New York (43.268491 N 78.823785 W, 468km). Their estimated cancer prevalence was 8.1%, 10.1%, 13.8%, and 7.3%, respectively. Using residuals, we identified one dominant high-risk region covering parts of Montana, Wyoming, North Dakota, South Dakota, Nebraska, Minnesota, and Iowa (47.723678 N 104.100726 W, 1834km), and four smaller clusters (radius <20km) in Florida and Maryland.

CONCLUSIONS: Variations in high-risk clustering patterns based on prevalence and residual values suggest that the identified five predictors can explain much of the initial variation in tract-level cancer prevalence. However, the high-risk regions based on residuals require further investigation.

Keywords: Cancer prevalence, United States, Geospatial analysis, Cancer high-risk clusters



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Cancer and Cancer-Precursors » Other (to be specified with keywords in the keywords section)

Greenness Exposure in Relation to Residing in Areas of High Colorectal Cancer in Kentucky

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BACKGROUND AND AIM: Colorectal cancer (CRC) is the third most common in the US. Natural vegetation exposure, also called greenness, is associated with CRC risk-reducing behaviors like lower BMI and increased physical activity. Studies concerning greenness and CRC are sparse. The aims were to identify high-incidence clusters for CRC in Kentucky and examine the relationship between residential greenness and residing in areas of high CRC incidence. We hypothesize that lower greenness is associated with living in areas of higher CRC incidence.

METHODS: We calculated age-standardized CRC rates from the 1995-2018 Kentucky Cancer Registry. Spatial cluster analyses identified CRC hotspot census tracts. The Normalized Difference Vegetation Index (NDVI) is a commonly used measure of greenness. Residential addresses of CRC cases diagnosed between 1996-2015 (n=49,540) were linked to 5-year average NDVI before diagnosis and to census tract estimates of socioeconomic factors and rural-urban designations. Logistic regression analyses were used to estimate odds ratios (ORs) and 95% confidence intervals (CI) for a standard deviation increase in NDVI in relation to residing in a CRC hotspot, adjusting for demographic, socioeconomic, and lifestyle factors. We assessed effect modification by urbanicity.

RESULTS: Residential greenness was inversely associated with odds of residing in a CRC hotspot (OR=0.48, 95%CI 0.45, 0.50), adjusting for demographics, marital status, insurance, family history, smoking, physical inactivity, obesity, and neighborhood economic factors. The association was modified by urbanicity with urban cases (adjusted OR 0.52 95%CI 0.49, 0.56) having lower odds of residing in a hotspot with one standard deviation increase in NDVI than rural cases (adjusted OR=0.68 95%CI 0.57-0.80) adjusting for aforementioned factors.

CONCLUSIONS: Residential greenness was inversely associated with residing in a CRC hotspot. Individuals in urban areas may experience a greater reduction in CRC risk from greenness exposure than individuals in rural areas. More robust epidemiologic studies should evaluate greenness and colorectal cancer incidence.

Keywords: green space, cancer and cancer precursors, environmental epidemiology



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Incidence

Urinary parabens and breast cancer risk: Modification and interaction by LINE-1/LUMA methylation in the Long Island Breast Cancer Study Project

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BACKGROUND AND AIM: Parabens, ubiquitous endocrine disrupting chemicals used in personal care products, may interact with DNA methylation status to impact breast cancer (BC) risk. We examined whether global DNA methylation modifies or interacts with paraben levels to impact BC risk and whether paraben levels are associated with tumor gene-specific promoter methylation in 12 BC-related genes.

METHODS: Participants included 708 cases and 598 controls from the population-based Long Island Breast Cancer Study Project. Levels of methyl-/propyl-/butyl-parabens and Σ parabens were measured in spot urine samples, creatinine-corrected, and dichotomized at the 80th percentiles. Global DNA methylation status (methylated vs. unmethylated) was measured in peripheral blood using LINE-1 and LUMA. Among 509 cases, the promoter methylation status of 12 BC-related genes was measured in tumor samples. For effect measure modification, we used logistic regression to estimate covariate-adjusted odds ratios (aORs) and 95% confidence intervals (CIs) for the associations between paraben levels and BC stratified by LINE-1/LUMA methylation status. For additive interactions, we used logistic regression to estimate aORs and CIs for the joint associations between paraben levels and LINE-1/LUMA methylation status and BC. To examine outcome heterogeneity, we used multinomial logistic regression to estimate aORs and CIs for the associations between paraben levels and gene-specific promoter methylation status (unmethylated cases vs. controls; methylated cases vs. controls).

RESULTS: Propylparaben levels >80th (vs. \leq 80th) percentile were associated with a 50% increase in the odds of having a methylated APC promoter than being a control (aOR=1.50, 95%CI=1.02-2.20), but not with having an unmethylated APC promoter than being a control (aOR=0.94, 95%CI=0.63-1.42). LINE-1/LUMA did not modify the associations between parabens and BC and did not interact with parabens to increase BC risk.

CONCLUSIONS: Exposure to parabens may increase the risk of BC with methylated promoter regions of APC, a tumor suppressor gene and regulator of the WNT signaling pathway.

Keywords: Breast cancer, parabens, endocrine disrupting chemicals, DNA methylation, gene promoter methylation



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ABSTRACT E-BOOK



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Chemical exposures » Phenols

Higher quality maternal diet attenuates negative associations of maternal paraben concentrations with newborn weight and length

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BACKGROUND AND AIM: We and others previously observed sex-specific negative associations of maternal paraben concentrations with birth weight (BW) and length (BL). Here, we evaluated whether maternal diet quality modifies these associations.

METHODS: Pregnant women ages 18-40 years from Champaign-Urbana, IL provided 5 first-morning urines across pregnancy, which we pooled for analysis of butylparaben, ethylparaben, methylparaben, and propylparaben concentrations. We collected BW and BL data within 24hrs of birth and calculated sex-specific BW-for-gestational-age z-scores (BWz). Women completed 3-month semi-quantitative food frequency questionnaires in early and mid-to-late pregnancy, which we used to calculate mean Alternative Healthy Eating Index 2010 (AHEI-2010) – reflecting foods predictive of chronic disease risk. Multivariable linear regression models evaluated whether associations of parabens with BWz (n=403) and BL (n=429) were modified by AHEI-2010 (dichotomized at the median) and whether the modification varied by fetal sex. We modeled ethylparaben, methylparaben, and propylparaben as continuous variables and butylparaben as zero/non-zero.

RESULTS: This predominately non-Hispanic white, college-educated population had lower urinary paraben concentrations than other U.S. women. Median (range) AHEI-2010 was 55.8 (28.1–82.8) out of 110, while BW and BL were 3.5 kg (2.2–4.9) and 50.0 cm (43.9–55.9), respectively. Associations of parabens with birth size only emerged in female newborns whose mothers consumed a poorer diet (AHEI-2010<median). In these newborns, each 2-fold increase in maternal methylparaben was associated with 0.1 (95%CI: 0.02, 0.2) lower BWz and 0.2 cm (95%CI: 0.02, 0.3) shorter BL, with similar associations observed for propylparaben. Similarly, female newborns of women who ate a poorer diet and had non-zero butylparaben concentrations had 0.4 (95%CI: 0.1, 0.8) lower BWz and 0.9 cm (95%CI: 0.1, 1.6) shorter BL than women with zero butylparaben concentrations.

CONCLUSIONS: Healthier maternal diets may effectively minimize the negative associations between parabens and birth size in female newborns. Additional studies in more diverse populations are needed to confirm these findings.

Keywords: Birth outcomes, endocrine disrupting chemicals, phenols



ABSTRACT E-BOOK

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Chemical exposures » Phenols

Associations Between Gestational Environmental Phenols and Preterm Birth; a Nested Case-Control Study

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BACKGROUND AND AIM: Studies report associations between environmental phenols exposure and preterm birth (PTB). There is significant racial disparity in PTB rates yet little data to characterize the effects of phenol exposure by race. To begin to address this data gap we conducted a case-control pilot study, nested within a larger U.S. investigation.

METHODS: We enrolled 26 women with a PTB (<37 weeks completed gestation) and 26 women with a term delivery, matched by race (non-Hispanic Blacks and non-Hispanic whites). Participants provided urine specimens at 18-22 weeks gestation, completed a questionnaire, and allowed access to hospital records. We measured ten environmental phenols in urine, including methyl- (MP), ethyl- (EP), propyl- (PP), and butylparabens (BP), benzophenones 1 (BZP-1) and 2 (BZP-2), pentachlorophenol, triclosan, and bisphenols A (BPA) and S (BPS), using liquid chromatography-tandem mass spectrometry. After specific gravity correction, we estimated associations between environmental phenols and PTB using logistic regression, adjusted for race, age, body mass index, and education. We tested interactions by race.

RESULTS: Urinary BZP-1 (difference=12.01 ng/mL; P=0.001) and BZP-2 (difference=162.24 ng/mL; P=0.01) concentrations were greater among whites, and pentachlorophenol (difference=0.40 ng/mL; P=0.01) and BPS (difference=0.40 ng/mL; P=0.01) were greater among Blacks. Higher urinary BP was associated with greater odds of PTB (odd ratio (OR)=1.32; 95%CI:0.95-2.43), while higher urinary BZP-1 (OR=0.96; 95%CI:0.91-0.99), pentachlorophenol (OR=0.62; 95%CI:0.18-2.01), triclosan (OR=0.98; 95%CI:0.97-0.99), and BPS (OR=0.75; 95%CI:0.35-1.47) were associated with lower odds of PTB, although some confidence intervals were imprecise. We detected an interaction for race (P=0.08), such that Blacks had lower PTB odds (OR=0.70; 95%CI:0.29-1.02) than whites (OR=0.97; 95%CI:0.92-1.00) in association with higher BZP-1.

CONCLUSIONS: In this pilot study, exposure to environmental phenols differed by race and individual phenols demonstrated variable associations with PTB risk. It does not appear that exposure to environmental phenols was associated with a greater risk of PTB in either Black or white mothers.

Keywords: Phenols, Environmental disparities, birth outcomes



ABSTRACT E-BOOK

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Air pollution » Other (to be specified with keywords in the keywords section)

Residential proximity to emissions of dioxins and furans and risk of breast cancer in the Sister Study cohort

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BACKGROUND AND AIM: Few studies have investigated the relationship between ambient polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F) and risk of breast cancer. We evaluated associations between proximity-based residential exposure to industrial emissions of PCDD/F and breast cancer risk in a U.S. cohort.

METHODS: Sister Study participants, who have a sister with breast cancer but no history of breast cancer themselves at enrollment, were followed for incident breast cancer. PCDD/F exposures were estimated using a historical U.S. Environmental Protection Agency database of 4,478 facilities (>85% of PCDD/F air emissions) and their toxic equivalency quotient (TEQ) emissions. After restricting to participants with at least 10 years of continuous residential history prior to enrollment (2003-2009; n=34,103), we generated 10-year distance- and TEQ-weighted average emissions indices (AEI [g TEQ/km²]) within 3, 5, or 10km of participants' residences, overall and by facility type. Cox regression was used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for the association between AEI (dichotomized, quartiles) and risk of breast cancer (invasive or ductal carcinoma in situ). Models were adjusted for breast cancer risk factors and residential outdoor air pollutants. We evaluated whether associations differed by smoking status and tumor estrogen receptor (ER) status.

RESULTS: There were 2,583 incident breast cancer cases over a median of 11 years of follow-up. We found an increased risk of breast cancer associated with AEI exposure within 3km (HR Q4.vs.0:1.19, 95% CI: 1.00,1.42, P_{trend}=0.03). The relationship was stronger for exposure to emissions from municipal solid waste facilities (HR ≥median.vs.0:1.46, 95% CI: 0.96,2.24; P_{trend}=0.08) and among former smokers (HR Q4.vs.0: 1.46, 95% CI: 1.14,1.87, P_{trend}=0.004), but did not differ by ER status (P_{heterogeneity}=0.47). No associations were observed for the AEI at 5 or 10km.

CONCLUSIONS: Our findings suggest that increased residential exposure to PCDD/F emissions may confer a higher risk of breast cancer.

Keywords: air pollution, chemical exposures, long-term exposure, cancer and cancer precursors, female, environmental epidemiology



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ABSTRACT E-BOOK



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Chemical exposures » Phthalates

Phthalate metabolite exposure during pregnancy and risk of preeclampsia in an ethnically diverse nulliparous pregnancy cohort in the United States

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BACKGROUND AND AIM: Preeclampsia is a serious pregnancy complication and a leading cause of maternal mortality and morbidity. Here we examine exposure to phthalate metabolites during pregnancy and preeclampsia risk in an ethnically diverse nulliparous pregnancy cohort.

METHODS: 572 cases of preeclampsia and controls individually matched by site, date of child birth, and child sex from the Nulliparous Mothers To Be Study cohort study were included. Up to three urine specimens (one per trimester) for each woman (total = 1621 samples) were analyzed for 16 phthalate metabolites. Phthalate metabolites were adjusted for specific gravity (SG); concentrations below the limit of detection (LOD) values were replaced with LOD/√2. Metabolite exposure for each woman was calculated as the geometric mean of the values in each trimester. We divided phthalate metabolite concentrations into quartiles. Multivariate conditional logistic regression analyses were performed to examine the associations between phthalate metabolites in pregnancy and preeclampsia, adjusting for confounders identified using a DAG. Race/ethnicity and infant sex were considered a priori effect modifiers.

RESULTS: 52.1% of the women were non-Hispanic white, 21.3% were non-Hispanic black, 16.8% were Hispanic, and 9.8% were of Other race. Associations differed by both infant sex and race/ethnicity. In general, the odds of preeclampsia were reduced in mothers of boys with exposure to MCINP, MEHHP, MEHP, MEOHP, and DEHP. Patterns of association were more variable in mothers of infant girls. In non-Hispanic black women, most phthalate metabolites trended towards increased odds of preeclampsia. Hispanic women had increased odds of preeclampsia for MECPP. Non-Hispanic white women had increased odds of preeclampsia for MBZP and decreased odds of preeclampsia for MCOP.

CONCLUSIONS: Associations between phthalate exposure during pregnancy and preeclampsia show distinct differences by infant sex and by race/ethnicity, suggesting that interventions to reduce exposure be tailored for distinct groups.

Keywords: Phthalates, Pregnancy outcomes, Environmental epidemiology



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Chemical exposures » Phthalates

Phthalate Exposure Across Pregnancy: Can We Use a Single Measure to Stand in for Exposure?

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BACKGROUND AND AIM: Exposure to non-persistent chemicals remains difficult to assess, as spot samples only reflect exposure in a short time frame. Often researchers will only have a single spot sample to estimate exposure across pregnancy and to estimate associations with outcomes in the infant and child. Using a large nationally representative birth cohort with measures of phthalate metabolites across pregnancy, we evaluate whether these measures are reliable across pregnancy. **METHODS:** In a cohort of 2,040 nulliparous women, we measured 16 urinary phthalate metabolites up to three times during pregnancy (each trimester). We assessed reliability of the metabolite concentrations during pregnancy in two ways: using the intraclass correlation coefficient and using Spearman correlation coefficients.

RESULTS: Over 70% of samples had values less than the limit of detection for MCOH, MHNCH, MINP and MCIOP, and they will not be considered in these calculations. For the other metabolites, the ICCs between adjacent trimesters ranged from values close to zero for DEHP metabolites to moderate values (e.g., 0.3 to 0.6) for MiBP and MBzP. In contrast, Spearman correlations coefficients were expectedly uniformly higher, and ranged from 0.2 to 0.7; MiBP and MBzP had the highest values of the Spearman correlation coefficients.

CONCLUSIONS: Spot measure of phthalate metabolites during pregnancy likely do not reflect exposure and should not be used to estimate associations between 'timing of exposure' and health outcomes. Even for measures taken in adjacent trimesters, the values of the ICCs were low, possibly reflecting different patterns of product use during pregnancy. Values of Spearman correlation coefficients were somewhat higher (although still in the moderate to good range) and reflect the rank ordering of exposure in these women. We urge caution in interpreting results from studies which have one (or even two) measures of these metabolites.

Keywords: Phthalates, Pregnancy outcomes, Environmental epidemiology



ABSTRACT E-BOOK

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Chemical exposures » Phthalates

Exposure to phthalates in relation to sleep duration and social jetlag among adolescent boys and girls in Mexico City

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BACKGROUND AND AIM: Emerging research has demonstrated the importance of environmental toxicants, such as phthalates, for sleep health, as they may disrupt neuronal sleep regulation circuitry. However, the impact of high-molecular-weight (HMW) versus low-molecular-weight (LMW) phthalates remains unknown. Among Mexican adolescents, we evaluated the association between exposure to HMW and LMW phthalates with sleep duration and social jetlag (a circadian marker that measures the discrepancy between weekend and weekday sleep duration).

METHODS: Participants included 413 adolescents from the Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) study. In 2015, urinary concentrations of 13 phthalates were measured from spot urine samples, and sleep duration was assessed with wrist-actigraph devices over 7 consecutive days. We examined associations between phthalates with mean weekday and weekend sleep duration and social jetlag using linear regression models, adjusted for specific-gravity, sex, age, BMI z-score, total energy intake, caffeine intake, and physical activity.

RESULTS: The mean (SD) age was 15.6 (2.0) years; 53.5% were girls. The mean (SD) sleep duration was 8.4 (1.2) hr/night on weekdays and 9.0 (1.3) hr/night on weekends. In adjusted models, each IQR increase in the HMW phthalate, mono-(2-ethyl-5-oxohexyl) phthalate was associated with a 13.3 minute (95%CI: -26.3, -0.41; $p < 0.05$) lower social jetlag, and each IQR increase in mono-benzyl phthalate was associated with an 8.0 minute (95% CI: -16.8, -0.72; $p < 0.05$) shorter sleep duration on weekends. Among LMW phthalates, we found that each IQR increase in monoethyl phthalate was associated with an 8.6 minute (95% CI: -17.9, -0.63; $p < 0.05$) shorter sleep duration on weekends and a 15.3 minute (95% CI: -29.0, -1.6; $p < 0.05$) lower social jetlag.

CONCLUSIONS: In contrast to other literature, higher phthalate exposure was related to shorter weekend sleep duration and lower social jetlag among Mexican adolescents, sleep characteristics that may be indicative of better sleep health.

Keywords: phthalates; environmental epidemiology; adolescent sleep health; social jetlag, sleep duration, wrist-actigraphy



ABSTRACT E-BOOK

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Chemical exposures » Phthalates

DEHP in house dust in relation to housing characteristics in the CHILD Cohort Study

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BACKGROUND AND AIM: Di-(2-ethylhexyl) phthalate (DEHP), a widely used plasticizer, is ubiquitous in indoor environments. DEHP was the most prevalent phthalate measured in house dust in the CHILD Cohort, and was found to be associated with increased risk of childhood asthma in our recent case-cohort sub-analysis. Our aim was to identify possible sources of DEHP in dust in this cohort.

METHODS: CHILD is a multi-center Canadian birth cohort study. DEHP levels were measured in house dust samples collected at age 3-4 months. Housing characteristics were assessed by Research Assistants at the time of dust collection and families completed an environment-related questionnaire. Using dust data from 726 homes involved in the case-cohort study, factors such as vinyl flooring, vinyl furniture and mattress coverings were investigated as potential indicators of DEHP sources. Mass-based DEHP concentrations were log-transformed and multivariable linear regression models were used to assess the associations, controlling for possible confounders such as household income and age of home.

RESULTS: The quantity of vinyl/plastic furniture in homes was significantly associated with DEHP concentration. Higher DEHP concentrations were observed in homes with older flooring (> 3 years) in the mother's bedroom. Homes with vinyl flooring in both the kitchen and bathroom showed higher levels of DEHP on average than those without vinyl flooring but the effect decreased after adjusting for the age of home as a proxy for unmeasured related confounders. The presence of mold, suggestive of dampness, was also associated with higher DEHP concentrations. No significant difference in DEHP concentrations in dust was observed between homes with and without mattress covering on children's beds.

CONCLUSIONS: DEHP in house dust is associated with specific housing characteristics. These findings could provide guidance to the public on the choice of building materials and furnishings, as well as in the development of policies, aimed at improving the indoor environment.



ABSTRACT E-BOOK

Keywords: phthalates, children's environmental health, endocrine disrupting chemicals, chemical exposures, built environment

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Chemical exposures » Phthalates

Targeting the contribution of cosmetics brands to phthalate gestational exposure among Puerto Rican women in the PROTECT cohort

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BACKGROUND AND AIM: Puerto Ricans are a highly exposed population to chemical substances from multiple sources, including personal care products. Our study, the Puerto Rico Testsite for Exploring Contamination Threats (PROTECT), has shown higher urinary phthalate levels among pregnant participants compared to women of reproductive age in the US. Pregnancy is a vulnerable time for the woman and the developing fetus. The contribution of cosmetics to phthalate levels has not been studied in Puerto Rico. Cultural context may influence access to healthier care products triggering an additional exposure burden for underrepresented populations. We examined urinary phthalate levels among PROTECT participants and frequency-specific cosmetic brand usage.

METHODS: Use of personal care products was collected by interviewer-administered questionnaire at three separated times during pregnancy and phthalate urinary biomarkers were collected at the same time for a cohort of 1498 participants. Non-parametric (Mann-Whitney U Test and Kruskal Wallis Test) statistics were used to detect differences in median phthalate concentrations among groups and to detect differences among brands. Linear regression was used to compared phthalate levels by frequency of cosmetic usage.

RESULTS: Overall, 78% of participants reported daily use of cosmetics, but usage declined from the first to the third visit. Daily users had higher levels of the metabolite mono-ethyl phthalate (MEP) compared to monthly, weekly, or no usage ($p < 0.05$). For all three visits, the median concentration of MEP was higher in those participants that used cosmetics compared did not. From the 76 brands reported in our cohort, six brands were used by 63% of participants. Among that group, MEP concentrations varied by cosmetics brand and those differences were statistically significant.

CONCLUSIONS: Cosmetic use during pregnancy is ubiquitous among PROTECT participants and their use appear to contribute to the phthalate burden during pregnancy. Results of this study could enhance risk assessments targeting pregnant women and consumer product use.



ABSTRACT E-BOOK

Keywords: Phthalates, Females, Exposures

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Chemical exposures » Phthalates

Phthalates and pyrethroids in infants and toddlers: concentrations, stability of repeat measures, and predictors of exposure

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BACKGROUND AND AIM: Determinants of phthalate and pyrethroid exposures are not well understood in early life, a period of rapid brain development with heightened vulnerability to toxicant exposure. Our aims were to characterize concentrations, stability, and predictors of phthalate and pyrethroid metabolites in infants and toddlers.

METHODS: We included a subset of participants in the UNC Baby Connectome Project, who provided ≥ 1 urine sample(s) between birth and 77-months. We measured 8 phthalate and 4 pyrethroid metabolites in pediatric urines. At baseline, mothers completed an environmental questionnaire on household and personal care product usage and behaviors, during-and after-pregnancy. We calculated descriptive statistics of specific gravity unadjusted (Unadj) and adjusted (Adj) phthalate concentrations, estimated intraclass correlation coefficients (ICCs), and built predictive models. Detection frequencies of any pyrethroid metabolites and their Kappa statistics were calculated.

RESULTS: 62 children provided 125 urine samples, with near-ubiquitous detection of all phthalate metabolites (95%). Median concentrations were highest for monobutyl phthalate (MBP; Unadj: 15.35ug/L; Adj: 5.30ug/L), followed by mono-isobutyl phthalate (MiBP; 11.50ug/L; 4.59ug/L) and monobenzyl phthalate (MBzP; 4.03ug/L; 1.56ug/L). ICCs were higher for MBzP (0.58 [0.39, 0.72]; 0.46 [0.24, 0.63]) as compared to MBP (0.29 [0.05, 0.50]; 0.17 [-0.24, 0.53]) or MiBP (-0.05 [-0.29, 0.20]; 0.12 [-0.13, 0.35]). In the subset of first urine samples with questionnaire data (n=45), 54.86% of the variability in log(MBzP) was explained by specific gravity, pets, household/personal/child care product, income, pregnancy cosmetics use, race/ethnicity, pesticide use in and around the home, and infant birthweight. Besides specific gravity, having cat and dog in household was the strongest determinant. Any pyrethroid metabolites were detected in 35.2%, with a high agreement between second and third samples (0.86 [0.60, 1.00]) but not between other piecewise-comparisons.

CONCLUSIONS: Phthalates, but not pyrethroids, were commonly detected during early childhood. MBzP had moderate ICCs and was partially explained by pets and household/personal care product preferences.



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ABSTRACT E-BOOK

Keywords: Phthalates, pyrethroids, infants, toddlers, predictors



ABSTRACT E-BOOK

P-299

Chemical exposures » Phthalates

Hormone concentrations mediate the associations between exposure to phthalate mixtures and preterm birth

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BACKGROUND AND AIM: Mixtures of phthalate compounds can be found in many consumer products, resulting in widespread human exposure. Previous work has suggested that phthalates display endocrine disrupting capabilities that may differ based on molecular weight of the parent compound, and are associated with preterm birth (PTB). Given the importance of hormone regulation during pregnancy, we hypothesized that phthalates may affect the timing of labor via disruption of hormone concentrations. We aimed to assess the mediating effects of hormone concentrations on the associations between phthalate mixtures and timing of delivery.

METHODS: Urinary phthalate metabolite measurements were repeated up to 3 times, and serum hormone measurements up to 2 times, during mid-gestation, among 1011 women in the PROTECT (Puerto Rico Testsite for Exploring Contamination Threats) longitudinal birth cohort. We utilized ridge regression as a shrinkage and variable selection tool to create phthalate environmental risk scores (ERS) at each study visit for both low and high molecular weight (LMW, HMW) compounds, which represent a weighted sum of each individual's exposure to the mixture of metabolites. Causal mediation analyses were then conducted on a subset of 705 women for whom hormone data was available.

RESULTS: First visit testosterone and ft4 mediated 17.2% and 10.2%, respectively, of the association between LMW phthalate ERS and spontaneous PTB. When analyses were stratified by fetal sex, the association between LMW phthalate ERS and spontaneous PTB was mediated by CRH (28.8%), progesterone (17.6%), and testosterone (30.6%) among only pregnancies with a male fetus. Third visit CRH also mediated 38.3% of the association between HMW phthalate ERS and reduced gestational age at birth among only male fetuses. There were no significant mediating results observed for mothers carrying a female fetus.

CONCLUSIONS: These results provide introductory evidence of hormone disruption on the causal pathway between phthalate exposure and preterm birth.

Keywords: endocrine disrupting chemicals, birth outcomes, mixtures analysis, mediation analysis



ABSTRACT E-BOOK

P-300

Air pollution » Mixtures

Health Effects of Air Pollutant Mixtures on Overall Mortality Among the Elderly Population Using Bayesian Kernel Machine Regression (BKMR)

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BACKGROUND AND AIM: It is well documented that air pollutants are associated with a range of adverse health outcomes. In reality, humans are exposed to multiple pollutants that are likely highly correlated with each other. However, the majority of the existing research has primarily focused on the health effect of a single pollutant, partially because we lack the methodology to evaluate the complicated relationship of mixture exposures.

METHODS: We collected the health data of 1,406,185 Medicare enrollees residing in North Carolina, South Carolina, and Georgia through the Centers for Medicare and Medicaid Services. Ambient PM_{2.5}, O₃, and NO₂ concentrations, derived from a well-validated ensemble machine learning model, were assigned to individuals based on their ZIP codes. We assessed the individual and joint effect of air pollutant mixtures (PM_{2.5}, O₃, and NO₂) on all-cause mortality by applying a novel mixture modeling approach, Bayesian Kernel machine regression (BKMR).

RESULTS: We observed a statistically significant adverse effect of the multi-pollutant mixture (PM_{2.5}, O₃, and NO₂) on overall mortality. We found significant evidence for the association between PM_{2.5} and increased mortality on the population level in this study; the positive association with mortality appears stronger at lower percentiles of other pollutants. An interquartile range (IQR) change in PM_{2.5} concentration was associated with a significant increase in mortality of 1.7 (95% CI: 0.5, 2.9), 1.6 (95% CI: 0.4, 2.7), and 1.4 (95% CI: 0.1, 2.6) SDs when O₃ and NO₂ were set at the 25th, 50th, and 75th percentiles, respectively.

CONCLUSIONS: This finding suggests a strong association between pollutant mixture and all-cause mortality, mainly driven by PM_{2.5}. BKMR analysis did not identify statistically significant interactions among PM_{2.5}, O₃, and NO₂. However, since the small sub-population might weaken the study power, additional studies (in larger sample size and other regions in the US) are in need to reinforce the current finding.

Keywords: Air pollution, Mixtures, Long-term exposure, Mortality, Bayesian kernel machine regression (BKMR)



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-301

Air pollution » Other (to be specified with keywords in the keywords section)

Effects of the COVID-19 shutdown on spatial and temporal patterns of air pollution in New York City

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BACKGROUND AND AIM: To mitigate the COVID-19 pandemic, many governments across the world implemented “lockdown” measures. The resulting changes in economic activity had effects that cascaded across numerous aspects of everyday life. Using data from the New York City Community Air Survey (NYCCAS) and from the New York State (NYS) Department of Environmental Conservation (DEC), we characterized changes in fine particulate matter (PM_{2.5}) and nitrogen dioxide (NO₂) following the COVID-19 shutdown in New York City (NYC).

METHODS: Difference-in-difference analysis of PM_{2.5} and NO₂ measured at the DEC sites was used to calculate the change in citywide daily average pollutant concentrations that could be attributed to the COVID-19 shutdown. Spatial patterns of PM_{2.5} and NO₂ in the winter and spring seasons of 2019 and 2020 were interpolated across NYC by fitting generalized additive models to measurements at 82-93 NYCCAS sites. Weather conditions and emission source trends were analyzed to determine the potential effects of meteorology and specific emission sources on the observed pollution changes.

RESULTS: Difference-in-difference analysis suggests that PM_{2.5} and NO₂ decreased by approximately 20% and 27%, respectively, because of the COVID-19 shutdown. Weather readings at LaGuardia Airport in NYC show little evidence that meteorology played a major role in observed pollutant decreases. Both PM_{2.5} and NO₂ exhibited decreased spatial variability in NYC during the COVID-19 shutdown. Widespread increases in daytime (6am-8pm) traffic speeds and fewer open small businesses following the shutdown suggest that decreased vehicle traffic and business activity contributed to declines in air pollution during this period.

CONCLUSIONS: Given the devastating effect the pandemic has had on lives and livelihoods, these pollution reductions are not truly cause for celebration. However, this study shows the potential for regulations on specific emission sources, such as traffic and commercial cooking, to control citywide pollution in the future.

Keywords: Air pollution, Oxides of nitrogen, Particulate matter, Policy, Causal inference



ABSTRACT E-BOOK

P-302

Cancer and Cancer-Precursors » Other (to be specified with keywords in the keywords section)

Urinary concentrations of 2,5-dichlorophenol and prevalent endocrine-related female cancers

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BACKGROUND AND AIM: Para-dichlorobenzene (p-DCB) is a chlorinated volatile organic compound that is commonly found in the household and public buildings due to its widespread use as pest repellent and deodorant. There has been an increasing concern about the potential effect of p-DCB on endocrine and metabolic function. Little is known about the relationship between p-DCB exposure and endocrine-related cancers.

METHODS: A nationally representative subsample of 4459 women, aged 20 years or older, in the 2003-2016 National Health and Nutrition Examination Survey was analyzed for the association between urinary concentrations of 2,5-dichlorophenol (2,5-DCP), the primary metabolite of p-DCB, and endocrine-related female cancers (including breast, ovarian, and uterine cancers) using multivariate logistic regression models, adjusting for potential confounders.

RESULTS: Of the study participants, 202 women (weighted prevalence, 4.20%) reported being diagnosed with any of these endocrine-related reproductive cancers. Women with reproductive cancers showed a statistically significant increase in urinary 2,5-DCP concentrations (weighted geometric mean, 7.97 vs. 5.84 µg/g creatinine; $p < 0.0001$) as compared to women without these cancers. After adjusting for potential confounders, we found that women in the intermediate (1.94- < 28.10 µg/g creatinine) and higher quartiles (≥ 28.10 µg/g creatinine) of 2,5-DCP had significantly increased odds of endocrine-related reproductive cancers with the odds ratio of 1.66 (95% CI: 1.02, 2.71) and 1.89 (95% CI: 1.08, 3.29), respectively, as compared with those in the lower quartile.

CONCLUSIONS: Our study demonstrates a potential relationship between p-DCB exposure, measured as urinary 2,5-DCP, and endocrine-related reproductive cancers in US women. Additional studies would further explore these interactions and elucidate the pathogenesis of endocrine-related female cancers associated with p-DCB exposure.

Keywords: 2,5-dichlorophenol, endocrine-related reproductive cancers, para-dichlorobenzene, prevalence; women



ABSTRACT E-BOOK

P-303

Air pollution » Short-term exposure

Air pollution and emergency department visits for diseases of the musculoskeletal system, Toronto, Canada

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BACKGROUND AND AIM: The objective of this study is to examine the associations between urban ambient air pollution and emergency department (ED) visits due to diseases of the musculoskeletal system in Toronto, Canada.

METHODS: The National Ambulatory Care Reporting System database was used to retrieve health cases corresponding to these diseases using ICD-10 codes M00-M99. The studied period is April 2004 to December 2015 (4,292 days). Six air pollutants (fine particulate matter PM_{2.5}, CO, NO₂, SO₂, ozone O₃ as a daily average, ozone O₃-8 hour, as a maximum eight hour average) and two indexes were considered. Conditional Poisson regression was applied to daily ED visit counts. Temperature and relative humidity were represented in the form of splines. The potential associations were analyzed by strata (sex, age group, and season: warm/cold) and for lagged concentrations (lag 0-14 days).

RESULTS: 691,703 ED visits were retrieved, among which 368,089 were female individuals, and 323,614 males. Among 2,160 tested models, 106 positive associations were statistically significant at P-Value<0.05. Ozone concentration constituted 24 of the positive associations for exposures lagged by 1 and 8 or more days. Strong effects were obtained for same-day exposures to CO and NO₂. Relative risk (RR) was reported for a one interquartile range (IQR) increase in the concentration of NO₂ (IQR=8.8 ppb). For nitrogen dioxide RR=1.014 (95% confidence interval: 1.008, 1.020), RR=1.019 (1.011, 1.026), and RR=1.009 (1.002, 1.017) for all, female, and male patients, respectively. The values for CO (IQR=0.1 ppm) in 60+ individuals were: RR=1.013 (1.005, 1.021), RR=1.017 (1.007, 1.027), and RR=1.007 (0.995, 1.019), respectively.

CONCLUSIONS: The results suggest that carbon monoxide and nitrogen dioxide concentrations can increase ED visit frequency particularly for same-day exposures. Ground-level ozone showed a delayed effect of one week. The most affected demographic out of those studied were older individuals, as reflected in their relative risk values.

Keywords: Air pollution, Exposures, Female, Traffic-related



ABSTRACT E-BOOK

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Air pollution » Short-term exposure

Short-term exposure to air pollution and COVID-19 mortality with susceptibility factors: a case-crossover study for Cook County, Illinois

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BACKGROUND AND AIM: Evidence on individual-level association between exposure to aerodynamic diameter $<2.5\mu\text{m}$ (PM_{2.5}) and ozone (O₃) and coronavirus 2019 (COVID-19) mortality is lacking. Susceptibility to air pollution-related COVID-19 mortality is unknown.

METHODS: With individual mortality records of 8020 deaths from COVID-19 (January, 2020–February, 2021) confirmed by medical examiners in Cook County, Illinois, we conducted time-stratified case-crossover analysis to link COVID-19 mortality and inverse-distance weighting interpolated PM_{2.5} and O₃ at geocoded location of death. We further adjusted for viral transmission, temperature, relative humidity, and residual temporal confounding over the course of the pandemic. We conducted stratification analyses by age, sex, race/ethnicity, the number of comorbid conditions, age-adjusted Charlson Comorbidity Index, ZIP code-level poverty rate, and accessibility to adult intensive care unit (ICU) beds.

RESULTS: Averages of daily pollution levels assigned to cases and self-controls were $8.6\mu\text{g}/\text{m}^3$ for PM_{2.5} and $18.7\mu\text{g}/\text{m}^3$ for O₃. An interquartile range (IQR) increase ($5.11\mu\text{g}/\text{m}^3$) in three-week PM_{2.5} was associated with a 34.1% [95% confidence interval (CI): 9.2, 64.6%] increase of COVID-19 mortality. This association was higher for those aged ≥ 65 years (vs. those aged <65 years), Black, non-Hispanic White (vs. Hispanic White), and those with less comorbid conditions. An IQR increase ($7.52\mu\text{g}/\text{m}^3$) in O₃ on two days before the death was associated with a 5.0% (-2.7, 13.3%) increase of COVID-19 mortality. The mortality increase for non-Hispanic White was a 14.0% (0.7, 28.9%), which was higher than for Hispanic White. The mortality increase was also higher for those with more comorbid conditions. The association between the air pollutants and COVID-19 mortality was stronger for areas with lower poverty rate and higher accessibility to ICU beds.

CONCLUSIONS: Short-term exposure to air pollution below national air quality standards may immediately increase COVID-19 mortality. This increase may be unequal by demographics, pre-existing conditions, area-level poverty, and access to healthcare.

Keywords: Air pollution, COVID-19, susceptibility, environmental justice, case-crossover design, individual-level association



ABSTRACT E-BOOK

P-305

Air pollution » Short-term exposure

Urban air pollution and emergency department visits related to central nervous system diseases, Toronto, Canada

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BACKGROUND AND AIM: Ambient air pollution has been associated with various adverse neurological health outcomes. This work comprehensively examined possible associations between concentration of five major urban air pollutants, two air quality indexes, and emergency department (ED) visits.

METHODS: The analysis was done by sex, age group, and season for ED visits for central and peripheral nervous system diseases, in the period April 1, 2004-December 31, 2015 (4,292 days in total). The study was done in Toronto, a Canadian megacity, using a case-crossover design. Conditional Poisson regression was realized to construct statistical models. Our focus was on daily ED visits covering all diseases of the nervous system and identified by ICD-10 codes (G00-G99).

RESULTS: In the study period, 140,511 ED visits for diseases of the nervous system among Toronto residents were recorded: 83,602 (59.5%) for women and 56,909 (40.5%) for men. We found that nearly 64% of the considered ED visits were related to the episodic and paroxysmal disorders (G40-G47), with the majority of those visits related to migraines (39%). Based on a number of positive consistent associations, largest effect on ED visits for G40-G47, especially G43 (migraines) was among women exposed to ambient CO, especially with either immediate effect (0 and 1 lag) or a week long effect (6 and 7 lag) were found. Relative risks (RR) with 95% confidence intervals were reported for a one interquartile range (IQR) increase, (IQR=0.1 ppm). Women exposed to CO had RR of 1.036 (1.007-1.065) on the same day (especially older women), and 1.019 (1.004-1.033), 1.024 (1.010-1.039), and 1.022 (1.007-1.036) for lags 1, 6, and 7 days, respectively.

CONCLUSIONS: Our findings support the associations between onset of possible diseases of the central nervous system (particularly migraines) and concentration of ambient CO, even at relatively low levels, detected in Toronto.

Keywords: acute exposure, ambient carbon monoxide, case-crossover, conditional Poisson, migraine, female



ABSTRACT E-BOOK

P-306

Air pollution » Other (to be specified with keywords in the keywords section)

Residential Cleaning of Indoor Air to Reduce Acute Exacerbations of COPD (CARE): A Pilot Study

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BACKGROUND AND AIM: Current studies of indoor air cleaning and respiratory disease generally use portable air-filtering devices that lack ventilation capabilities. We hypothesized that 8 weeks of air filtration and ventilation in the homes of COPD patients would improve functional status (measured by the St. George's Respiratory Questionnaire; SGRQ) and decrease systemic inflammation (measured by serum high sensitivity C-reactive protein; hsCRP).

METHODS: Our pilot randomized crossover trial in 2019 of 9 COPD patients (mean FEV1 of 47%; range: 20%-79%) used 2 window-mounted filtering/ventilation units (HEPAirX[®]) per home. Each participant was randomized to 8 weeks of residential air filtering/ventilation, followed by a 3-week washout period and a second 8 weeks of sham filtering (climate control without filtering or ventilation), or vice versa. Measurements of hsCRP and SGRQ were made before and after each 8 weeks of air-filtration/ventilation or sham, while step counts and indoor PM2.5 measurements were made continuously during each period. We compared hsCRP, SGRQ, PM2.5, and step count of the two groups (filter minus sham), subtracting baseline values from each.

RESULTS: The baseline PM2.5 concentration averaged 3.4 µg/m³ (range: 1.0-11.4 µg/m³). The average PM2.5 concentration was 2.2 µg/m³ lower (95% CI: -8.7, 4.3 µg/m³) and the average hsCRP was 4.0 mg/L lower (95% CI: -17.7, 9.7) after 8 weeks of air filtration/ventilation compared to 8 weeks of sham filtering. Participants also walked 16.6 additional steps per hour (95% CI = -59.9, 93.2) and had a 1.0 unit improvement in SGRQ (95% CI: -9.7, 11.8) after air filtration/ventilation compared to sham.

CONCLUSIONS: Although this study's sample size was small, all of the non-statistically significant participant outcomes and pollutant changes associated with air filtration/ventilation were in the hypothesized direction. Though our initial findings are encouraging, a larger study is needed to test the respiratory health benefits of indoor air cleaning in the homes of patients with COPD.

Keywords: Indoor air pollution, Air filtration, Respiratory health effects, COPD, CRP, PM2.5



ABSTRACT E-BOOK

P-307

Air pollution » Short-term exposure

Exposure to Spill-related Chemicals and Incident Myocardial Infarction among Deepwater Horizon Response and Cleanup Workers

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BACKGROUND AND AIM: No study has examined exposure to individual oil spill-related chemicals in relation to cardiovascular outcomes among oil spill workers. During the 2010 *Deepwater Horizon (DWH)* disaster, response and cleanup workers were potentially exposed to toxic volatile components of crude oil. We investigated the association of several spill-related chemicals (benzene, toluene, ethylbenzene, xylene, n-hexane, i.e. BTEX-H) and total hydrocarbons (THC) with incident non-fatal myocardial infarction (MI) among these workers.

METHODS: We examined data from *DWH* oil spill workers enrolled in the prospective GuLF Study. Cumulative exposures to BTEX-H and THC across the cleanup period were estimated via a job-exposure matrix that linked air measurement data with detailed work histories. Physician-diagnosed non-fatal MIs that occurred after the start of cleanup were self-reported at enrollment and in two follow-up interviews. We estimated hazard ratios and 95% confidence intervals (95%CI) for the associations of each exposure (quartiles (Q)) with incident MI. We applied inverse probability weights to account for confounding and potential non-response bias in the follow-up interviews.

RESULTS: Among 22,766 workers without MI diagnoses before the cleanup, 443 reported an incident MI up to 10.9 years after the spill. Compared to the referent group (i.e. lowest quartile (Q1)), workers in the higher quartiles of benzene (Q4 vs. Q1: 1.46, 95%CI: 1.04, 2.06), ethylbenzene (Q4 vs. Q1: 1.50,



ABSTRACT E-BOOK

95%CI: 1.07, 2.10), n-hexane (Q4 vs. Q1: 1.52, 95%CI: 1.08, 2.12), and THC (Q4 vs. Q1: 1.46, 95%CI: 1.05, 2.03) had elevated hazards of MI. Associations were stronger among workers with lower education (\leq high school) or with lower body mass index (<30 kg/m²).

CONCLUSIONS: Exposure to volatile components of the crude oil, notably benzene, ethylbenzene, and n-hexane, was associated with higher risk of MI among oil spill workers. Planned mixtures analysis will help identify the contribution of each of these chemicals.

Keywords: myocardial infarction, occupational epidemiology, petroleum hydrocarbons, oil spills



ABSTRACT E-BOOK

P-308

Air pollution » Oxides of nitrogen

A National Land Use Regression Model for NO₂ using Street View Imagery and Satellite-based Air Quality Estimates

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BACKGROUND AND AIM: Characterizing air pollution with high spatiotemporal resolution is important for assessing health impacts and crafting control strategies. Land Use Regression (LUR) is often used to estimate fine-scale ambient concentrations; national-scale LURs typically employ hundreds of geographic features which offer information at neighborhood or regional scales. In this study, we develop national NO₂ models with (1) built environment features derived from street view imagery and (2) satellite estimates of air quality. Both data sources are publicly available and consistent across large geographies.

METHODS: We collected NO₂ concentrations at EPA monitors and satellite-based NO₂ tropospheric column abundance during 2007-2015. In a previous study, we successfully developed single city LUR models for measures of particulates using variables extracted from Google Street View (GSV) images. Following the same method, we extracted features from GSV images (n=242836) within 500m of NO₂ monitors using a deep learning model (PSPNet). We used only GSV images collected during the same year of the NO₂ observations. For comparison, we developed two random forest models: 1) a full model with both GSV features and satellite-based estimates of NO₂ and 2) a model with only GSV features.

RESULTS: Our full model (GSV + satellite) had good performance (10-fold cross validation [CV] R²: 0.69; mean absolute error [MAE]: 2.04 ppb). When only GSV features within 500m of NO₂ monitors were included in the model, performance decreased (10-fold CV R²: 0.50; MAE: 2.85 ppb), consistent with previous national LUR studies. We plan to improve these models by exploring the impact of GSV image availability and density for monitor-year pairs, expanding the buffer area for collecting images, and adding kriging into our models.

CONCLUSIONS: Our findings suggest that street view imagery and satellite estimates of air quality have great potential for building large scale air quality models (national or global) under a unified framework.

Keywords: air pollution, modeling, oxides of nitrogen



ABSTRACT E-BOOK

P-309

Air pollution » Other (to be specified with keywords in the keywords section)

Maternal exposure to biomass fuel and birthweight in Kaduna, Northwestern Nigeria: Results from the Child Electronic Growth Monitoring System (CEGROMS)

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BACKGROUND AND AIM: Despite the high burden of household air pollution from solid biomass fuel in sub-Saharan Africa, the association of prenatal biomass fuel exposure and birth weight as a continuous variable and independent of preterm birth has not been extensively studied. In this study, we aimed to determine the association of prenatal exposure to biomass fuel with birthweight analyzed as a continuous variable among term births in a Nigerian population.

METHODS: This cross-sectional study was conducted at the Child Welfare Clinic of Barau Dikko Teaching Hospital, Kaduna (Kaduna State, Northwestern Nigeria), an urban metropolis with the country's fourth-largest population. We obtained data from the Child Electronic Growth Monitoring System (CEGROMS), a database of all women who brought their newborns to the study site for BCG vaccination and growth monitoring around the time of birth. A total of 1348 women with term births and information on birthweight, cooking fuel type, and other risk factors met the inclusion criteria. We used linear regression to estimate the adjusted associations (β and 95% confidence interval (CI)) between birthweight and biomass fuel exposure.

RESULTS: Thirteen percent of mothers used biomass fuel relative to 78.5% using liquified petroleum gas (LPG) and 8.5% using kerosene. On average, infants of mothers exposed to biomass fuel were 111g lighter (95% CI -205,-18), compared with those of mothers using LPG adjusted for maternal age, education, and parity. Kerosene use resulted in a 10 g (95% CI -107; 86) reduction in mean birth weight compared to mothers using LPG.

CONCLUSIONS: Maternal exposure to biomass fuel was associated with shifting of the birth weight distribution among term newborns.

Keywords: Biomass fuel, House air pollution, birthweight, Nigeria



ABSTRACT E-BOOK

P-310

Air pollution » Mixtures

Air pollutant mixtures and autoimmune skin disease prevalence: findings from the Personalized Environment and Genes Study

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BACKGROUND AND AIM: Autoimmune (AI) diseases are thought to be a product of genetic predisposition and environmental triggers. Disruptions of the skin barrier cause exacerbations of psoriasis where oxidative stress represents a mechanistic pathway for the pathogenesis of the disease. Oxidative stress is also thought to be the primary mechanism for the detrimental effects of air pollution.

METHODS: We evaluated the association between the prevalence of autoimmune skin diseases (psoriasis or eczema,) and mixtures of air pollutants including six criteria air pollutants and constituents of PM_{2.5} in the Personalized Environment and Genes Study (PEGS) cohort consisting of 9414 subjects centered in NC, USA. We utilized land-use regression (LUR) predictions from the Center for Air, Climate, and Energy Solutions (CACES) and the Atmospheric Composition Analysis Group (ACAG). For increased spatial resolution, we included cumulative exposure to volatile organic compounds (VOC) based on the sum of exponentially decaying contributions from the EPA Toxic Release Inventory and the density of major roads within a 5km radius of a participant's address. We will use logistic regression with quantile g-computation, adjusting for age, gender, income, and smoking history to evaluate the relationship between self-reported diagnosis of an AI skin condition and mean air pollution mixtures from 2000-2016.

RESULTS: The PEGS cohort reported a high prevalence of autoimmune diseases with 3177 (33.7%) reporting 1+ AI disease. In our specific outcomes of interest, 1173 (12.5%) reported psoriasis (398) and/or eczema (873). Preliminary results for PM_{2.5} composition show that the mixture components of sulfate, black carbon, and nitrate contribute to a positive overall conditional odds ratio for risk of AI skin disease.

CONCLUSIONS: Using publicly available LUR air pollution data joined with the PEGS cohort, we elucidate the potential important components of particulate exposure on AI skin disease.

Keywords: mixtures, air pollution, autoimmune disease, LUR,



ABSTRACT E-BOOK

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Exposures » Multi-pollutant/Multi-media

Environmental exposures and anti-Müllerian hormone: a mixture analysis in the US based Nurses' Health Study II (NHSII)

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BACKGROUND AND AIM: Previous studies have linked exposures such as air pollution and greenness with anti-Müllerian hormone (AMH), a marker of ovarian reserve. However, the association of multiple environment factors has not been addressed. We aimed to assess the impact of a mixture of environmental exposures on AMH.

METHODS: A total of 2,449 premenopausal women in the NHSII, a US nationwide prospective cohort who provided blood samples for AMH assay were included. Exposure to greenness, particulate matter, noise, outdoor light at night (LAN), ultraviolet radiation, and 6 hazardous air pollutants (HAPs) (1,3-butadiene, benzene, diesel particulate matter, formaldehyde, methylene chloride, and tetrachloroethylene) were available at all residential addresses since 1989. We first estimated associations with AMH in single exposure models adjusting for relevant covariates and then explored patterns of exposure using principal component analysis (PCA). Hierarchical Bayesian kernel machine regression (BKMR) was used to select key exposures and estimate the joint associations. We further conducted subgroup analyses by age at blood draw.

RESULTS: Median age at blood collection was 40. Single exposure models showed negative associations of AMH with benzene (percentage reduction in AMH per interquartile range (IQR) increase = 5.44%, 95%CI=1.05, 9.62) and formaldehyde (percentage reduction in AMH per IQR increase = 6.04%, 95%CI=1.72, 10.17) but not the other exposures. PCA identified four major exposure patterns and only the one with high exposure to HAPs and LAN was associated with lower AMH. Hierarchical BKMR selected benzene, formaldehyde, and greenness as important exposures, and suggested an inverse joint association with AMH (percentage reduction comparing all exposures at the 75th percentile to



ABSTRACT E-BOOK

median= 8.12%, 95%CI=0.54, 15.12). The observed associations were mainly found among women aged above 40.

CONCLUSIONS: We found exposure to benzene and formaldehyde to be consistently associated with lower AMH levels. Older reproductive aged women were the most susceptible, suggesting these exposures may accelerate reproductive aging.

Keywords: multi-pollutant, mixtures analysis, reproductive outcomes



ABSTRACT E-BOOK

P-312

Exposures » Other (to be specified with keywords in the keywords section)

Blood Lead Levels in U.S. Children Ages 1-11 years over the 40-year period from 1976 to 2016

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BACKGROUND AND AIM: Blood lead levels (BLLs) have generally declined over the past 40 years in the United States (U.S.). We describe the distribution of BLLs in U.S. children age 1-11 years from 1976-2016 and associations with demographic, housing and regional characteristics.

METHODS: Data from the National Health and Nutrition Examination Survey (NHANES) II, NHANES III 1988-1991 and 1991-1994, and 1999-2016 NHANES cycles were used to describe the distribution of BLLs in U.S. children age 1-5 years and 6-11 years from 1976-2016. For all children with valid BLLs (n=27,122), geometric mean (GM) BLLs (95% confidence intervals [CI]) and estimated prevalence were calculated overall, stratified by age group (1-5 years; 6-11 years) and selected characteristics.

RESULTS: The GM BLL in U.S. children age 1-5 years has declined from 15.2 µg/dL (CI 14.3,16.1) in 1976-1980 to 0.83 µg/dL (CI 0.78,0.88) in 2011-2016, representing a 94.5% decrease over time. A large portion of this decline occurred before 1992 as GM BLLs for 1-5 year olds had decreased to 3.6 µg/dL (CI 3.2,4.0) by 1988-1991. For children age 6-11 years old, GM BLL have declined from 12.7 µg/dL (CI 11.9,13.4) in 1976-1980 to 0.60 µg/dL (CI 0.58,0.63) in 2011-2016, representing a 95.3% decrease. As with the younger age group, much of this decrease occurred before 1992. Despite this substantial decline, disparities exist by income, race/ethnicity, and housing age.

CONCLUSIONS: Lead exposure in U.S. children age 1-5 years and 6-11 years has substantially decreased over this forty-year period. Despite this significant achievement, children, particularly those of minority and low-income backgrounds, are still at risk of lead exposure. Risk factors, such as income and housing age, persist throughout regardless of child's age. NHANES estimates of BLLs have played a key role in monitoring the decline in BLLs in U.S. children and have influenced public health action and national policy around childhood lead exposure.

Keywords: Epidemiology, children's environmental health, heavy metals



ABSTRACT E-BOOK

P-313

Exposures » Other (to be specified with keywords in the keywords section)

The role of heavy metals in thyroid cancer: a meta-analysis

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BACKGROUND AND AIM: Although trace amounts of some metals are essential, high concentrations may be toxic and several metals have even been classified as carcinogenic by the International Agency for Research on Cancer. Certain metals also have endocrine disrupting properties and may therefore affect thyroid function. The objective of current study was to determine the possible association between metal levels in tissue or serum and thyroid cancer by performing a meta-analysis.

METHODS: A systematic literature review was performed using the search terms thyroid cancer and metal(s), searching PubMed, Embase and Scopus through February 2021, and reviewing reference lists of all previously published relevant reviews. Articles were included if mean levels of metals in blood or tissue were reported or could be calculated and at least one comparison group was included (healthy or benign controls). Summary estimates were calculated using a random effects model including the weighted standardized mean difference (SMD) for each comparison.

RESULTS: The search returned 9416 studies of which 125 studies were full-text reviewed and eventually 21 studies were included. No significant difference in blood levels between thyroid cancer patients and healthy controls was found for cadmium (SMD: 1.14; 95% CI: -0.44; 2.72), lead (SMD: 1.65; 95% CI: -0.37; 3.68), or zinc (SMD: -0.29; 95% CI: -2.21; 1.63). No significant difference in tissue levels between thyroid cancer patients and benign controls was found for lead (SMD: -0.17; 95% CI: -2.01; 1.67) or zinc (SMD: -0.54; 95% CI: -2.08; 1.00).

CONCLUSIONS: Although no significant difference was found, only limited, mainly cross-sectional studies compared blood or tissue metal levels between thyroid cancer patients and a control group. Large, prospective studies including multiple blood draws over time over needed to better understand the risks of heavy metal exposure on the thyroid gland, especially given their potential carcinogenic and endocrine disrupting properties.

Keywords: Heavy metals, cancer and cancer precursors



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Exposures » Other (to be specified with keywords in the keywords section)

Per-and Polyfluoroalkyl Substances (PFAS) Concentrations in Serum and Drinking Water in Pregnant Women from the Greater Cincinnati Area HOME Study

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BACKGROUND AND AIM: The occurrence, fate, and transport of PFAS in the environment is understood, but the contribution of drinking water to serum PFAS concentrations in humans is poorly defined.

METHODS: We examined data from a prospective pregnancy and birth cohort (HOME Study) in Cincinnati, Ohio. We quantified PFOA and PFOS in sera of 227 pregnant women at 16 weeks gestation between 2003 and 2006. Tap water was collected from the participants' homes within one month of blood collection. We mapped serum and tap water PFAS concentrations using ArcGIS and examined clustering via spatial hotspot analyses for each participant.

RESULTS: The median (range) of PFOA serum concentration in pregnant HOME Study participants between 2003-2006 was 5.4 (0.5-24.5) ng/ml, which is over twice the geometric mean serum concentration of 2.4 ng/l as measured in a representative sample of pregnant women in NHANES 2003 and 2004. Median PFOA drinking water concentrations in samples collected from participants' homes were 3.7 ng/l in 2003, 4.5 ng/l in 2004, 6.4 ng/l in 2005 and 11.0 ng/l in 2006. For each doubling of water PFOA concentration, serum PFOA increased by 0.6 ng/l (95% CI: 0.02, 1.20) after adjusting for water source type (bottled/filtered vs tap water). For every doubling of water PFOS, serum PFOS increased 0.95 ng/l (95%CI: -0.10, 2.00).

CONCLUSIONS: Drinking water is an important contributing source of PFAS exposure in pregnant women. This research adds to the literature, helping to delineate the relationship between drinking water and circulating serum concentrations of PFAS in pregnant women.

The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

Keywords: PFAS, drinking water, pregnant women, HOME Study, Cincinnati



ABSTRACT E-BOOK

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Exposures » Multi-pollutant/Multi-media

Associations between birthweight and metals: A real world example of bias amplification in a North Carolina birth cohort

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BACKGROUND AND AIM: Air pollution comprises a mixture of gases and small particles, including metals, and has been associated with changes in mean birthweight (BW). Often, studies estimate exposure for a single metal in isolation or multiple metals simultaneously, but rarely evaluate both or examine the potential bias amplification.

METHODS: We evaluated census tract level concentrations of 8 metals (arsenic, cadmium, chromium, cobalt, lead, manganese, mercury, and nickel) from the 2011 National Air Toxics Assessment linked with 431,929 infant-mother pairs with births between 2012-2015. Correlations were low to moderate ($r < 0.62$) between the metals. The change in BW (grams, g) and 95% confidence interval (CI) per one log-transformed unit of change in concentration was estimated with generalized estimation equation models, adjusted for race/ethnicity, age, marital status, education, and Medicaid status. Exposure to each metal was considered in isolation (IPM) and part of a multiple pollutant model (MPM) of 8 metals (mutually adjusted).

RESULTS: We observed the largest decrease in BW for manganese [-8.0g(95% CI:-10.0,-6.1)] in the IPM and for arsenic [-11.5g(-19.0,-4.0)] in the MPM. The greatest increase in BW was observed with cadmium for both models [isolated: 16.5g(11.5,21.56); multiple: 13.7g(6.2,21.2)]. The direction of association changed with arsenic, chromium, and lead between the IPM and MPM. All metals, except manganese, were associated with more than a 10% change in BW per one log-transformed unit change in metal concentration when comparing the results from the IPM to the MPM, suggesting possible bias amplification.

CONCLUSIONS: We observed changes in directionality and substantial changes in the magnitude of the associations between IPM and MPM. Evaluating MPM may over or under emphasize associations due to residual confounding or collinearity, leading to bias amplification. Considering the potential for bias amplification and its magnitude is useful in evaluating MPM. This abstract does not reflect EPA policy.

Keywords: Birth outcomes, Heavy metals, Multi-pollutant, Mixtures analysis, Air pollution



ABSTRACT E-BOOK

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Outcomes » Mortality

Residential proximity to animal feeding operations and mortality among postmenopausal women in the Iowa Women's Health Study

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BACKGROUND AND AIM: Industrialized animal feeding operations (AFOs) are sources of numerous pollutants (e.g., particulates, pathogens, nitrate). Evidence links residential proximity to AFOs to respiratory diseases and cancer incidence, but directions of associations are inconsistent, and no studies have investigated associations with mortality. We examined these relationships in a population-based cohort of postmenopausal women.

METHODS: We linked enrollment (1986) addresses of 25,285 Iowa Women's Health Study participants with street-level geocodes to a statewide database of permitted AFOs that included animal counts standardized by animal size and manure production (animal units; AUs). Underlying causes of death (n=15,330) were identified through 2014, including 3,468 cancer, 4,038 cardiovascular, and 1,638 respiratory (n=911 chronic obstructive pulmonary disease (COPD)) deaths. Cox models estimated hazard ratios (HR) and 95% confidence intervals (CIs) for quartiles or tertiles (based on the number of cases for each outcome) of total inverse distance-weighted AUs within 5km, after adjusting for demographics, residence type/size, smoking pack-years, and occupation.

RESULTS: Sixty-three percent of women had ≥ 1 AFO within 5km of their residence. Participants in the highest exposure quartile had non-significantly elevated risks for death from any cancer (HR Q4.vs.none=1.07, 95%CI 0.96-1.19, p-trend=0.13). Risk of death from non-Hodgkin lymphoma was non-significantly elevated (HR T3 vs.none=1.35, 95%CI 0.93-1.94, p-trend=0.15). Participants in the highest quartile had decreased risk of mortality from respiratory disease (HR Q4.vs.none=0.84, 95%CI 0.71-0.99, p-trend=0.03); this persisted in the subset of COPD deaths (HR T3.vs.none=0.83, 95%CI 0.70-0.99, p-trend=0.05). The highest AU tertile was non-significantly associated with elevated risks of cardiovascular mortality (HR T3.vs.none=1.06, 95%CI 0.98-1.15, p-trend=0.13). No associations were observed for other cancers or other non-cancer causes of death.

CONCLUSIONS: Our novel analysis suggests that higher exposure to animals from AFOs may increase risk of mortality from cancer and cardiovascular diseases. Consistent with limited agricultural/occupational studies, higher AFO exposures were associated with decreased mortality from respiratory diseases, including COPD.

Keywords: Mortality, Environmental epidemiology, Female, Respiratory outcomes



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Exposures » Other (to be specified with keywords in the keywords section)

Daily particulate matter and temperature from satellite-hybrid models and 1.5 million deaths: A time-stratified case-crossover analysis in Central Mexico

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BACKGROUND AND AIM: Highly spatio-temporally resolved (daily 1x1-Km) fine particulate matter (PM_{2.5}) and air temperature (Ta) models are being used to advance exposure science and refine health effect estimates in developed countries. Limited evidence exists about their use in densely populated areas from middle-income regions, and different exposure conditions.

METHODS: We use a time-stratified case-crossover study design, matching cases to control days on day of week, month and year, for 1,516,442 non-external deaths (≥18 years-old) from 586 sub-county areas in Central Mexico (including Mexico City) from 2004-2019. Daily 1x1-Km PM_{2.5} (median=23.4µm³; IQR=17–30.6µm³) and Ta estimates from our new satellite-based models for the region were employed for exposure assessment at the sub-county level using population-weighted centroids. Acute associations of PM_{2.5} and Ta with mortality were estimated with distributed lag conditional logistic models.

RESULTS: Mortality was significantly associated with 10µm³ PM_{2.5} increase with stronger effects for lag0 [1.44% (95% CI:1.37–1.50%)] and lag1 [0.67% (0.60–0.75%)], with a 1-week cumulative effect (lag06) of 3.52% (3.41–3.63%). The minimum mortality temperature (MMT) was estimated at 18.4°C (18.3–18.4°C), and used as reference to estimate effects from cold (p5=12°C) and heat (p95=20.6°C) from the daily Ta distribution. Heat effects peaked at lag0 [4.64% (4.40–4.89%)] and persisted for 2-days with a cumulative lag02 effect of 7.07% (6.83–7.32%).

CONCLUSIONS: We performed the largest case-crossover study of PM_{2.5} and Ta with mortality in Mexico. Our linked datasets utilizing highly spatio-temporally resolved exposure models will enable inference for developing new concentration-response functions in the Central Mexico region. Additional analyses will investigate effect modification by individual characteristics (e.g., occupational classes, sex, and age) and heterogeneity of associations for specific causes of death.

Keywords: Mortality, Particulate matter, Temperature, Short-term exposure



ABSTRACT E-BOOK

P-318

Outcomes » Infectious diseases

Proximity to Industrial Poultry and Hog Production and Emergency Department Visits for Urinary Tract Infection in North Carolina, USA

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BACKGROUND AND AIM: An increasing share of urinary tract infections (UTIs) are caused by uropathogenic *Escherichia coli* lineages that have also been identified in poultry and hogs with high genetic similarity to human clinical isolates. We investigated industrial food animal production as a potential source of community uropathogen exposure by examining relationships of poultry and hog density with emergency department (ED) visits for suspected UTI in North Carolina (NC).

METHODS: ED visits for UTI in 2016-2019 were identified by ICD-10 code from NC's ZIP Code-level syndromic surveillance system and livestock counts were obtained from permit and agricultural census data. We calculated separate poultry and hog densities (animals/km²) by census block with a 5km buffer on the block perimeter and weighted by block population to estimate mean ZIP Code densities. Associations between livestock density and UTI incidence were estimated using a reparametrized Besag-York-Mollié (BYM2) model with Poisson likelihood and ZIP Code population offset to account for spatial autocorrelation. We assessed effect measure modification by ZIP Code rurality and patient sex, age, and race/ethnicity.

RESULTS: Complete covariate data were available for 726 contiguous NC ZIP Codes; 233 had zero density of both poultry and hogs. UTI incidence was positively associated with a log₁₀ density increase of both poultry (rate ratio [RR]: 1.05, 95% confidence interval [CI]: 0.99-1.11) and hogs (RR: 1.05, 95%CI: 0.98-1.14). Compared with hog-free ZIP Codes, all hog density tertiles were associated with increased UTI incidence (highest-density tertile RR: 1.21, 95%CI: 1.06-1.40); associations with poultry density tertiles were similar but weaker. The strongest associations were observed for ZIP Codes with hogs but no poultry (n=39) or with the highest-density tertiles of both animals (n=52; RR: 1.35, 95%CI: 1.11-1.62). Estimates were consistently elevated among females, young adults, and American Indian and Asian individuals.

CONCLUSIONS: Industrial livestock production may be associated with increased UTI incidence in neighboring communities.

Keywords: Confined animal feeding operation (CAFO), syndromic surveillance, areal data, Bayesian hierarchical spatial model, intrinsic conditional autoregressive (ICAR) prior



ABSTRACT E-BOOK

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Exposures » Other (to be specified with keywords in the keywords section)

Perfluoroalkyl Substances (PFAS) and Red Blood Cell Folate Levels in the U.S. Adult Population, NHANES

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BACKGROUND AND AIM: Adequate folate is essential for many physiological processes, and low folate levels have been associated with cardiovascular disease, anemia, and various health outcomes, including developmental outcomes in relation to low folate status during pregnancy. On the other hand, perfluoroalkyl substance (PFAS) have been associated with multiple health outcomes, with scarce data on the mechanistic pathways by which these substances exert their effects. Our objective is to investigate the individual and joint associations of a mixture of PFAS with red blood cell (RBC) folate concentrations in the adult U.S. population.

METHODS: We assessed associations of five chemical biomarkers of 8961 participants ages 18-80 from the U.S. National Health and Nutrition Examination Survey (2007-2016). RBC folate were quantified using a micro bioassay and mass spectrometry. We estimated covariate-adjusted independent and joint associations between PFAS and RBC folate concentrations and triangulated evidence from three approaches developed to examine chemical mixtures: Exposome Wide Association (ExWAS), Bayesian Kernel Regression (BKMR), and Quantile G-Computation (QgComp). We additionally evaluated potential effect modification by sex.

RESULTS: The geometric mean RBC folate was 468 µg/L (geometric standard deviation: 1.5 µg/L). In ExWAS analyses, all PFAS were associated with lower RBC folate concentrations. For instance, a twofold increase in Perfluorononanoic acid was associated with a 10% (95% CI: 9%, 11%) decrease in RBC folate concentrations. BKMR and QgComp showed convergent results with a one quartile increase in the PFAS mixture associated with comparable decreases in RBC folate concentrations. Associations did not differ between males and females.

CONCLUSIONS: This study is the first to examine the associations between PFAS and RBC folate concentrations in a nationally representative sample. These results may deepen our understanding of the mechanistic pathways by which PFAS impact health outcomes.

Keywords: PFAS,Folate,Methods,BKMR,ExWAS,G-Computation



ABSTRACT E-BOOK

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Exposome » External exposome

“Where do these chemicals come from?” Tracing-back chemical exposures to consumer products
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BACKGROUND AND AIM: Non-targeted analysis has enabled us to screen biological samples for a broad spectrum of chemical compounds that would otherwise remain undetected with traditional targeted analytical techniques. While our previous studies have presented a number of man-made chemicals in human serum, the sources of many of these chemicals remain unknown. The aim of our study was to understand the sources of a group of chemicals, some of which are not actively biomonitored, (n=18; phenols, surfactants and per- and polyfluoroalkyl substances) identified and quantified in 300 maternal and 300 cord matched blood samples collected at delivery and analyzed with a non-targeted analysis workflow.

METHODS: We matched measured concentrations in serum to questionnaire responses about participants' use of consumer products in homes (n total = 148 questions) and evaluated their relationship using linear models. We also used an indoor environment multimedia fate model to test observed relationships by simulating concentrations of the chemicals in the carpets, furniture, dust and indoor air to evaluate the potential of exposure based on chemical mobility.

RESULTS: We found strong positive correlations ($r > 0.5$ and p-value < 0.05) between concentrations in serum and carpets (installation and treatment), furniture (renovation and treatment), and floor (installation and treatment). One example where we measured widespread exposure in pregnant women is 4-nitrophenol. Our modeling calculations estimated that when 4-nitrophenol is emitted from carpets, it is expected to be resuspended and redeposited on vinyl floors and other surfaces leaving only a small fraction in the air available for inhalation (0.01 % of the total mass). Our modeling calculations also estimated that, due to its low volatility, the main route of exposure to 4-nitrophenol in the indoor environment is through dermal contact.

CONCLUSIONS: Integrating non-targeted analysis with questionnaire data and multimedia modeling provided unique insights into the sources of environmental chemicals and pathways of exposure.

Keywords: exposome, non-targeted analysis, chemicals, exposure, modeling



ABSTRACT E-BOOK

P-321

Other » Other (to be specified with keywords in the keywords section)

Exposure to Industrial Hog Operations and Gastrointestinal Illness in North Carolina, USA

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BACKGROUND AND AIM: With 9 million hogs, North Carolina (NC) is the second leading hog producer in the United States. Most hogs are housed at concentrated animal feeding operations (CAFOs), where millions of tons of hog waste can pollute the air and water with fecal pathogens that can cause diarrhea, vomiting, and/or nausea (known as acute gastrointestinal illness (AGI)).

METHODS: We used NC's ZIP code-level syndromic surveillance system to calculate rates of AGI emergency department (ED) visits during 2016-2019 and swine permit data to estimate hog exposure. Exposure was estimated as the inverse distances from each hog CAFO to census block centroids, weighting with Gaussian decay and by hogs per CAFO, then aggregated to ZIP codes using population weights. We compared ZIP codes in the upper quartile of hog exposure to those without hog exposure. Using inverse probability of treatment weighting, we created a control with similar demographics to the high hog exposed population and calculated rate ratios (RR) using quasi-Poisson models. We examined effect measure modification of rurality and race using adjusted models.

RESULTS: Among the 111 high hog exposed ZIP codes, the median number of hogs per ZIP code was 50,022. In high hog exposed areas compared to areas without hog exposure, we observed a 17% increase in AGI rate (95% CI: 1.08, 1.26) and a 24% increase in rural areas (95% CI: 1.04, 1.48). The association was stronger during the weeks after heavy rain (RR=1.54, 95% CI: 1.25, 1.83). When restricted to rural areas, we found an increased AGI rate among American Indian (RR=5.26, 95% CI: 4.60, 5.91) and Black (RR=1.47, 95% CI: 1.04, 1.89) patients.

CONCLUSIONS: Residing near hog CAFOs may increase rates of AGI ED visits. Hog CAFOs are disproportionately built near rural Black and American Indian communities in NC and are associated most strongly with increased AGI in these populations.

Keywords: Concentrated animal feeding operation (CAFO), animal production, swine, environmental pollution, gastrointestinal illness, waterborne pathogens



ABSTRACT E-BOOK

P-322

Exposures » Pharmaceuticals

Trends and patterns of prescription opioids in motor vehicle crash injuries in the United States: 2014-2018

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BACKGROUND AND AIM: Motor vehicle crashes (MVCs) are a leading cause of death in the US, and about 3 million people are nonfatally injured in MVC each year. However, to the best of our knowledge, no study investigated the trends in nonfatal MVC injuries in the US. The objective of this study is to investigate the trends and patterns of prescription opioids among MVC injuries in 50 US states and the District of Columbia from 2014-2018.

METHODS: This population-based cross-sectional study analyzed all emergency department visits for an MVC event (N = 142,204) from the IBM[®] MarketScan[®] Databases, one of the largest collections of claims data for insured population. If an MVC injury occurred during an opioid prescription period, this injury was considered involving prescription opioids. Prevalence ratios (PR), estimated by log binomial regression models with random effect of state, were used to quantify whether the prevalence of prescription opioids in MVC injuries varied temporally, spatially, or by enrollees' characteristics.

RESULTS: Prevalence of prescription opioids in MVC injuries continuously decreased from 24% in 2014 to 12% in 2018 [compared to 2014, PR for 2015: 0.95 (0.92, 0.98), PR for 2016: 0.82 (0.80, 0.85), PR for 2017: 0.69 (0.67, 0.72), PR for 2018: 0.51 (0.49, 0.54)], adjusting for age, relationship to the primary beneficiary, employment status, geographic regions, and residence in metropolitan statistical area. The prevalence decreased 28% [PR: 0.72 (0.71, 0.74)], after the publication of CDC guidelines on safer and more effective opioids prescription in chronic pain treatment in March 2016. Spatial variations were observed in the prevalence and temporal trend of prevalence.

CONCLUSIONS: The prevalence of prescription opioids in MVC injuries has decreased from 2014-2018. The decreasing trend is consistent with the decrease in dispensing rate of opioids and prescriptions of high-dosage opioids in the study population.

Keywords: Pharmaceuticals, Big data, Exposures



ABSTRACT E-BOOK

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Exposures » Other (to be specified with keywords in the keywords section)

Effects of indoor and outdoor temperatures on blood pressure and central hemodynamics in a wintertime panel of peri-urban Chinese adults

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BACKGROUND AND AIM: Excess wintertime cardiovascular mortality has been observed in populations globally and is partly attributed to cold-induced elevated blood pressure (BP). An inverse relationship between outdoor temperature and BP is well documented. The influence of indoor environmental conditions (e.g., heating, insulation) and indoor temperature on BP is less clear. We examined the effects of indoor and outdoor temperature on wintertime BP and central hemodynamics among older adults in peri-urban Beijing, China.

METHODS: We enrolled 1,285 older adults into a panel study conducted in two winter seasons (2018-19 and 2019-2020). Staff traveled to participant homes to administer a questionnaire and measure their brachial and central systolic and diastolic BPs, pulse pressures, and pulse pressure amplification. Indoor temperature was measured within the 5-minutes prior to BP measurements for all participants and 12-month indoor temperature measurements were obtained in a 37% (1st season) and 32% (2nd season) random subsample. Village-level outdoor temperature was estimated from regional meteorological stations. Multivariable mixed-effects regression models were used to estimate the within- and between-individual effects of indoor and outdoor temperature on BP, allowing for effect measure modification.

RESULTS: Indoor and outdoor winter temperatures ranged from 0.0 to 28.0°C and -14.3 to 6.4°C, respectively. Those in colder homes had a lower wealth score and less home insulation. We observed an inverse linear relationship between indoor temperature and BP (mmHg per 1°C increase in temperature: -0.4 to -0.5 systolic, -0.3 diastolic, and -0.2 pulse pressure). We found little evidence of any effect of outdoor temperature with BP, or that outdoor temperature modified the effect of indoor temperature.

CONCLUSIONS: We found an inverse association between indoor temperature and BP, but no relationship of BP with outdoor temperature. This suggests a stronger effect on BP of indoor compared to outdoor temperature. Improving insulation and household heating may help lower BP and prevent excess winter mortality.

Keywords: Cardiovascular diseases, Epidemiology, Socio-economic factors, Temperature



ABSTRACT E-BOOK

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Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

In vivo Quantification of Bone Lead and Strontium using Portable X-ray Fluorescence (XRF)

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BACKGROUND AND AIM: Exposure to lead (Pb) or strontium (Sr) is of concern due to potential neurotoxicity or impaired bone health, respectively. Human bone is reliable biomarker for cumulative Pb and Sr exposures and for studying associated health outcomes. However, the applicability of standard K-shell x-ray fluorescence (KXRF) bone Pb measurement technology is significantly limited by its lack of portability, long measurement times, and licensing - restricting its use in large-scale population studies. In this study, we measured Pb and Sr in two populations using portable x-ray fluorescence (XRF), compare bone Pb measurements from a portable XRF device and a KXRF device, and assess differences in bone Sr level across sex, age and ethnicity.

METHODS: We measured bone Pb and Sr concentrations in mid-tibia bone using portable XRF in 76 Americans, age 38 – 95 years, living in Indiana, and bone Sr concentrations in 29 Chinese, age 53 – 82 years, living in Shanghai.

RESULTS: The detection limits for 3-minute portable XRF measurements for in vivo bone Pb and Sr ranged from 4.0 to 12.6 ug/g dry bone (ppm) and 2.0 to 5.2 ppm, respectively, with overlying soft tissue (ST) thickness ranging from 2 to 6 mm. Bone Pb measurements via KXRF and portable XRF were highly correlated: $R = 0.73$ (95% CI, 0.28 to 0.70) among participants with ST thickness < 6 mm (72% of the measured population). Furthermore, the mean bone Sr concentration for American participants was 66.1 ppm (95%CI: 56.5 ppm, 75.6 ppm) and for Chinese was 74.7 ppm (95%CI: 55.6 ppm, 93.8 ppm). Interestingly, the bone Sr in Chinese female participants decreased with age, while the bone Sr in American female participants increased with age.

CONCLUSIONS: We conclude that portable XRF is a valuable technology to study health outcomes related to Pb and Sr exposures.

Keywords: Heavy Metals, Exposure Assessment, X-ray Fluorescence, Lead (Pb), Strontium (Sr)



ABSTRACT E-BOOK

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Exposures » Multi-pollutant/Multi-media

Exposure to Multiple Per- and Polyfluoroalkyl Substances In Relation To Thyroid Function Among Adolescents and Young Adults from NHANES 2011-2012

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BACKGROUND AND AIM: Per- and polyfluoroalkyl substances (PFASs) are persistent chemicals with a wide range of industrial applications, measured in human serum samples. Experimental studies have identified PFASs as endocrine disrupting chemicals and epidemiological studies suggest that PFASs can affect normal thyroid function in humans. We investigated the association between exposure to mixtures of serum PFASs and changes in serum thyroid hormone levels among 12 to 20 year olds.

METHODS: Using data from the NHANES 2011-2012 cycle, we employed principal component analysis (PCA) and identified three factors, describing mixtures of PFASs. Using multivariable linear regression models, we estimated associations between exposure to PFAS mixtures and changes in serum thyroid hormone concentrations.

RESULTS: Factor 1 was characterized by carboxylates, comprising of PFUnA, PFDA, and PFNA, Factor 2 was described by sulfonates which included PFHxS, PFOS, PFA, and MeFOSAA and Factor 3 was described PFHpA alone. Greater exposure to Factor 1 PFASs was associated with an overall increase in free T4, TSH, and thyroid peroxidase antibodies levels, without any statistical significance. Exposure to Factor 2 PFASs was associated with an overall decrease in free T3, total T3, free T4, and total T4 levels. Factor 3 resulted in an increase in most of the serum thyroid hormone levels with the exception of thyroglobulin and thyroglobulin antibodies levels.

CONCLUSIONS: Our results suggest the importance of modeling the effects of exposure to a mixture of PFASs simultaneously. The findings of this analysis can better inform researchers and policy makers on which PFASs behave analogously or inversely in an effort to better assess the effect PFASs may have on health effects.

Keywords: biomarkers, chemical mixtures, endocrine disruptors, polyfluoroalkyl substances, thyroid function



ABSTRACT E-BOOK

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Exposures » Microplastics

Partial Scoping Review of Microplastic Exposure Publications

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BACKGROUND AND AIM: Plastic particles are widely considered microplastics once one dimension of that plastic is <5 millimeters (mm) in length. Microplastics have been discovered to be pervasive throughout multiple environments around the world, including all oceans, many terrestrial environments, in the atmosphere, and in food. This pervasiveness has led to a surge of publications regarding microplastics in the global scientific community in the last decade. Microplastics as a field of study is relatively novel, with little known about the adverse health effects from exposure for humans. This review aims to understand and categorize the current literature.

METHODS: To assess the size and scope of the available research, the NCEH/ATSDR Microplastic Work Group (MPG) is conducting a scoping review on literature from 1946-2020 surrounding published microplastic literature. The MPG categorized included abstracts into bins showing the characteristics of microplastics such as: identification, exposure, health effects, and transportation. The full papers of the included abstracts were read and screened with 12 binary questions for inclusion into the final scoping review.

RESULTS: The majority of publications included in the study were published after 2015. This poster identifies a portion of the categorized and included papers in the final scoping review. A majority of the screened papers were in the broad environmental category with the second largest category including ad/absorption.

CONCLUSIONS: This group of screened papers illustrates the increasing trends in microplastic publications in the last 6 years. The included papers focused on a variety of subjects including plastic concentration in the ocean, human exposure and effects, chemical characteristics and microplastic pollution in a variety of settings. These findings indicate a need to forward the state of the research to better understand microplastics.

Keywords: Microplastics, exposure, health effects, systematic scoping review



ABSTRACT E-BOOK

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Built environment » Green space

Residential surrounding greenness and DNA methylation: an epigenome-wide association study

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BACKGROUND AND AIM: DNA methylation is a potential biological mechanism through which residential greenness affects health, but little is known about its association with greenness and whether the association could be modified by genetic background. We aimed to evaluate the association between surrounding greenness and genome-wide DNA methylation and potential gene-greenness interaction effects on DNA methylation.

METHODS: We measured blood-derived DNA methylation using the HumanMethylation450 BeadChip array (Illumina) for 479 Australian women, including 66 monozygotic, 66 dizygotic twin pairs, and 215 sisters of these twins. Surrounding greenness was represented by Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) within 300, 500, 1000 or 2000 metres surrounding participants' home addresses. For each cytosine-guanine dinucleotide (CpG), the association between its methylation level and NDVI or EVI were evaluated by generalized estimating equations, adjusting for age, education, marital status, area-level socioeconomic status, smoking behavior, cell-type proportions and familial clustering. We used comb-p and DMRcate to identify significant differentially methylated regions (DMRs). For each significant CpG, we evaluated the interaction effects of greenness and single-nucleotide polymorphisms (SNPs) within ± 1 Mb window on its methylation level.

RESULTS: We found associations between surrounding greenness and blood DNA methylation for one CpG (cg04720477, mapped to the promoter region of CNP gene) with false discovery rate [FDR]<0.05, and for another 9 CpGs with $0.05 \leq \text{FDR} < 0.10$. For two of these CpGs, we found 33 SNPs significantly (FDR<0.05) modified the greenness-methylation association. There were 35 significant DMRs related to surrounding greenness that were identified by both comb-p (Sidak p-value<0.01) and DMRcate (FDR<0.01). Those CpGs and DMRs were mapped to genes related to many human diseases, such as mental health disorders and neoplasms as well as nutritional and metabolic diseases.

CONCLUSIONS: Surrounding greenness was associated with blood DNA methylation of many loci across human genome, and this association could be modified by genetic variations.

Keywords: Green space, Epigenomics, Molecular epidemiology, Environmental epidemiology



ABSTRACT E-BOOK

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Built environment » Walkability

Association of City-level Walkability and Accessibility to Transportation with COVID-19 Transmission in Massachusetts: An Ecological Study

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BACKGROUND AND AIM: Massachusetts experienced the peak COVID-19 epidemic on April 23, 2020. Subsequently, the state issued a “stay-at-home” advisory order on March 24, 2020. With people restricted to their residences, neighborhood characteristics may affect behavior and risk of COVID-19 infection through pathways of physical distancing, access to amenities, and the ability to travel for essential needs. We aim to explore the association of walkability and public transit services with COVID-19 transmission.

METHODS: We used Walk Score, Bike Score, and Transit Score indices to assess the walkability and transportation of cities in Massachusetts. We collected the total COVID-19 case numbers of the 72 cities from the Massachusetts Department of Public Health up to October 22. We used univariate and multivariate linear models to analyze the effects of these scores on COVID-19 cases per 100,000 in each city. We adjusted for potential confounders and predictors of the outcome: population density, median household income, unemployment rate, race, aged population, and hospital beds.

RESULTS: Higher Walk Score, Transit Score, and Bike Score rankings were negatively associated with COVID-19 cases per 100,000. Every 10 points increase in Walk Score was associated with a decrease of 473.01 (95% CI: -909.49 to -36.53) cases per 100,000 persons. Every 10 points increase in Transit Score was associated with a decrease of 775.23 (95% CI: -1402.75 to -147.72) cases per 100,000 persons, and 677.44 (95% CI: -1029.62 to -325.26) for 10 points increase in Bike Score.

CONCLUSIONS: Higher Walk Score, Transit Score, and Bike Score are shown to be protective against COVID-19 transmission. Potential residual confounding may exist by SES; however, there is a clear signal that the built environment has a role in public health and infectious disease transmission beyond its role in non-communicable diseases. Further understanding of built environment factors can better inform public health strategies.

Keywords: Built environment, Walkability, Infectious diseases



ABSTRACT E-BOOK

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Built environment » Noise

Assessment of Noise Level Pollution from Powered Generators – A Case Study of UTC Commercial Business Area Abuja, Nigeria

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BACKGROUND AND AIM: This environmental pollution research work was carried out to ascertain the level of exposure of noise an average worker is exposed to during the working hour in the Abuja Commercial Business Area.

METHODS: The study was conducted between June and August 2019. A handheld digital sound level meter (BENETECH GM 1356 Digital Sound Level Meter 30dB-130dB) was used in obtaining the noise level at the study area (UTC Area 11 Commercial Business District). Two different measurement were taken simultaneously. First, inside the offices (personal exposure) and outside the offices (environmental exposure).

RESULTS: The results shows that on the average, the overall mean value for personal assessment i.e. the noise level which an individual worker was exposed to was 74.7 dB(A) and for the environmental assessment i.e. the noise level of the commercial district was 71.9 dB(A). The comparative analysis between mean personal and environment exposure level values were all above the commercial area maximum permissible noise limit of Nigeria, Unites State of America, Japan, India, Australia and World health Organization (WHO) values of 60 dB(A), 65 dB(A), and 55 dB(A) respectively except for the Occupational Safety and Health Administration (OSHA) which has a maximum limit of 85 dB(A).

CONCLUSIONS: From the data obtained and analysis carried out, it revealed that the noise level at the commercial business district, Abuja, Nigeria was way above the permissible noise limit for a commercial area in Nigeria according to the National Environmental (Noise Standards and Control) Regulations 2009.

This should be a source of concern to responsible stakeholders because of the danger this possesses to the health and wellbeing of workers and residents. It was also recommended that tress should be planted within the business hub to tackle noise pollution.

Keywords: Noise, Pollution, Environment, Noise level, Generators, Abuja Nigeria.



ABSTRACT E-BOOK

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Built environment » Green space

Association between greenness structures and frailty among older adults: analysis of the Chinese Longitudinal Healthy Longevity Survey

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BACKGROUND AND AIM: Frailty is a predictor of well-being, representing a person's vulnerability due to degenerative changes. There is evidence on the health benefits of greenspace measured with normalized difference vegetation index (NDVI) on frailty, but little is known about different health effects of various landscape types. We aim to study the association between greenness structures and frailty in an elderly Chinese cohort.

METHODS: We included older adults from the 2008-2014 waves of the China Longitudinal Healthy Longevity Survey (CLHLS). We calculated landscape indices to quantify greenspace structure characteristics: area-edge, shape, and proximity, and calculated frailty index (FI) as the outcome. We did the cross-sectional analysis using the linear regression and logistical regression, and did the longitudinal analysis using the generalized estimating equations (GEE). Additionally, participants were categorized into groups with no change, decreased, or increased FI in 2014. All models were adjusted for covariates.

RESULTS: Among 8,776 participants at baseline, the mean LPI, SHAPE, COHESION, and FI were 7.93, 8.11, 97.6, and 0.17. We found a consistent dose-response relationship for greenspace structures and frailty in the cross-sectional analysis. Each 0.1-unit increase in LPI, SHAPE, and COHESION was associated with a 0.026-point (95% CI -0.019 to -0.005), 0.028-point (-0.035 to -0.021), and 0.025-point (-0.032 to -0.018) lower FI score in the fourth quartile. Compared to participants living in the lowest quartile of greenness structures, those in the highest quartile had an average 23% lower odds of frailty. The association was stronger among females, city residents, people without a spouse, and deteriorated frailty. However, we did not find a significant association in the longitudinal analysis.

CONCLUSIONS: The larger value of area-edge, shape, and proximity are related to a lower likelihood of frailty. We proposed several greenness planning strategies, including maximizing the largest green patch proportion, building greenspaces with complex shapes, and connecting fragmentary greenspaces.

Keywords: Green space, Built environment, Incidence, Long-term exposure, Policy



ABSTRACT E-BOOK

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Built environment » Green space

Is outdoor artificial light at night confounding studies on green space and health?

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BACKGROUND AND AIM: There is a growing body of evidence that exposure to green space, particularly biodiverse green space, is good for our health: spending time in green space can improve depressive symptoms, obesity, and sleep problems, and reduce the risk of breast and prostate cancer. We also know that exposure to light at night, particularly urban light pollution, is bad for you: it increases the risk of breast and prostate cancer, and can worsen depression, obesity and sleep problems. As both green space exposure and outdoor artificial light at night (O-ALAN) have been implicated in the same health outcomes, we aimed to establish if O-ALAN was itself correlated with green space, potentially confounding studies of green space and health outcomes (and vice versa).

METHODS: We used Australian major cities as a case study, and investigated the correlation between green space diversity (Shannon diversity index of National Vegetation Information System's vegetation classes within 3 km radius buffer zones), and night-time light data (NOAA/NCEI Nighttime Visible Infrared Imaging Radiometer Suite Day/Night Band 2015 Annual Composite product).

RESULTS: Our results show a clear inverse correlation between O-ALAN and green space diversity for major Australian cities ($P < 0.001$, Adjusted R-squared = 0.325, $n = 139$). The finding makes intuitive sense because more developed areas are likely to have fewer trees and more artificial light, which is consistent with our hypothesis that that O-ALAN could be confounding studies of the relationship between green space and health.

CONCLUSIONS: Both green space (ideally including a measure of diversity) and O-ALAN should be included in spatial epidemiological models examining environmental determinants of health. Without considering the potential confounding effects of O-ALAN, public health-driven initiatives such as green space conservation and restoration in urban environments may not be optimised for health benefits.

Keywords: Light pollution, Green space, Built environment



ABSTRACT E-BOOK

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Built environment » Green space

Association between residential greenness and oxidative stress in AIRLESS study in Beijing, China

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BACKGROUND AND AIM: Greenness has been associated with lower risks of cardiovascular diseases, diabetes, cancer, and mortality among urban residents. Under the biophilia hypothesis, nature confers health benefits, but the underlying biological mechanisms need to be better elucidated.

METHODS: This study investigates the associations between contemporary Normalized Difference Vegetation Index (NDVI) and urinary oxidative stress in participants residing in an urban district (Haidian) and a peri-urban district (Pinggu) of Beijing (N=251). Our outcome measurements are urinary creatinine-normalized concentrations of three oxidative stress biomarkers (free, total MDA, and 8-OHdG). Due to right skew of biomarkers data, they were ln-transformed. We calculated contemporaneous greenness level of winter 2016 and summer 2017 by the average daily satellite-derived NDVI in the zone with 500m*500m grids through Google Earth Engine (GEE). Linear mixed-effects models adjusted for demographic characteristics, morbidity, and environment covariates were used to explore associations of NDVI and the biomarkers.

RESULTS: Baseline mean free MDA, total MDA and 8-OHdG were 1600.11 ng/ml, 11126.16 ng/ml, and 4.68 ng/ml, respectively. Individuals who live in greener areas tended to have lower levels of oxidative stress. Compared to the participants in the lowest NDVI tertile (0.11-0.25), those in the highest tertile (0.36-0.83) had significantly lower free and total MDA levels, with the decreased mean (95%CI) percentage of -21.32% (-38.91%, -2.38%) and -20.06% (-35.06%, -3.92%), respectively, (p = 0.020). In the urban participants, we found significant negative associations of NDVI with free MDA (p = 0.003), total MDA (p = 0.005), 8-OHdG (p = 0.020), but not in the peri-urban participants.

CONCLUSIONS: Even within the same city, the protective effects of greenness on oxidative stress were more evident for urban residents. Considering that oxidative stress is a pathophysiologic risk factor for many diseases and natural aging, this research provides mechanistic insights on health benefits of green space in built environment and urban planning process.

Keywords: Greenness, oxidative stress, Malondialdehyde(MDA), 8-hydroxy-2 deoxyguanosine(8-OHdG)



ABSTRACT E-BOOK

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Built environment » General

Verification and Optimization of an Ultra-low Volume (ULV) Sprayer Used for the Inactivation of Indoor Total Bacteria

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BACKGROUND AND AIM: Physical and chemical cleaning to remove indoor microorganisms, which cause allergic reactions and respiratory diseases, is labor-intensive and time-consuming. An ultra-low volume (ULV) sprayer, a newly introduced device to inactivate pathogenic microorganisms, allows the disinfectant particles to reach hard-to-reach spaces indoors and is more cost-effective than the existing methods. However, few studies have been conducted to verify the efficiency of the ULV sprayer. We aimed to verify the disinfection efficiency of the ULV sprayer for inactivating total bacteria indoors, considering the factors affecting bacteria inactivation, and present the optimal ULV sprayer usage conditions to achieve the highest disinfection efficiency depending on room size.

METHODS: Two-stage experiments were conducted. Total bacteria were grown in broth culture, seeded into biofilm templates, and placed in each location. VirkonTM Micro was dispersed into the rooms. Samples were collected pre-and post-spraying using Rodac plates to evaluate the disinfection efficacy. A response surface model was developed to optimize usage conditions for bacterial inactivation.

RESULTS: The total bacteria removal efficiency was high (0.56 – 2.46 log₁₀ reductions), including hard-to-reach spaces. The disinfectant concentration, spray amount, and room size had interactive effects on the total bacteria disinfection efficiency. The experimental data were fitted to a second-order polynomial model, with high coefficients of determination (R²) for all models (R² > 0.82). The optimum conditions were a spray amount of 3.08 – 6.40 L in 160 m³, 3.78 – 7.22 L in 230 m³, and 5.68 – 8 L in 300 m³ when using dilution rates of 100 times. These conditions predicted a bacterial disinfection efficiency of > 1.10 log₁₀ reductions (92%) on all surfaces.

CONCLUSIONS: Our results clearly indicate that the ULV sprayer effectively inactivates total bacteria indoors. The study results can be used as basic data for effective control of indoor surface microbes using ULV sprayer based on quantitative evidence.

Keywords: Built environment, Particle components, Microbes



ABSTRACT E-BOOK

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Built environment » Green space

The associations of greenness and incident depression with co-exposed of particulate matter

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BACKGROUND AND AIM: Surrounding green as a part of resilience environment is reported to benefit mental health by direct protection and the mitigation of hazardous environmental exposure. In this study, we aimed to evaluate the association of surrounding green with incident depression and explore whether and how the association is affected by co-exposure to PM.

METHODS: Data were derived from a large-prospective cohort of community-dwelling adults in China. Depression cases were ascertained from local Health Information System linking participants to the health records of hospitals. We estimated the exposure to surrounding green (the average Normalized Difference Vegetation Index, NDVI) and particulate matter (PM, predicted by land-use regression models) at the participants' residential addresses. We conducted Cox proportional hazards models upon adjusting a series of potential confounders including sociodemographic characteristics, lifestyle factors and health status, such as self-perceived stress and morbidity. Furthermore, we explored the confounding, interaction and mediation relationship between greenness and particulate matter on the incident depression and estimated the cumulative risk indexes (CRIs).

RESULTS: In single exposure models, NDVI was inversely associated with depression incidence. The estimates were attenuated slightly when further adjusted for PM_{2.5} and PM₁₀. The joint hazard ratio (JHR) of per IQR decrease of NDVI and per IQR increase of PM₁₀ was higher than both in single exposures. Besides, we found the protective effect of greenness was not mediated by PM but was interacted with PM₁₀.

CONCLUSIONS: In this large prospective cohort study, residents living in the greener neighborhoods had a lower risk of incident depression. The protective effect was found to be confounded by the PM, since the mediation analysis showed no significance.

Keywords: Green space, Particulate matter, Mental health outcomes, Incidence.



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-336

Built environment » Green space

Green space, neighborhood walkability and cardiometabolic health in early pregnancy: The Healthy Start study

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BACKGROUND AND AIM: Green space and neighborhood walkability have been associated with cardiometabolic health, but relationships with cardiometabolic markers during pregnancy are unclear. We estimated associations of residential green space and neighborhood walkability with cardiometabolic health in early pregnancy.

METHODS: We included 1208 pregnant women enrolled in the Colorado-based Healthy Start study (2009-2014). During a study visit in early pregnancy (median 17 weeks of gestation), we measured systolic and diastolic blood pressure and collected fasting blood samples. We measured serum glucose and insulin and calculated the Homeostatic Model for Assessment of Insulin Resistance (HOMA-IR). We used the average Normalized Difference Vegetation Index (NDVI) in circular buffers of 250m, 500m and 1000m surrounding the participants' homes to estimate exposure to green space. The walkability of the Census block group of the maternal residence was assessed by the National Walkability Index of 2010. Associations of green space and neighborhood walkability with cardiometabolic markers in early pregnancy were assessed by linear regression, adjusting for covariates.

RESULTS: A higher average NDVI in all buffer sizes was associated with a lower diastolic blood pressure and (non-significantly) lower systolic blood pressure in early pregnancy. For example, women in the highest tertile of green space in a buffer of 500m (NDVI ≥ 0.21) had a 1.21mmHg [95%CI -2.23, -0.20] lower diastolic blood pressure than women in the lowest tertile. Additionally, pregnant women who lived in the most walkable neighborhoods had a 3.41mmHg [95%CI -5.31, -1.51] lower systolic and 2.18mmHg [95%CI -3.73, -0.63] lower diastolic blood pressure than women residing in the least walkable neighborhoods. We found no associations of green space or neighborhood walkability with glucose, insulin or HOMA-IR.

CONCLUSIONS: In this racially and ethnically diverse population, higher exposure to residential green space and higher neighborhood walkability were associated with lower systolic and diastolic blood pressure in early pregnancy.

Keywords: Green space, Walkability, Female, Obesity and metabolic disorders



ABSTRACT E-BOOK

P-337

Built environment » Green space

Residential Green Space Structures and Mortality in an Elderly Prospective Longitudinal Cohort in China

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BACKGROUND AND AIM: Greenness is beneficial to health and is associated with lower mortality. Many studies used the normalized difference vegetation index (NDVI) to measure greenness. However, these measures cannot reflect the type of landscape. We aim to study the association between greenness structures and all-cause mortality in an elderly Chinese cohort.

METHODS: We used the 2008-2014 waves of the China Longitudinal Healthy Longevity Survey (CLHLS), a prospective cohort representative of China's older population in a wide range of geographic and climatic regions. We calculated landscape indices to quantify three greenspace structure characteristics: area-edge, shape, and proximity. The health outcome was all-cause mortality. We used the Cox-proportional hazards model, adjusted for the study entrant year, age, sex, activities of daily living (ADL), marital status, geographic region, urban or rural residential location, literacy, annual household income, smoking status, alcohol consumption, exercise status, biodiversity index, numbers of hosts for zoonosis, contemporaneous NDVI, annual average temperature, and three-year average PM_{2.5}.

RESULTS: Among 12,999 individuals (average age at baseline 87.2 years, 5,502 males), we observed 7,589 deaths between 2008 and 2014. We did not find a consistent dose-response relationship for greenspace structures and all-cause mortality, however, there were some signals of associations. Compared with individuals living in the lowest quartile of the number of patches, the adjusted-HR (95%CI) of individuals living in the highest quartile was 0.85 (0.80-0.92). In stratified analyses, the largest patch index and perimeter-area ratio had protective effects on males, individuals aged <90, with sufficient capacity to perform activities of daily living independently, and with higher income. The protective influence of greenspace structures was not as evident as NDVI.

CONCLUSIONS: Specific types of greenspace structures (larger area-edge, higher complexity, more concentrated greenspace) have influences on mortality, but without an evidence dose-response curve.

Keywords: Green space, Built environment, Incidence, Long-term exposure, Policy



ABSTRACT E-BOOK

P-338

Built environment » Green space

Individual and joint effects of prenatal green spaces and PM2.5 exposure on BMI Z-score of children: a birth cohort study

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BACKGROUND AND AIM: Few studies examined the association of prenatal exposure to green spaces with children's body mass index (BMI) Z-score, and no study evaluated the joint effect of prenatal green spaces and PM2.5 exposure on children's BMI Z-score. We aimed to assess the individual and joint effect of prenatal green spaces and PM2.5 exposure on BMI Z-score of children.

METHODS: The study was based on a birth cohort (2014-2017) in Beijing, China, in which 13,688 mother and their children were included. We estimated prenatal exposure to green spaces by calculating averaged normalized difference vegetation index with 500m buffers (NDVI-500), and prenatal PM2.5 exposure based on maternal residential addresses. Weight and height were measured at approximately 2 years old. We calculated BMI Z-score and defined overweight and obesity based on the WHO Standards. Generalized linear regression was used to examine the individual and joint effects of prenatal NDVI-500 and PM2.5 exposure on children's BMI Z-score and overweight or obesity.

RESULTS: A 0.1 increase in prenatal NDVI-500 exposure and a 10 µg/m³ decrease in PM2.5 were associated with 0.192 [95% confidence interval (95%CI): 0.158, 0.225] and 0.020 (95%CI: 0.001,0.040) increase of children's BMI Z-score, respectively. Compared with exposed to low-level NDVI-500 and high-level PM2.5, the BMI Z-score was higher in children whose mother exposed to high-level of NDVI-500 (greater than median) and low-level PM2.5 (not greater than median) [β :0.163 (95%CI: 0.117, 0.209), Pinteraction=0.025]. We did not observe significant associations of NDVI-500 and PM2.5 with the risk of overweight or obesity.

CONCLUSIONS: The study suggested the beneficial effect of prenatal exposure to green spaces on children's growth and its interaction with PM2.5. The findings call for developing public health policy to improve green infrastructure and control PM2.5 concentrations, in order to promote children's growth.

Keywords: Prenatal exposure, green spaces, PM2.5, body mass index, children, growth



ABSTRACT E-BOOK

P-339

Built environment » Other (to be specified with keywords in the keywords section)

Health impacts of E-Scooters sharing systems in Atlanta and Portland, USA

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BACKGROUND AND AIM: Since 2017 electric kick scooters (E-Scooters) have been expanded across cities around the globe. E-Scooter share systems provide a micro-mobility solution in urban areas. To our knowledge, no previous studies have quantified the health risks and benefits of E-Scooters.

METHODS: This study followed a quantitative health impact assessment approach, to estimate the risks and benefits of e-scooter sharing systems. Specifically, we quantified the health impacts related to three exposures: physical activity, air pollution, and traffic incidents. We analyzed E-scooter systems, in Atlanta, Georgia, and Portland, Oregon. Input data on transport, traffic safety, air quality, and physical activity were collated from public records and scientific publications. We modeled the health impacts on adult users related to mortality, disease incidence, disability-adjusted life years, and health economic impacts (related to morbidity and mortality).

RESULTS: In Atlanta, 15,792 E-scooter trips were made each day. From those 42% substituted car trips, 48% walk trips, 4% bike trips, and 2% transit trips. Among all travelers, we estimated an increment of 3.4 million USD in health economic impacts of E-Scooters, mainly derived by the increment in traffic injuries. In Portland, 4,885 E-scooter trips were made each day, with a similar mode shift than in Atlanta. Among Portland travelers, we estimated a reduction of 1.5 million USD in health economic impacts of E-Scooters, mainly derived from the reduction in traffic fatalities. When we disaggregate the analysis by mode of transport, the substitution of public transit, bike or walk trips by E-Scooter resulted in more health risks, and the substitution of car trips by E-Scooter resulted as a health benefit.

CONCLUSIONS: E-scooters implementation will benefit from a health lens. Depending on the modal shift, and the traffic safety measures implemented around E-Scooters, this micro-mobility solution could be a health risk or benefit. This study supports the E-scooter implementation that prioritizes car trip substitution.

Keywords: Transport, E-Scooter, Urban health, Health Impact Assessment, Traffic incidents, Air Pollution



ABSTRACT E-BOOK

P-340

Built environment » Other (to be specified with keywords in the keywords section)

Health impacts of bike sharing systems in the U.S

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BACKGROUND AND AIM: Bike-sharing systems (BSS) are short-term bike rentals, that can be borrowed from one location and retired to another at the conclusion of the trip. In 2019, the top 10 US largest BSS fleets counted more than 33,500 bikes. To our knowledge, no assessment has quantified the health risk and benefits of multiple BSS in the US.

METHODS: This study followed a quantitative health impact assessment approach, to estimate the risks and benefits of BSS. Specifically, we quantified the health impacts related to three exposures: physical activity, air pollution, and traffic incidents. We analyzed all the trips made by BSS systems in the US. Input data on transport, traffic safety, air quality, and physical activity were collated from public records and scientific publications. We modeled the health impacts on adult users related to mortality, disease incidence, disability-adjusted life years (DALYs), and health economic impacts (related to morbidity and mortality).

RESULTS: In the US, 109,589 BSS trips were made each day. From those 45% substituted car trips, 28% walk trips, and 9% transit trips. Among all travelers, we estimated an annual reduction of 36 million USD in health economic impacts, 737 DALYs, and 4.7 premature deaths related to BSS trips, mainly derived from the increment in physical activity. When we disaggregate the analysis by mode of transport, in all the cases the substitution of public transport, walk and car trips by BSS resulted in more health benefits. In the US, the average estimated health benefit-risk ratio for BSS was 19:1.

CONCLUSIONS: BSS in the US provides a health benefit for travelers. Improvements in air quality and traffic safety across the US cities will maximize the health benefits of BSS. This study supports the implementation and expansion of BSS across cities in the US.

Keywords: Transport, Bicycling, Bike-sharing systems, Health Impact Assessment, Physical activity, Air Pollution



ABSTRACT E-BOOK

P-341

Built environment » General

Health and equity opportunities of commercial corridors revitalization in Colorado

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BACKGROUND AND AIM: In the U.S. transport corridors have received large attention as an opportunity area for urban regeneration.

AIM. This study aims to quantify the health and equity impacts of land-use changes from low-density commercial corridors to high-density mixed-use commercial corridors with special attention on affordable housing and green spaces in Fort Collins and Denver, Colorado.

METHODS: This study quantified opportunities on housing, employment, and green space of commercial corridors regeneration, based on land use scenarios at the parcel level. For the health assessment, we quantified health impacts on mortality and disease incidence related to increases of urban vegetation at parcel level in both cities through a quantitative health impact assessment approach. We developed two main policy scenarios: a) transforming low-dense commercial parcels into mixed-use developments; and b) transform vacant and parking surface lots into green spaces.

RESULTS: In Denver, commercial corridors revitalization based on shifting low-density commercial parcels to mixed-use developments could absorb a 22% increment in city inhabitants, 29% new dwelling units, 59% new affordable housing, and 16% new jobs. In the same commercial corridors, the revitalization of vacant and parking surface lots to green spaces will increase 715 acres of green spaces across the city, resulting in a reduction of 35 premature deaths.

In Fort Collins, commercial corridors revitalization could absorb a 77% increment in city inhabitants, 115% new dwelling units, 600% new affordable housing, and 63% new jobs. In the same commercial corridors, the revitalization of vacant and parking surface lots to green spaces will increase 54 acres of green spaces across the city, resulting in a reduction of 5 premature deaths.

CONCLUSIONS: The regeneration of commercial corridors in Colorado could help to reduce urban sprawl, increase affordable housing, employment, green spaces, and health equity-related benefits.

Keywords: Commercial corridors, affordable housing, sprawl, green spaces, equity, health impact assessment



ABSTRACT E-BOOK

P-342

Built environment » Other (to be specified with keywords in the keywords section)

Influence of Urbanization on Physical Activity Across High, Middle and Low Income Countries

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BACKGROUND AND AIM: There is a growing body of literature examining how urbanization influence physical activity (PA), but most research is from developed countries. Limited evidence is available to inform how urbanization influences PA, and the specific domains of PA, in low and middle-income countries (LMICs).

METHODS: We evaluated the associations between urbanization and total PA, as well as work, leisure, home, and transport PA, for 138,206 adults (35-70 years) living in 800 communities across 27 countries within the Prospective Urban and Rural Epidemiology (PURE) study. PA was measured using the 1-week total PA long-form International PA Questionnaire (IPAQ) collected at study baseline (2005-2015). We measured urbanization using population density and impervious surface area for PURE communities and examined change per year for the 5-year period prior to PA measurements in each community. Hierarchical linear regression models were used to examine associations between urbanization metrics and PA.

RESULTS: The baseline mean (SD) population density and percent impervious area for study communities was 4276 people/sq km (7284) and 45% (36) respectively. Over a 5-year period prior to baseline, population density and impervious surface area change rate per year was 2 (1.4) and 4 (11), respectively. Change in population density was associated with decreases in total PA [-353 MET × min per week (95% CI: -584, -123) per 2% people/sq km increase). Small increases in transportation and recreational physical activity were associated with increased population density. Stratified analyses revealed increases in population density was associated with a larger decrease in total PA in HIC, in rural communities and for men. No consistent associations were observed for changes in impervious surface area of communities.

CONCLUSIONS: Urbanization influences PA levels, but the relationship is context dependent. This information will help to understand how urbanization influences PA and how urbanization can be optimized to enhance PA levels across different income countries.

Keywords: urbanization, physical activity, adult



ABSTRACT E-BOOK

P-343

Built environment » Noise

Environmental noise and admissions to the emergency service in population of Mexico City, 2012-2017. A case-crossover study

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BACKGROUND AND AIM: Environmental noise is a growing public health problem. International studies agree that exposure to high noise concentrations causes health damages, this kind of environmental noise exposition decreases quality of life, increases the risk of premature death or disability, increases inequity, and generates economic losses. In 2017, Mexico City was the seventh city with the highest noise pollution worldwide, however, there are no studies that show the effects on health, so it is relevant to generate national information to support decision-making about environmental noise policies. The aim of this study was to evaluate the association between complaints about environmental noise and admissions to emergency rooms in Mexico City during 2012-2017.

METHODS: Case-crossover study, bidirectional and symmetric. The exposure variable corresponds to noise complaints and the response variable is admissions to the emergency room for conditions previously related to the exposure.

RESULTS: A positive association was found between the number of complaints and admission to the emergency services for all the causes studied (OR 1.027 95% CI 0.99-1.06). After adjusting for meteorological covariates and air pollutants (OR 1.063 95% CI 1.00-1.12), the results remained with a positive and significant association. Similarly, this association was obtained when performing the stratified analysis between the number of complaints made for noise and admissions to the emergency room for the 50-59-year-old group (OR = 1.129 95% CI 1.00-1.26) and the Arterial Hypertension condition (OR = 1.088 95% CI 1.00-1.17), adjusted for meteorological covariates and air pollutants.

CONCLUSIONS: Even using proxy variables to measure the exposure to environmental noise in the general population, a positive and significant relationship is evidenced between it and the presence of acute health events in Mexico City during 2012-2017.

Keywords: Noise, Methodological study design, Environmental epidemiology



ABSTRACT E-BOOK

P-344

Outcomes » Other (to be specified with keywords in the keywords section)

Association between indoor green environment and mental health during COVID-19 lockdown period in a low-middle income country

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BACKGROUND AND AIM: There is increasing evidence that exposure to greenspaces promotes psychological well-being. The COVID-19 control measures restricted public greenspaces, which is likely to impact the people's psychological well-being. However, evidence on how the indoor or surrounding green environment might benefit mental well-being is limited when access to public greenspaces is restricted. As such, this research aims to examine the relationship between the presence of green environment (house and surroundings) and mental health in a low-middle income country during the COVID-19 lockdown period. The following hypotheses were tested: Is there any association between indoor green features (H1) and residential outdoor greenery access (H2) with psychological outcomes during the COVID-19 lockdown period?

METHODS: An online cross-sectional study was conducted with Bangladeshi residents (N=500) between February 2 to April 5, 2021. The psychological outcomes measured were anxiety (GAD-2) and depression (PHQ-2). Logistic regression estimated the association between green features and psychological outcomes after adjusting for the socioeconomic status, house type, crowding, long-standing illness and COVID-19 diagnosis information. To test for effect modification, interaction terms between sleep quality and green features, and between social interaction and green features, were added to models.

RESULTS: We found that the presence of more plants at home (OR = 0.89, 95% CI = 0.46-1.71, p<0.05), window views of outdoor greenery (OR = 0.83, 95% CI = 0.61-1.12, p<0.05), access to balcony (OR = 0.33, 95% CI = 0.18-1.18, p<0.1) and visits to open space (OR = 0.66, 95% CI = 0.40-1.07, p<0.1) were associated with less anxiety and depressive symptoms during the early stages of the COVID-19 lockdown. Interaction terms showed that sleep quality has a modifying effect on the relation between window green view and mental anxiety.

CONCLUSIONS: Our findings suggest that exposure to indoor greenery may be a valuable resource to improve mental health during social isolation at home.

Keywords: Greenspace, indoor greenery, COVID-19, mental health, Global south



ABSTRACT E-BOOK

P-345

Outcomes » Mortality

Long-term exposure to ambient fine particles and mortality: a longitudinal cohort study in Taiwan

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BACKGROUND AND AIM: Cohort studies on the positive association between long-term exposure to fine particulate matter (PM_{2.5}) and mortality have been well established for America and Europe but limited and inconsistent in Asia. This study drew on a large longitudinal cohort sample from Taiwan to investigate the associations between long-term exposure to ambient PM_{2.5} and all-cause and cause-specific mortality.

METHODS: A total of 400,459 adults (18 years of age or above) were enrolled from a standard medical examination program during the period of 2001 to 2016, and were followed up until 31 May, 2019. The mortality data were obtained from the National Death Registry maintained by the Ministry of Health and Welfare in Taiwan. The ambient PM_{2.5} exposures were estimated using a satellite-based spatiotemporal model. We performed a Cox regression model with time-dependent covariates to investigate the associations of PM_{2.5} with deaths from all-cause, natural-cause, cancers, cardiovascular diseases (CVDs), and influenza and pneumonia. Stratified and sensitivity analyses were also conducted.

RESULTS: We found that each 10µg/m³ increase in PM_{2.5} was associated with an increased hazard risk (HR) of 29% (95% confidence interval [CI]: 24%-35%) in all-cause mortality. The risk of deaths from natural-cause, cancers, CVDs, and influenza and pneumonia increased by 30%, 20%, 42%, and 53%, respectively for each 10µg/m³ increase in PM_{2.5}. Each participant could live 0.66 years longer if the PM_{2.5} concentrations was reduced to 10 µg/m³. The stratified and sensitivity analyses generally yielded similar results.

CONCLUSIONS: Long-term exposure to ambient PM_{2.5} is associated with increased risks of all-cause mortality and deaths from cancers, natural-cause, CVDs, and influenza and pneumonia. Longitudinal study design should be adopted for air pollution epidemiological investigation.

Keywords: Long-term exposure, Particulate matter, Mortality, Environmental epidemiology



ABSTRACT E-BOOK

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Cancer and Cancer-Precursors » Survival

Combined Effects of Chronic PM_{2.5} Exposure and Habitual Physical Activity on Cancer Mortality: A Longitudinal Cohort Study

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BACKGROUND AND AIM: Physical activity (PA) may increase the inhalation and deposition of air pollutants, possibly reducing its beneficial effects. We thus examined the combined effects of chronic exposure to fine particle matter (PM_{2.5}) and habitual PA on the risk of cancer mortality in Taiwan.

METHODS: A total of 384,128 adults (≥18 years) with 842,384 medical examinations were recruited between 2001 and 2016. All participants were followed up until May 31, 2019. Vital data were obtained from the National Death Registry of Taiwan. Ambient PM_{2.5} exposure was estimated using a satellite-based spatiotemporal model. Information on habitual PA was collected using a standard self-administered questionnaire. The time-dependent Cox regression model was used to evaluate the combined effects.

RESULTS: Higher habitual PA was associated with lower risk of cancer mortality, whereas higher PM_{2.5} exposure was associated with higher risk of cancer mortality. The inverse associations of habitual PA with cancer mortality were not modified by chronic exposure to PM_{2.5}. Compared to the participants with inactive-low-PA and high-PM_{2.5}, those with high-PA and low-PM_{2.5} exhibited a 35% lower risk of cancer mortality [95% confidence interval (CI): 28%-42%].

CONCLUSIONS: Increased PA and reduced PM_{2.5} exposure are associated with lower risk of cancer mortality. Habitual PA reduces the risk of cancer mortality regardless of the levels of chronic PM_{2.5} exposure. Our results indicate that habitual PA is a suitable health promotion strategy even for people residing in relatively polluted regions.

Keywords: Particulate matter, Long-term exposure, cancer mortality



ABSTRACT E-BOOK

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Air pollution » Wildfires

Costing the health impacts of prescribed burns and wildfire smoke in New South Wales, Australia

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BACKGROUND AND AIM: Fine particulate matter (PM_{2.5}), is associated with multiple adverse health outcomes and costs. Smoke produced during wildfires and prescribed burns, has the potential to produce substantial population exposure to PM_{2.5}. There is limited evidence on the aggregate and per hectare health burden attributable to wildfire smoke (WFS) and prescribed burning smoke (PBS). The aim of this study was to estimate health costs attributable to landscape fire smoke (LFS) PM_{2.5} in New South Wales, Australia, between July 2000 and June 2020.

METHODS: We applied a health impact assessment to estimate the health burden attributable to wildfire and prescribed burning smoke. We combined a spatial landscape fires database with estimated daily health costs attributable to LFS-related PM_{2.5} and estimated the total and per hectare health costs attributable to WFS and PBS.

RESULTS: Total health costs for the 20-year period were \$AUD 3,497 million (95% CI, 1,253 million – 5,800 million) (2018 Australian Dollars), with more than 70% of the burden attributable to WFS. Average estimated health costs per hectare burned for all LFS days were \$229, with higher costs for PBS (\$AUD 1,286 per hectare) compared to WFS (\$AUD 221 per hectare). We did a sensitivity analysis on the methods used to classify days as affected by WFS and PBS, and the time variables used to aggregate health costs and area burned (days, weeks, months, years), and our results remained consistent across all scenarios.

CONCLUSIONS: Our work quantifies significant health costs attributable to WFS and PBS. The substantially higher costs per hectare estimated for PBS should be further considered by fuel management policy as an input for the assessment of the trade-offs between wildfires and prescribed burns.

Keywords: Air pollution, Climate, Modeling, Policy, Wildfires



ABSTRACT E-BOOK

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Air pollution » Traffic-related

Impacts of Ambient Carbon Monoxide on Hospital Admissions and Hospitalization Expenditures for Three Cardiorespiratory Diseases in 74 Cities of China

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BACKGROUND AND AIM: Evidence about health burden and economic loss of cardiorespiratory diseases (CRDs) caused by ambient carbon monoxide (CO) is sparse. We aimed to assess health burden as well as economic loss caused by coronary heart disease (CHD), stroke and lower respiratory infections (LRI) attributed to ambient CO in multiple cities in China.

METHODS: Hospital admission and expenditures data were obtained from urban employee-based basic medical insurance scheme (UEBMI) of the national health insurance system in China. We performed a three-stage time-series analysis approach based on Generalized Linear Model controlling for potential confounding factors to examine the association between ambient CO and hospitalization data of CHD, stroke and LRI in 74 cities of China from January 1, 2015 to December 31, 2017. We conducted subgroup analyses by geographical region, gender and age (15-64 and ≥65), and tested the robustness of the results in two-pollutant models and sensitive analyses.

RESULTS: We found that the average daily concentration of ambient CO across 74 cities from 2015 to 2017 was 1.10 mg/m³ (SD: 0.62). For a 1 mg/m³ increase in CO concentrations, the largest excess risks (ERs) were 3.82% (95% CI: 1.27% to 6.44%) at lag04 for CHD, 3.14% (95% CI: 1.90% to 4.38%) at lag0 for stroke and 2.71% (95% CI: 1.21% to 4.23%) at lag01 for LRI. Moreover, we observed that 4.50%, 3.33% and 2.97% of CHD, stroke and LRI related hospital admissions during 2015 to 2017 could be attributed to ambient CO in included cities, and the annualized attributable numbers of hospitalization expenditures were enormous, with 490 million CNY (US\$ 73 M), 371 million CNY (US\$ 55 M) and 217 million CNY (US\$ 32 M) for CHD, stroke and LRI, respectively.

CONCLUSIONS: Our study provides robust evidence for substantial excess hospitalization burden of CHD, stroke and LRI attributable to ambient CO based on multi-city analyses.

Keywords: Air pollution, Cardiovascular diseases, Environmental epidemiology, Traffic-related, Respiratory outcomes



ABSTRACT E-BOOK

P-349

Air pollution » Traffic-related

Is metro railway a commute friendly option? an environmental health perspective

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BACKGROUND AND AIM: Installation of new transport facilities has quasi-stabilized the commute pattern in megacities. However, the subsequent effects on commuters' health are not well examined. This study aims to estimate commuters' relative risk (RR) in switching to newly installed metro railways from buses or auto-rickshaws in Mumbai. Additionally, how the adaptation to this newer facility will reduce the population attributable air pollution exposure has been estimated.

METHODS: The study is based on the real-time PM_{2.5} measurements inside different transportation modes and the observed travel activity pattern in Mumbai. PM_{2.5} was measured inside buses (without air-condition), auto-rickshaws and metro rails on a predefined route through several staggered trips. Household questionnaire survey of ~750 people was conducted to understand the existing commute behavior. The reduction in relative risk from all-cause mortality was deduced by dose-response function (DRF), assuming the metabolic rates to be consistent with previous studies.

RESULTS: PM_{2.5} levels inside metros were 2-3 times ($p < 0.05$) lower than buses ($128 \pm 25 \mu\text{g}/\text{m}^3$) and auto-rickshaws ($136 \pm 45 \mu\text{g}/\text{m}^3$). Thus for the same commute distance, using metros may reduce the relative risk by ~40%-80% than using buses or auto-rickshaws. Commuters travelling longer distances, will experience higher health benefits. Commuters residing within 2-3 km of the nearest metro station will have 25-30% lesser risk if there is a better feeder system to the station. Moreover, travelling any distance longer than 5 km by metro, will be beneficial for health irrespective of the feeder system. Based on the survey results, we have estimated that that overall the potential switch to metro travel in Mumbai will decrease the attributable risk by 1.2-1.4 times and largely this is due to the commuters traveling < 10 km.

CONCLUSIONS: This study concludes that the less polluting modes such as metros are beneficial for both the environment as well as public health, if supported by an efficient feeder system.

Keywords: Traffic Related Air Pollution, PM_{2.5}, Commute Pattern, Mass Transit, Relative Risks



ABSTRACT E-BOOK

P-350

Air pollution » Short-term exposure

Association between air pollution and hospital admissions for upper respiratory tract infection among children in urban area, Malaysia

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BACKGROUND AND AIM: Recent epidemiological studies have discovered the short-term effect of air pollution on upper respiratory tract infection (URTI). However, few studies have evaluated air pollution association with hospital admissions for URTI among Malaysian children. This study investigates the association between ambient air pollution and children's hospital admissions for URTI aged 0-17 years in Klang Valley, Malaysia, between 2010-2018.

METHODS: Daily URTI hospital admissions among children from 14 hospitals in Klang Valley were obtained via the national electronic database. Data on daily ambient air pollution (PM₁₀, SO₂, NO₂, CO and O₃) were collected from 7 local monitoring stations. A Poisson generalised linear model was used to evaluate the lag effects (lag 0-7) between daily changes in air pollutants and numbers of URTI hospital admissions among children in 2010-2018, after controlling for the confounding effects of long-term trends, day of the week, public holidays and meteorological factors. The analysis was stratified by sex and age.

RESULTS: Short-term exposure to PM₁₀, SO₂, NO₂, and CO had significant positive effects on the number of children hospitalised with URTI. The excess risk (ER) of total children admitted to hospitals for URTI was significantly associated with SO₂ at lag 2 days (ER 3.22%; CI 95% 0.01-6.53). The ER of girls hospitalised for URTI was associated with PM₁₀, NO₂ and CO with the highest ER for every 10 µg/m³ increase of the pollutants was 1.42% (CI 95% 0.00-2.86) at lag 0-4 days, 3.92% (CI 95% 1.06-6.87) at lag 0-5 days, and 0.19% (CI 95% 0.08-0.29) at lag 0-6 days, respectively. No significant associations were observed between air pollution and hospital admissions for URTI among boys and children age 10-17 years.

CONCLUSIONS: This study showed that short-term exposure to air pollution was positively associated with increased URTI admissions among children in Klang Valley, Malaysia.

Keywords: air pollution, short-term exposure, respiratory diseases, children's environmental health



ABSTRACT E-BOOK

P-351

Respiratory and Allergic Outcomes » Other (to be specified with keywords in the keywords section)

Long-term exposure to air pollution and prognosis of idiopathic pulmonary fibrosis

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BACKGROUND AND AIM: Short-term exposure to ambient air pollution has been associated with the prognosis of idiopathic pulmonary fibrosis (IPF). However, few studies have investigated the association of long-term exposure. This study aimed to investigate the association between long-term exposure to PM₁₀, PM_{2.5}, and NO₂ and the prognosis of IPF including hospital admission, disease progression (DP), and mortality.

METHODS: Our study population included 225 IPF patients, as a subset of a national multicenter prospective cohort of IPF in South Korea. We assessed individual long-term exposure as the annual average concentration of PM₁₀, PM_{2.5}, and NO₂ in 2015 at geocoded home addresses of cohort participants. The prognosis was defined as hospitalization, DP (> 10% of lung function decline), or death that occurred after IPF diagnosis. We applied Cox's proportional hazard model to estimate the hazard ratio(HR)s and 95% confidence interval(CI)s for IPF prognosis per 10 µg/m³ increase in PM₁₀ and PM_{2.5}, and 10 ppb increase in NO₂ after adjusting for the individual- and area-level characteristics.

RESULTS: HRs were mostly greater than 1 with some variation depending on the air pollutant and IPF prognosis, although all estimates were statistically insignificant possibly because of our limited sample size. For PM₁₀, HRs of hospital admission, DP, and mortality were 1.78 (95% CI=0.68-4.67), 1.25 (0.54-2.93), and 1.15 (0.50-2.63), respectively. PM_{2.5} gave a positive estimate only for DP (HR=6.30, 95% CI=0.94-42.29), while NO₂ showed only for mortality (1.09, 0.67-1.78).

CONCLUSIONS: Our pilot study provided suggestive evidence that long-term exposure to air pollution is associated with a poor prognosis of IPF. We plan to expand our study population to the full cohort and to re-examine the association.



ABSTRACT E-BOOK

Keywords: Long-term exposure, air pollution, IPF, cohort study, prognosis

P-352

Air pollution » Short-term exposure

Short-term exposure to airborne particulate matter and COVID-19 infection in South Korea

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BACKGROUND AND AIM: Coronavirus disease 2019 (COVID-19) has become a global public health problem. Previous studies have indicated that COVID-19 infection can occur through airborne transmission, and atmospheric particulate matter may favor the spread of the virus. This study aimed to explore the relationship between daily particulate matter ≤ 2.5 or 10 micrometers in diameter (PM_{2.5} or PM₁₀) and daily COVID-19 confirmed cases in South Korea.

METHODS: We obtained daily confirmed cases, PM concentrations, and meteorology in South Korea from the first occurrence on February 24 through December 31 in 2020. Using generalized additive model, we estimated relative risks (RRs) of COVID-19 new cases for a 10 $\mu\text{g}/\text{m}^3$ increase in PM averaged over the previous 1, 3, 5, 7, 10, 14, and 21 days after adjusting for a temporal trend, meteorology, new confirmed cases on the previous day, and day of week. Non-linear associations of the temporal trend and meteorology with new cases were assessed by using regression spline. In particular, we applied 35 degrees of freedom (df) to the temporal trend, which is larger than as used in previous studies to account for relatively short-term changes in new cases derived by people's activity patterns.

RESULTS: Although there was no evidence of the association of daily confirmed cases with recent exposures to PM_{2.5}, we found the positive association with extended exposure for the previous 14 and 21 days (RR=1.13, 95% CI=1.01-1.27; 1.17, 1.04-1.3, respectively). These patterns were similar for PM₁₀ (1.03, 0.95-1.12; 1.1, 1.00-1.2, respectively). The findings were also consistent with more or less adjustment for time in our sensitivity analysis.

CONCLUSIONS: Our findings suggested that airborne particulate matter can accelerate risk of COVID-19 transmission in two or three weeks. Further studies should account for other transmission-related characteristics to confirm the association.

Keywords: Air pollution, short-term exposure, COVID-19 incidence



ABSTRACT E-BOOK

P-355

Air pollution » Traffic-related

Have Air Quality Regulations in South Korea Improved or Exacerbated the Environmental Health Disparity?

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BACKGROUND AND AIM: Many studies found a gap in air quality and its health impacts by socio-economic status (SES) in South Korea. Although extensive air quality regulations have been implemented in Seoul, Korea, policy-level effort to reduce the disparity has been insufficient. Thus, this study aimed to evaluate the health benefits of air quality regulations in Seoul by area-level SES.

METHODS: Study area includes 25 "gu"s in Seoul ("gu" is a unit of an administrative district in Korea). Each gu was categorized into three groups based on the proportion of residents who received education higher than secondary school. Health benefits were estimated by multiplying relative risk (RR) for PM₁₀ and NO₂ with the change in annual average concentration after the regulations, respectively, which were expressed as the number of prevented deaths and years of life gained (YLG) per 100,000 for over 5 and 10 years. This study assumed a linear relationship between long-term exposure to air pollution and all-cause death using RRs derived from a meta-analysis. Summary RRs per 10µg/m³ increase of PM₁₀ and NO₂ were 1.04 (95% CI, 0.99, 1.10) and 1.03 (95% CI, 1.02, 1.05).

RESULTS: The baseline PM₁₀ concentration was lowest in regions having the highest SES. However, reduction in concentration was highest in regions having the lowest SES. For NO₂, the baseline concentration didn't show a gradient by area-level SES, but the reduction was highest in regions with the lowest SES. Accordingly, the prevented deaths and YLG for over 5 and 10 years were greatest in regions with the lowest SES and least in regions with the highest SES.

CONCLUSIONS: Air quality regulations in Seoul reduced the environmental health disparity in air quality, although specific pathways are still in a black-box. Further studies are needed to provide clear evidence, and it will enable policymakers to make appropriate policies for mitigating the disparity.

Keywords: Air Pollution, Environmental Policy, Health Disparity



ABSTRACT E-BOOK

P-356

Air pollution » Short-term exposure

Association between air quality and COVID-19 infection case numbers

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BACKGROUND AND AIM: The coronavirus disease (COVID-19) has become a global pandemic affecting many countries, including Singapore. Previous studies have investigated the relationship of air pollutant levels with respiratory disease risk and hospital admission rates. However, associations between air pollutant concentrations and COVID-19 infection remains unclear. This study aimed to assess the association between core air pollutant concentrations and daily confirmed COVID-19 case numbers in Singapore.

METHODS: Data on air pollutant levels (particulate matter [PM_{2.5}, PM₁₀], ozone [O₃], carbon monoxide [CO], nitrogen dioxide [NO₂], sulphur dioxide [SO₂] and pollutant standards index [PSI]) was obtained from the Singapore National Environment Agency from January 23, 2020 to April 6, 2020. The daily reported COVID-19 case numbers were retrieved from the Singapore Ministry of Health. Generalized linear models with Poisson family distribution and log-link were used to estimate the coefficients and 95% confidence intervals (CIs) for the association between air pollutant concentrations with COVID-19 case numbers, adjusting for humidity, rainfall and day of week.

RESULTS: We observed significantly positive associations between PM_{2.5}, NO₂ and PSI with COVID-19 case numbers. Every 1-unit increase (15-day MA) in PSI, 1 µg/m³ increase (15-day MA) in PM_{2.5} and NO₂ were significantly associated with a 35.0% (95% CI: 29.7%–40.5%), 22.6% (95% CI: 12.0%–34.3%) and 34.8% (95% CI: 29.3%–40.4%) increase in the average daily number of COVID-19 cases respectively. On the contrary, PM₁₀, O₃, SO₂, CO were significantly associated with lower average daily numbers of confirmed COVID-19 cases.

CONCLUSIONS: Future studies could explore the long-term consequences of the air pollutants on COVID-19 infection and recovery.

Keywords: Air quality, COVID-19, Infection



ABSTRACT E-BOOK

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Air pollution » Traffic-related

Exposure to exhaust fume at work is associated with hearing impairment

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BACKGROUND AND AIM: To determine whether hearing impairment, defined by using objective audiometry, is associated with exhaust fume exposure at work.

METHODS: Study participants are US adults aged 18 years or older (N = 3,867) who participated in the National Health and Nutrition Examination Survey (NHANES), 2007-2012, a nationally representative sample. Hearing ability was defined according to a speech-frequency pure tone average of thresholds at 0.5, 1, 2, and 4 kHz in the better-hearing ear. Thresholds of hearing impairment severity were based on American Speech-Language Hearing Association guidelines (normal hearing <25.0 dB, mild to profound impairment ≥25.0).

RESULTS: After adjusting for sex, BMI, income, education level, smoking status, multivariate odds ratios (ORs) for hearing impairment were 1.521 (95%CI, 1.042 - 2.221) comparing normal hearing for 65 years or older

CONCLUSIONS: Exposure to exhaust fume at work were significantly associated with hearing impairment for 65 years or older.

Keywords: Exhaust fume, Exhaust gas, Hearing impairment



ABSTRACT E-BOOK

P-358

Air pollution » General

Associations between air pollution and depressive symptoms in older adults: a repeated measurement study

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BACKGROUND AND AIM: Epidemiological studies concerning the relationships between different exposure windows of air pollution and symptoms of depression in older adults are limited. Hence, we investigate the relations between short-term and long-term exposure to ambient air pollution (PM₁₀, O₃, SO₂, CO, and NO_x) and depressive symptoms in a community-dwelling, free-living elderly population.

METHODS: Study participants were in a multiple-wave representative sample (Taiwan Longitudinal Study on Aging, n=1956). In four surveys between 1996 and 2007, their depressive symptoms were assessed using the 10-itemed Center for Epidemiologic Studies Depression (CESD-10). We estimated air pollution from 1993 to 2007, including daily concentrations of five air pollutants from air quality monitoring stations, based on the administration zone of each participant's residence. Generalized linear mixed models were applied to examine these associations after adjusting for covariates at different exposure windows (7-, 14-, 21-, 30-, 60-, 90-, 180-days, and 1-year moving averages).

RESULTS: In one-pollutant model, the short-term and long-term exposure to CO and NO_x were associated with increased risk of depressive symptoms; the ORs and 95% CIs for each 1 ppm increment in CO at 7-, 14-, 21-, 30-, 60-, 90-, 180-days, and 1-year moving averages were 2.23 (1.53, 3.27), 2.27 (1.63, 3.16), 2.19 (1.62, 2.96), 2.23 (1.62, 3.07), 2.12 (1.55, 2.90), 2.15 (1.55, 2.98), 2.14 (1.53, 2.99), 2.13 (1.56, 2.91), respectively. Moreover, for each 10 ppb increment in NO_x at series exposure windows were 1.16 (1.08, 1.25), 1.18 (1.11, 1.26), 1.17 (1.11, 1.24), 1.18 (1.11, 1.25), 1.18 (1.11, 1.26), 1.18 (1.11, 1.26), 1.18 (1.11, 1.26), 1.18 (1.11, 1.26), respectively. In two-pollutant model, only the associations of exposure to NO_x with depressive symptoms remained robust after adjustment for any other pollutant.

CONCLUSIONS: Exposure to traffic-related air pollutants could increase the risk for depressive symptoms in older adults.

Keywords: air pollution, depressive symptoms, older adults, repeated measurement.



ABSTRACT E-BOOK

P-360

Air pollution » Traffic-related

A South Bronx Community-based Study: Impacts on Traffic, Air Pollution, and Noise from a Large Delivery Service Warehouse

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BACKGROUND AND AIM: Mott Haven, a low-income neighborhood in New York City, suffers from increased air pollution and accommodates several industrial facilities and interstates. In 2018, a large delivery service warehouse opened. In 2018, incentivized with a \$100 million subsidy, an online grocery delivery warehouse opened, potentially increasing traffic in the overburdened community. Our objectives were to characterize black carbon (BC), fine particulate matter (PM_{2.5}), and noise in the community; model changes in traffic due to the facility opening; and estimate associated BC and noise changes.

METHODS: BC, PM_{2.5}, and noise were measured at eight sites pre-opening, and traffic counted continuously at two sites (June 2017-May 2019). An interrupted time series model was used to determine change in traffic flow due to the facility opening. Post-opening changes in traffic-related BC/noise were estimated from regressions of BC/noise with traffic flow.

RESULTS: Mean (SD) pre-warehouse measures of BC and PM_{2.5} were 1.33 µg/m³ (0.41) and 7.88 µg/m³ (1.24), respectively. At four of eight sites, equivalent sound levels exceeded EPA's recommended 70 dBA limit. After the warehouse opening, traffic increased significantly, predominantly at night. At one site, the greatest change for trucks occurred 9PM-12AM: 31.7% (95%CI: 23.4%, 0.6%). Increased traffic translated into mean predicted increases of 0.003 µg/m³ (BC) and 0.06 dBA (noise).

CONCLUSIONS: In a community already impacted by high traffic, we found significantly increased traffic flow after the opening of a single additional warehouse. The increase in air pollution was small but of concern, because it negates the substantial decrease the community seeks. Our findings can help communities and policymakers better understand the impacts of traffic-intensive facilities.

Keywords: Traffic-related, Noise, Particle components, Particulate matter, Community outreach, Environmental justice



ABSTRACT E-BOOK

P-361

Air pollution » Traffic-related

Associations between Vehicle Miles Traveled and Ambient Air Pollution at Regulatory Monitoring Sites: A Natural Experiment using the COVID-19 Shutdown

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BACKGROUND AND AIM: Transportation planners calculate vehicle miles traveled (VMT) to forecast roadway usage and inform policy decisions. However, the relationship between VMT and ambient air pollution is not fully understood. In this analysis, we use proprietary smartphone sensing data with VMT calculations to examine the impact of VMT on ambient air pollution during the decline in vehicle usage from the COVID-19 shutdown. We aim to determine how VMT change contributes to change in NO₂, O₃, and PM_{2.5} concentrations and at what spatial scale these changes occur.

METHODS: We obtained access to a daily national database with VMT calculations for January to July 2020, which corresponds to various stay at home orders that limited travel needs. We linked VMT measures at different buffer distances (100, 300, 500, 1000, 2000 and 3000m) to ambient air pollution monitor from the Environmental Protection Agency (EPA). We implement multi-level linear regression models to examine how NO₂, O₃, and PM_{2.5} changed with VMT reductions in different distance buffers around monitoring locations.

RESULTS: Preliminary results show consistent associations between VMT and O₃ and NO₂ at varying buffer distances, but these associations are less consistent for PM_{2.5}. For O₃, we observe a 0.18 ppb (95% CI: -0.21, -0.15) reduction per 1,000 VMT at the 100m buffer but this reduction increases to 0.47 ppb (95% CI: 0.52, 0.43) at the 3,000m buffer. For NO₂, we observe a 2.21 ppb (95% CI: 2.13, 2.30) increase per 1,000 VMT at the 100m buffer and results are similar out to the 3,000m buffer. When we split out VMT by road type, we find that models for VMT from expressways yield smaller magnitudes of association than the models for VMT from non-expressways.

CONCLUSIONS: These results will be used to inform future analyses on how congestion reduction projects impact local air pollution and population health.

Keywords: Traffic-related, Policy research, Exposure assessment-air pollution, Oxides of nitrogen, Particle components, Ozone



ABSTRACT E-BOOK

P-362

Air pollution » Traffic-related

Influence of Dose Metrics on Associations between Exposure to Black Carbon and Exhaled Nitric Oxide in Children with Asthma

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BACKGROUND AND AIM: Few studies examined the associations between fractional exhaled nitric oxide (FeNO) and traffic-related air pollution (TRAP) from individual dosimetry models. Our study aimed to assess the associations between FeNO and black carbon (BC, as a surrogate of TRAP) from four dose metrics. Besides, we aimed to examine if more refined dose metrics would impact the health risk estimates.

METHODS: We recruited 35 children with asthma living in environmental justice communities. Daily FeNO measurements were followed for up to 30 days for each child. Four dose metrics were calculated based on measurements from a central-site and personal monitors, with and without estimates of inhalation rates based on a self-reported time-activity questionnaire. Linear mixed effect models were used to test the associations of BC at different lag periods and FeNO.

RESULTS: Exposure to BC was positively associated with FeNO within the first 24 hours of exposure. A log-transformed interquartile range increase in inhaled dose from metrics that used central-site estimates (Model A, C) increased 7% (95% CI: 1% - 14%) and 6% (95% CI: 0% - 13%) in FeNO at lag 0-6 hours in the adjusted model 4. The strength of association persisted at lag 7-12 hours and then decreased and became insignificant at longer lag periods. Similarly, the inhaled dose from personal monitored estimates (Model B, D) was positively associated with FeNO within the first 24 hours. Using personal BC measurements or dynamic inhalation rate did not improve prediction of changes in FeNO.

CONCLUSIONS: Our findings revealed that inhaled BC dose significantly increases FeNO level within the first 24 hours of exposure. Our results provide evidence that personal exposure to BC was associated with airway inflammation among children with asthma. Our results also add to the limited number of studies that compared the effect estimates among alternative dose metrics within a single study.

Keywords: traffic-related, air pollution, Short-term exposure, asthma, Children's environmental health



ABSTRACT E-BOOK

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Air pollution » Mixtures

Mixture effects of air pollutants on children's urinary levels of 8-isoprostane, a biomarker of oxidative stress

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BACKGROUND AND AIM: In single-pollutant models, individual air pollutants are reported to be associated with elevated levels of urinary 8-isoprostane, a marker of oxidative stress. Several air pollutants are highly correlated and might have joint effects in inducing oxidative stress, best assessed using mixture methods.

METHODS: Urinary total 8-isoprostane was measured in 299 children (ages 6–8) from the Fresno, CA area and adjusted for creatinine levels. Individual-level exposure to seven pollutants: (sum of 4-, 5-, and 6-ring polycyclic aromatic hydrocarbon compounds (PAH456), nitrogen dioxide (NO₂), carbon monoxide (CO), ozone (O₃), elemental carbon (EC), and particulate matter <2.5 μm (PM_{2.5}) and <10 μm in diameter (PM₁₀)) at the primary residential location was modelled with a spatiotemporal model up to a year prior to outcome assessment. To estimate mixture cumulative, potential non-linear and interactions in effects of pollutants on levels of 8-isoprostane, we relied on weighted quantile sum (WQS) regression and Bayesian kernel machine regression (BKMR).

RESULTS: WQS regression indicated a 70% (95% CI: 11%, 130%) increase in the urinary levels of the 8-isoprostane associated with a tertile increase in the WQS index of the air pollution mixture averaged over a 6-month period. O₃, EC and PAH456 contributed most to this overall mixture effect (sum of average weights = 79%). Associations were lower in magnitude and CIs included the null for other exposure windows. BKMR did not yield a significant mixture effect, although, similar to WQS, this model highlighted O₃, EC, and PAH456 as important contributors to the overall mixture effect (posterior inclusion probabilities range: 41 to 57%). BKMR was also suggestive of interactions between various pollutants.

CONCLUSIONS: Air pollutants may induce cumulative and joint oxidative stress effects in children. Future studies with larger samples may help confirm findings on the magnitude of mixture effects as well as presence of interactions between pollutants.

Keywords: Air pollution, Mixtures, Oxidative stress



ABSTRACT E-BOOK

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Air pollution » Oxides of nitrogen

Prenatal Air Pollution Exposure and Longitudinal Infant Weight Gain Trajectories

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BACKGROUND AND AIM: The prenatal period may play a critical role in childhood obesity development. We examined the association between prenatal nitrogen oxides (NO_x) and nitrogen dioxide (NO₂) exposure and weight trajectories from birth to 2-years-of-age among infants in the Maternal and Development Risks from Environmental and Social Stressors (MADRES) pregnancy cohort.

METHODS: Participants were enrolled during pregnancy and their children were followed up to 2 years. Anthropometric measurements were collected using a combination of medical record abstractions and study-staff measurements (n=471 participants; n=4,287 observations). Residential exposure to NO_x and NO₂ were estimated as: 1) spatial interpolation from air quality monitoring stations (daily NO₂, ambient background), 2) CALINE4 line source dispersion modeled contribution from nearby roadways (daily NO_x, traffic-related), and predictions from a machine-learning based spatiotemporal model (weekly NO₂ and NO_x, R²=0.87, RMSE=2.80 ppb). Exposures were averaged across pregnancy accounting for variable gestation lengths. Sex-stratified quadratic growth curve models were used to assess the association between prenatal NO₂/NO_x exposure and infant weight trajectories.

RESULTS: Prenatal spatiotemporal model predicted NO₂ exposure was associated with infant growth trajectories for both sexes. Infants experienced the most rapid growth early on with an average deceleration in weight gain of 0.02 grams/day over the two-year period. Among females (n=243), a 1-SD increase (3.3 ppb) in NO₂ exposure was significantly associated with growth acceleration of 0.001 grams/day (p=0.02) such that at 2-years-of-age, children exposed to higher prenatal NO₂ weighed significantly more than lower-exposed individuals. Among males (n=228), the linear and quadratic parameters of growth were both statistically significant. However, by 2 years the trajectories converged and no significant differences in weight were observed. We found similar trends when examining NO_x and ambient NO₂ exposures.

CONCLUSIONS: Our findings show prenatal NO₂/NO_x exposure may play a role in childhood obesity, with more pronounced effects on weight gain in females.

Keywords: Air pollution, oxides of nitrogen, birth outcomes, children's environmental health



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-365

Air pollution » Short-term exposure

Impact of Air Pollution on High-Caliber Athletic Performance

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BACKGROUND AND AIM: Athletes who regularly train and compete outdoors experience elevated levels of exposure to air pollutants due to high minute ventilation rates. While many sports committees use the US Environmental Protection Agency's Air Quality Index (AQI) to monitor the safety of high pollution events, little is known about the effect of repeated exposure to lower levels of air pollution. To quantify the burden, we estimated the association between repeated exposure to particulate matter (PM_{2.5}) and ozone and race performance of collegiate athletes using pollutant concentrations, two-pollutant (PM_{2.5} and ozone) version of the AQI, and a summed version of the AQI.

METHODS: We aggregated data on 334 collegiate male track & field athletes from 46 universities across the United States during the years 2010-2014, comprising a total of 1,104 5-km meter race outcomes. Using distributed lag non-linear models (DLNMs), we analyzed the relationship between race performance and air pollution exposures 21 days prior to the race. We reported cumulative effect estimates for the change in average race time associated with increases in exposure from the 20th to 80th percentile.

RESULTS: We observed a 12.8 (95% CI: 1.3, 24.2) second and 11.5 (95% CI: 0.8, 22.1) second increase in 5-km race times from 21 days of exposure to PM_{2.5} concentration (10.3 µg/m³ versus 4.9 µg/m³) and ozone concentration (54.9ppm vs. 36.9ppm), respectively. Exposure measured by the two-pollutant AQI was not significantly associated with race time (95% CI: -5.23, 16.60); however, the association for summed two-pollutant AQI was similar to the associations for the individual pollutants (12.4 seconds, 95% CI: 1.8, 23.0).

CONCLUSIONS: Training and competing at consistently higher levels of air pollution were associated with higher race times. This is a first step at identifying the association between pollution and running performance and a foundation for why coaches should consider approaches to reduce air pollution exposure.

Keywords: athletic performance, air pollution, particulate matter, ozone



ABSTRACT E-BOOK

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Air pollution » Traffic-related

Forty years of road transport NOX emissions reductions in the contiguous United States: an environmental justice analysis

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BACKGROUND AND AIM: Road transport-related nitrogen oxide (NOX) emissions in the United States (US) were drastically reduced over the last forty years. These improvements were mainly driven by environmental policies aiming to reduce emissions and, consequently, exposure to air pollutants. Prior research has identified inequalities in air pollution exposures in the US but, to our knowledge, no studies have evaluated potential disparities in emissions reductions across the country. We aim to describe the nationwide distribution of NOX emission reductions from 1970 to 2010 by race/ethnicity and socioeconomic status.

METHODS: We conducted analyses at the county level from 1970 to 2010 across the contiguous US. We used annual NOX transport emissions estimated by a global emissions inventory model at 50km² grid resolution, which we aggregated to area-weighted county averages. We obtained annual county-level race/ethnicity, education, family income, poverty, unemployment, and house value data from decennial Census and the American Community Surveys. We used a mixed-effects model with random intercepts for counties nested within states to estimate the change in kg/km²/day in emissions between decades, given county socio-demographics.

RESULTS: On average, annual road transport NOx emissions in the US have decreased by 42% between 1970 and 2010. We found that a one standard deviation (SD) increase in the percent White or Black population was associated with an increase in the reduction of NOx emissions ($\beta=0.48$, 95%CI: 0.37, 0.59 and $\beta=0.45$, 95%CI: 0.35, 0.56 respectively). Conversely, one SD increased in percent poverty or unemployment was associated with a decrease in the emissions reduction ($\beta= -0.17$, 95%CI: -0.19, -0.14 and $\beta= -0.02$, 95%CI: -0.04, -0.004 respectively), that is, a smaller reduction in NOx emissions.

CONCLUSIONS: Our preliminary results suggest that the decreases in road transport NOx emissions over the last decades may vary across counties based on socio-economic and demographic characteristics.

Keywords: Oxides of nitrogen, air pollution, environmental justice, environmental disparities, policy



ABSTRACT E-BOOK

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Air pollution » Short-term exposure

Air Pollutants and Daily Outpatient Visits for Cardiovascular and Cerebrovascular Diseases in Central Taiwan

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BACKGROUND AND AIM: This study aimed to evaluate the health impacts of air pollutants and meteorological factors (fog, haze, and low cloud) under megacity conditions in central Taiwan. In addition, we used the Kriging interpolation and land use regression for more accurate exposure assessment.

METHODS: We retrieved daily records of outpatient department (OPD) visits from the Health and Welfare Data Science Center of the Ministry of Health and Welfare of Taiwan and included those for ischemic heart and cerebrovascular diseases (ICD-9 codes 410 to 414 and 430 to 438; ICD-10 codes: I20 to I25 and I60 to I69) in 2016. We combined the air pollution data on the level of fine aerosol and chemical components obtained from the air quality monitoring stations established by the Environmental Protection Administration in the Taichung and Nantou areas with the meteorological data obtained from the Central Weather Bureau to assess their associations with the OPD visits. Autoregressive integrated moving average and classification and regression trees models were constructed to evaluate and describe the effects of air pollutants and meteorological factors on the OPD visits for ischemic heart and cerebrovascular diseases.

RESULTS: The PM_{2.5} measured at station in Nantou and Changhua were significantly higher than those measured at stations in Taichung. The OPD visits for cardiovascular and cerebrovascular diseases by residents nearby the station in Nantou and Changhua were also significantly more than those paid by residents nearby the stations in Taichung. OPD visits for ischemic heart and cerebrovascular diseases had positive association with PM_{2.5} concentration on the same day and the day before.

CONCLUSIONS: The level of PM_{2.5} was associated with OPD visits for ischemic heart and cerebrovascular diseases on the same day and the next day. Further studies are needed to identify the susceptible populations and evaluate the impacts.

Keywords: Fine particulate matters, air pollution, and cardiovascular diseases



ABSTRACT E-BOOK

P-368

Air pollution » Short-term exposure

Short-term effects of cumulative exposure to ambient air pollution on cardiovascular emergency department visits in Mexico City

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BACKGROUND AND AIM: Available data on the acute cardiovascular effects of ambient air pollution in Latin America is limited considering that over 80% of its 1 billion inhabitants live in urban centers with poor air quality. The study aim was to evaluate the acute effects and attributable burden of cumulative exposure to PM_{2.5}, NO₂, SO₂ and CO, on Cardiovascular Emergency Department Visits (CEDVs) in Mexico City from May 2016 to February 2019 using a time-series analysis.

METHODS: Daily count of CEDVs were collected from 38 medical units, as well as measurements of ambient air pollutants from 35 level-ground stations. We estimated daily pollutant exposure using inverse distance weighting interpolation and buffer analysis. Quasi-Poisson Generalized Additive Models and Distributed Lag Models were used to examine the percentage change of CEDVs associated to each pollutant. Then, we conducted a backward approach of time-series model to calculate attributable fractions considering the cumulative exposure effect.

RESULTS: A total of 48,891 CEDVs were recorded in a period of 1,019 days. We estimated a significant percentage change of CEDVs for each 10 µg/m³ of PM_{2.5} at lag0-6 (3.7%, IC95% 0.1 – 7.6), O₃ at lag0-5 (1.1%, IC95% 0.2 – 2.0), NO₂ at lag0-4 (2.5%, IC95% 0.3 – 4.7) and for each 1 mg/m³ of CO at lag0 (6.6%, IC95% 0.3 – 13.2). The estimated effects were higher in female population. Overall, 9.5% of CEDVs in Mexico City may be related to PM_{2.5} ambient exposure, 10.3% to O₃, 11% to NO₂ and 5.7% a CO.

CONCLUSIONS: Exposure to ambient air pollution has an effect on CEDVs in a Latin American city. The implementation of air quality control measures could significantly reduce the impact of cardiovascular diseases on emergency department services, which lead the main cause of death in Mexico and in the world.

Keywords: Ambient air pollution, Latin America, Cardiovascular, Emergency department visits, Attributable fraction



ABSTRACT E-BOOK

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Air pollution » Short-term exposure

Associations between Acute Exposures to PM_{2.5} and Carbon Dioxide Indoors and Cognitive Function in Office Workers

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BACKGROUND AND AIM: Despite the growing evidence of the effects of air pollution on cognitive function, there is scarce information about the acute effects of indoor air pollution on cognitive function among the working-age population, or whether the effects are observed even at low exposure levels. Our aim is to investigate whether cognitive function was associated with real-time indoor concentrations of particulate matter (PM_{2.5}) and carbon dioxide (CO₂).

METHODS: Analysis of a prospective observational longitudinal study among 302 office workers in urban commercial buildings located in six countries (China, India, Mexico, Thailand, the United States of America, and the United Kingdom). For a 12-month period, indoor environmental data using commercial real-time monitors were collected, and ecologic momentary assessments of cognitive function using the Stroop color-word test and Addition-Subtraction test (ADD) were administered via a custom-developed mobile research app.

RESULTS: Higher CO₂ and PM_{2.5} indoor concentrations were significantly associated with decreased performance on the Stroop and ADD tests. Each interquartile (IQR) increase in PM_{2.5} (IQR=8.8 µg/m³) was associated with a 0.82% (95%CI: 0.42, 1.21) increase in Stroop response time, a 6.18% (95% CI: 2.08, 10.3) increase in Stroop interference time, a 0.7% (95% CI: -1.38, -0.01) decrease in Stroop throughput, a 0.66% (95% CI: -0.16, 1.49) increase in ADD response time, and a 1.51% (95% CI: -2.65, -0.37) decrease in ADD throughput. For CO₂, each interquartile (IQR=315ppm) was associated with a 0.85% (95% CI: 0.32, 1.39) increase in Stroop response time, a 7.88% (95% CI: 2.08, 13.86) increase in Stroop interference time, a 1.32% (95% CI: -2.3, -0.38) decrease in Stroop throughput, a 1.13% (95% CI: 0.18, 2.11) increase in ADD response time, and a 0.72% (95% CI: -2.11, 0.63) decrease in ADD throughput.

CONCLUSIONS: We found that higher PM_{2.5} and lower ventilation rates are associated with acute effects on cognitive function.

Keywords: indoor air quality, cognitive function, exposure assessment



ABSTRACT E-BOOK

P-370

Other » Other (to be specified with keywords in the keywords section)

Air pollution and emergency department visits for disease of the digestive system

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BACKGROUND AND AIM: The objective of this work was to investigate associations between air pollution and emergency department (ED) visits for diseases of the digestive system in Toronto, Canada.

METHODS: The National Ambulatory Care Reporting System database was used to retrieve the cases of the diagnosed ED visits. The codes K00-K93 under Chapter XI: “Diseases of the digestive system” of the International Classification of Disease 10th Revision were applied to identify the corresponding ED visits. Only primary causes of ED visits were considered. The health data used in the study was organized as daily counts of ED visits, to which ambient air pollution and weather factors (temperature and relative humidity) were linked. Exposure to two air quality health indexes and six ambient air pollutants for exposure: fine particulate matter PM_{2.5}, O₃, CO, NO₂, SO₂, and maximum 8-hour average ozone was used. Statistical models were realized as conditional Poisson regressions.

RESULTS: In total, 993,364 ED visits were analyzed as related to the digestive system. A total of 314 statistically significant (P-Value <0.05) positive correlations were obtained over the 14 day lag period (from 0 to 14 days). Majority of the positive associations occurred for lags from 0 to 4, and were in summary for all pollutants and strata 71, 46, 66, 25, and 35, respectively. For nitrogen dioxide, positive associations were noted with following relative risks (RR) for an increase of one interquartile range (IQR=8.8 ppb): RR= 1.032 (95% confidence interval: 1.025, 1.039), 1.013 (1.005, 1.020), 1.013 (1.006, 1.021), 1.008 (1.000, 1.015), and 1.008 (1.000, 1.015) for all patients and lags from 0 to 4 days, respectively.

CONCLUSIONS: The results indicate that urban ambient air pollution could influence the daily cases of ED visits for diseases of the digestive system. Ambient nitrogen dioxide was identified as the main environmental factor contributing to these associations.

Keywords: Digestive, Nitrogen dioxide, Traffic-related, Short-term exposure



ABSTRACT E-BOOK

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Climate » Temperature

Socioeconomic inequality in vulnerability to all-cause and cause-specific hospitalisation associated with temperature variability: a time-series study in 1814 Brazilian cities

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BACKGROUND AND AIM: Exposure to temperature variability has been associated with increased risk of mortality and morbidity. We aimed to evaluate whether the association between short-term temperature variability and hospitalisation was affected by local socioeconomic level in Brazil.

METHODS: We collected city-level socioeconomic data, and daily hospitalisation and weather data from 1814 Brazilian cities between Jan 1, 2000, and Dec 31, 2015. All-cause and cause-specific hospitalisation data was from the Hospital Information System of the Unified Health System in Brazil. City-specific daily minimum and maximum temperatures came from a 0.25° × 0.25° Brazilian meteorological dataset. We represented city-specific socioeconomic level using literacy rate, urbanisation rate, average monthly household income per capita and GDP per capita over the study period. We used quasi-Poisson regression to do time-series analyses and obtain city-specific associations between temperature variability (TV) and hospitalisation. We pooled city-specific estimates according to different socioeconomic quartiles or levels using random-effect meta-analyses.

RESULTS: We included a total of 147 959 243 hospitalisations (59.0% female) during the study period. Overall, we estimated that the hospitalisation risk due to every 1°C increase in the temperature variability in the current and previous day (TV₀₋₁) increased by 0.52% (95% CI 0.50–0.55). For lower-middle-income cities, this risk was 0.63% (95% CI 0.58–0.69), for upper-middle-income cities it was 0.50% (0.47–0.53), and for high-income cities it was 0.39% (0.33–0.46). The socioeconomic inequality in vulnerability to TV₀₋₁ was especially evident for people aged 0–19 years (effect estimate 1.21% for lower-middle income vs 0.52% for high income) and people aged 60 years or older (0.60% vs 0.43%), and for hospitalisation due to infectious diseases (1.62% vs 0.56%), respiratory diseases (1.32% vs 0.55%), and endocrine diseases (1.21% vs 0.32%).

CONCLUSIONS: People living in less developed cities in Brazil were more vulnerable to hospitalisation related to temperature variability, which could exacerbate existing health and socioeconomic inequalities in Brazil.

Keywords: Temperature extremes and variability, Socio-economic factors (non-chemical stressors), Environmental justice, Environmental disparities



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Effects of hot weather on kidney disease morbidity and mortality: A systematic review and meta-analysis of epidemiological evidence

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BACKGROUND AND AIM: In the context of global warming and increase in kidney disease prevalence, a large body of literature suggests that high temperature is a risk factor for the development and exacerbation of kidney disease. However, limited studies have quantitatively summarised the evidence. This study systematically reviews the epidemiological evidence and summarises the quantitative effects of heat on kidney disease (ICD-10 N00-N39), including morbidity and mortality.

METHODS: A systematic search of peer-reviewed epidemiological studies in PubMed, Embase, Scopus, CINAHL, and Web of Science that linked high temperatures and kidney disease outcomes was conducted on literature published from 1990 to November 2020. We included studies that examined the quantitative association between temperatures and kidney disease morbidity (i.e. hospital admissions, emergency department visits, and medical services) or mortality in the general population, and evaluated the quality of evidence. Random-effects meta-analyses were conducted to pool relative risks (RRs) of the association between high temperatures (and heatwaves) and kidney disease outcomes.

RESULTS: From the 2739 identified studies, 91 were included in the review and 82 contributed to our meta-estimates. A 1 °C increase in temperature was associated with a 1% increase for kidney-disease morbidity (RR 1.010; 95% CI: 1.009-1.011), with the greatest risk for urolithiasis. For mortality, there was a 3% (RR 1.031; 95% CI: 1.018-1.045) increase in the risk per 1 °C temperature rise. The risk of kidney disease outcomes also increased in association with heatwaves, and a positive trend was observed for the risk of morbidity with increasing heatwave intensity (low, middle, high). In subgroup analyses, there were elevated risks for males, people aged less than 64 years, and those living in temperate climate zones.

CONCLUSIONS: Our findings show clear evidence of the association between heat exposure and kidney disease outcomes. Action is crucial to minimize the adverse impacts of rising temperature on kidney health.

Keywords: Risk assessment, Environmental epidemiology, Climate, Short-term exposure, Temperature extremes



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

How had climate variability affected the scrub typhus incidence in South Korea?

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BACKGROUND AND AIM: Climate change such as global warming unexpectedly compromised human health in particular increased incidence of infectious diseases. We aimed to investigate the long-term effects of climate variability on the scrub typhus incidence in South Korea.

METHODS: Meteorological variables were conjoined with scrub typhus cases reported from 2001 to 2019 in South Korea. Generalized additive model was used to explore the non-linearity of the lagged association between meteorological variables and weekly scrub typhus incidence. Then, modified generalized linear models were used to estimate weekly incidence changes beyond the identified thresholds of mean ambient temperature and relative humidity. Further, increases in annual average temperature and the number of heatwave days were linearly regressed for scrub typhus cases from September to December.

RESULTS: Mean ambient temperature and relative humidity above thresholds were linearly associated with the scrub typhus incidence with a simple lag of 15 weeks. Thresholds of mean ambient temperature and relative humidity ranged from 8.0°C to 11.6°C and from 29.7% to 65%, respectively. An increase in weekly incidence from September to December ranged from 11.2% (95% CI: 8.7, 13.8) to 35.7% (95% CI: 29.6, 42.1) per 1°C elevation in mean ambient temperature from June to August. Compared to the past 30 years' averages, mean ambient temperature elevated and the number of annual heatwave days increased. Scrub typhus cases between September and December increased by 481 (95% CI: 377, 585) per 1°C increase in mean ambient temperature, and by 406 (95% CI: 393, 419) as the annual number of heatwave days increased.

CONCLUSIONS: Mean ambient temperature elevation and relative humidity increase in the summer was associated with the increased incidence of scrub typhus in the fall. Increased annual average temperature and the number of heatwave days for the last 19 years were associated with increased scrub typhus cases in a peak period.

Keywords: climate change, temperature, humidity, scrub typhus, infections



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Outcomes » Infectious diseases

The impact of climate on infectious diseases in under-sixteen children in Varanasi City, India: A Prospective Cohort Study

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BACKGROUND AND AIM: The effects of climate on infectious diseases associated with children may increase their vulnerability under climate change scenario, the effect will be much apparent in an unfair socioeconomic condition like India. Thus the study aims in analyzing the association of climate with infectious diseases in children under 16 years of age in Varanasi city, India.

METHODS: In a community based cohort of 457 children under 16 years of age followed for three years from January 2017 to Jan 2020, a binomial regression was used to examine the association of maximum temperature; Tmax, relative; RH and absolute humidity; AH, rainfall; RF, solar radiation; SLR, and wind speed; WS with group of infectious diseases (gastrointestinal tract infection; GIT, upper; URTI and lower respiratory tract infection; LRTI, skin disease and vector-borne disease; VBD), adjusting for potential confounders and effect modifiers (socioeconomic status; SES and child anthropometry).

RESULTS: The result shows with each unit (1°C) increase in Tmax GIT and VBD increased by 4.18% and 6.09% respectively, and each unit (1°C) decline in Tmax increased URTI and Skin diseases by 3.35% and 3.6% respectively. RH (2.73%) and SLR (9.93%) shows association (positive) only with URTI. Increase in VBD (6.09%) and Skin disease (10.13%) was observed with each unit (1kg/m³) increase in AH and increase in LRTI (3.02%) with each unit decrease. WS shows association with most of the disease categories and RF showing little effect but significant. SES and anthropometric parameters shows to modify the association between climate and diseases as good proportion of children fell in stunting, wasting, and underweight categories.

CONCLUSIONS: Study findings advocate prioritization of effective measures by government and policymakers to curb child morbidity burden as the effect of climate could be more devastating under climate change scenarios in proportion of children that are already malnourished.

Keywords: Infectious diseases, Climate, Environmental epidemiology, Socio-economic factors, Children's environmental health



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Extreme temperature, health, and disability: A comparison of health effects between people with and without disabilities

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BACKGROUND AND AIM: People with disabilities are at greater risk of being socially and materially deprived, engaging in health-risk behaviors, and having comorbidities than the non-disabled population, which may impose an additional disease burden from extreme temperatures. However, no studies have compared the effects of extreme temperatures in people with and without disabilities. This study aimed to investigate the association of heat waves and cold spells with emergency hospital admissions by the existence of disability and disability types.

METHODS: The study subjects are from the Korean National Health Insurance Services –National Sample Cohort. We identified emergency admissions for non-external causes(NEC), cardiovascular(CVD), and respiratory(RES) diseases from people who resided in seven metropolitan cities in 2006-2013. A time-stratified case-crossover analysis using conditional logistic regression was used to investigate the association of heat wave and cold spell with emergency admissions. Heat wave and Cold spell were defined based on the intensity of temperature and duration of the day. The models were adjusted for daily PM10 concentration, relative humidity, and national holidays. We further explored effect modifications by the existence of a disability and disability types (physical, visual, hearing, intellectual disability/disability of brain lesion/mental disorder/kidney dysfunction).

RESULTS: The association between heat wave and emergency admissions for NEC was higher in people with disabilities (Odds ratio: 1.37, 95% Confidence Interval: 0.92, 2.04) than people without disabilities (OR: 0.92, 95% CI: 0.76, 1.12), which was consistent when using different heat wave definitions. A similar pattern was observed with respiratory admissions. However, the associations between cold spell and emergency admissions were similar or somewhat lower in people with disabilities than those without disabilities. We also found heterogeneity in the health effects of extreme temperatures among people with disabilities by their disability types.

CONCLUSIONS: To promote environmental health equity in an era of climate change, more attention to this unrecognized susceptible population is needed.

Keywords: Environmental disparities, Environmental justice, Temperature extremes



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Healthcare Costs of Emergency Department Presentations Related to Heatwave Intensity and Severity

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BACKGROUND AND AIM: The health impacts of heatwaves are a growing public health concern. However, little is known about the healthcare costs of heatwave-related morbidity. This study aims to examine the relationship between heatwaves and costs of emergency department (ED) presentations and to quantify heat-attributable presentations and costs in Adelaide, South Australia.

METHODS: Daily data on ED presentations and associated costs for the period 2014-2017 were obtained from the South Australian Department of Health and Wellbeing. Heatwave severity and intensity were determined using the excess heat factor (EHF) index, obtained from the Australian Bureau of Meteorology. A distributed lag non-linear model (DLNM) was used to quantify the cumulative risk of heatwave-intensity over a lag of 0-7 days on ED presentations and costs. Effects of heatwaves were estimated relative to no heatwave. The number of ED presentations and costs attributable to heatwaves was calculated separately for two EHF severity categories (low-intensity and severe heatwaves). Subgroup analyses by disease-diagnosis groups and age categories were performed.

RESULTS: For most disease diagnosis and age categories, low-intensity and severe heatwaves were associated with higher rates of ED presentations and costs. We estimated a total of 1,161 (95% empirical confidence interval (eCI): 342, 1,944) heatwave-attributable all-cause ED presentations and an associated healthcare costs of AU\$1,020,330 (95% eCI: 224,851, 1,804,745) during the warm seasons of 2014-2017. Heat-related illness was the disease category contributing most to ED presentations and costs.

CONCLUSIONS: Heatwaves produced a significant case-load and cost burden to the ED. The young and old peoples were most susceptible to heat. Developing tailored interventions for the most vulnerable populations may help reduce the health impacts of heatwaves and to minimise the cost burden to the healthcare system.

Keywords: Temperature, Climate, Temperature extremes



ABSTRACT E-BOOK

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Climate » Temperature

Understanding the Impacts of Temperature on Hospital Admissions, Length of Stay, and Related Healthcare Costs under the Changing Climate

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BACKGROUND AND AIM: A growing number of studies have investigated the effect of increasing temperatures on morbidity and health service use. However, there is a lack of studies investigating the temperature-attributable cost burden. This study examines the relationship of daily mean temperature with hospital admissions, length of hospital stay (LoS), and costs; and estimates the baseline temperature-attributable hospital admissions, and costs and in relation to warmer climate scenarios in Adelaide, South Australia.

METHODS: A daily time series analysis using distributed lag non-linear models (DLNM) was used to explore exposure-response relationships and to estimate the aggregated burden of hospital admissions for conditions associated with temperatures (i.e. renal diseases, mental health, diabetes, ischaemic heart diseases and heat-related illnesses) as well as the associated LoS and costs, for the baseline period (2010-2015) and different future climate scenarios in Adelaide, South Australia.

RESULTS: During the six-year baseline period, the overall temperature-attributable hospital admissions, LoS, and associated costs were estimated to be 3,915 cases (95% empirical confidence interval (eCI): 235, 7,295), 99,766 days (95% eCI: 14,484, 168,457), and AU\$159 million (95% eCI: 18.8, 269.0), respectively. A climate scenario consistent with RCP8.5 emissions, and including projected demographic change, is estimated to lead to increases in heat-attributable hospital admissions, LoS, and costs of 2.2% (95% eCI: 0.5, 3.9), 8.4% (95% eCI: 1.1, 14.3), and 7.7% (95% eCI: 0.3, 13.3), respectively by mid-century.

CONCLUSIONS: There is already a substantial temperature-attributable impact on hospital admissions, LoS, and costs which are estimated to increase due to climate change and an increasing aged population. Unless effective climate and public health interventions are put into action, the costs of treating temperature-related admissions will be high.



ABSTRACT E-BOOK

Keywords: Climate, Temperature, Temperature variability

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Climate » Temperature extremes and variability

Social and spatial variation in heatwave-related emergency department visits in Australia

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BACKGROUND AND AIM: Heatwaves are extreme weather events that cause more urgent medical care than any other hazard in Australia. Heatwave impacts vary between populations and locations and empirical evidence concerning vulnerable places and people at a local level is critical for effective policy, planning, and interventions, especially in a warming climate. This study aimed to examine heatwave-related morbidity in Australia (using emergency department (ED) presentations) at a small-area level and identify susceptibility by neighbourhood characteristics.

METHODS: ED presentations data for eight Australian cities from 2013-2018 during the warm-season (October- March) were extracted from a national database. In each city, we examined the association of heatwave severity (defined using Excess Heat Factor) with ED visits at the Statistical Areas 2 geographical unit using a time-stratified case-crossover approach. Effect modification by neighbourhood characteristics were examined and city-level estimates were pooled using random-effects meta-analyses.

RESULTS: A total of 23,233,374 all-cause ED presentations were included in the analysis. Pooled ED relative risk estimates indicate that ED visits increased by 2.9% (95%CI: 1.5-4.2%) and 3.4% (95%CI: 1.2-5.5%) during low-intensity and severe/extreme heatwaves, respectively. There were 67,974 excess ED presentations during heatwaves with 82% of these occurring during low-intensity events which are more frequent than severe/extreme heatwaves. The effects varied substantially by city with the highest number of excess ED presentations observed in Adelaide (28,198) and Sydney (19,899). Heat-related conditions such as dehydration and heat exhaustion/stroke were significantly greater during heatwaves and the effect increased from low-intensity to severe/extreme heatwaves. Analysis of neighbourhood characteristics on heatwave-related ED presentations revealed greater health impacts for areas with high social vulnerability e.g., household composition, language and culture, and housing quality.

CONCLUSIONS: Overall, ED presentations are sensitive to heatwaves across all severity classes and the effects are stronger for individuals with certain health conditions and neighbourhood contexts.

Keywords: Heatwaves, integrated data, vulnerability, excess heat factor



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-379

Climate » Temperature

Occupational heat stress and economic burden: A review of global evidence

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BACKGROUND AND AIM: The adverse effects of heat on workers' health and work productivity are well documented. However, the resultant economic consequences and productivity loss are less understood. This review aims to summarize the retrospective and potential future economic burden of workplace heat exposure in the context of climate change.

METHODS: Literature was searched from database inception to October 2020 using Embase, PubMed, and Scopus. Articles were limited to original human studies investigating costs from occupational heat stress in English.

RESULTS: Twenty studies met criteria for inclusion. Eighteen studies estimated costs secondary to heat-induced labor productivity loss. Predicted global costs from lost worktime, in US\$, were 280 billion in 1995, 311 billion in 2010 ($\approx 0.5\%$ of GDP), 2.4–2.5 trillion in 2030 ($>1\%$ of GDP) and up to 4.0% of GDP by 2100. Three studies estimated heat-related healthcare expenses from occupational injuries with averaged annual costs (US\$) exceeding 1 million in Spain, 1 million in Guangzhou, China and 250,000 in Adelaide, Australia. Low- and middle-income countries and countries with warmer climates had greater losses as a proportion of GDP. Greater costs per worker were observed in outdoor industries, medium-sized businesses, amongst males, and workers aged 25–44 years.

CONCLUSIONS: The estimated global economic burden of occupational heat stress is substantial. Climate change adaptation and mitigation strategies should be implemented to likely minimize future costs. Further research exploring the relationship between occupational heat stress and related expenses from lost productivity, decreased work efficiency and healthcare, and costs stratified by demographic factors, is warranted. Analyzing heat-attributable occupational costs may guide the development of workplace heat management policies and practices as part of global warming strategies. This article has been published in the journal of Environmental Health.

Keywords: workplace, heat stress, cost, climate change, labor productivity



ABSTRACT E-BOOK

P-380

Climate » Temperature extremes and variability

Ambient temperature and ambulance car visits in Japan by age category and severity

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BACKGROUND AND AIM: Using the Japanese public domain data, we have reported that a severe heat exposure during the power outage on 10th of September due to the typhoon raised the number of ambulance car visits due to heatstroke disproportionately. Here, we investigated which age groups and which severity categories were affected.

METHODS: Because the Typhoon Faxai hit Japan in September 2019, we collected the ambulance car visit data for September from 2010 to 2019 from the Fire and Disaster Management Agency, the Ministry of Internal Affairs and Communications. Corresponding weather data were collected from the Japan Meteorological Agency. Both datasets are publicly available from the respective websites. Because the already-categorized data either by age group or by severity level were available, we set the age groups as 0-6, 7-17, 18-64 and 65+, and severity levels as mild, moderate, severe, and deceased. The comparison was on the difference between the September heatstroke risk in 2019 and that in the preceding years. First, we examined Chiba prefecture, in which the power outage was by far extensive. As the control, we also examined the surrounding 6 prefectures, where the power outage was minimal.

RESULTS: As for Chiba, age groups 18-64 and 65+ and mild to moderate severity groups showed much higher risk. The control prefectures did not show increased risk. Deceased cases were rare, but two deaths in Chiba and no death in the other prefectures were identified on 10th of September.

CONCLUSIONS: The severe heat exposure during the typhoon-related power outage increased the risk of mild and moderate heatstroke among 18 years and older age group.

Keywords: Temperature, Heatstroke, Ambulance car visits



ABSTRACT E-BOOK

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Climate » Temperature

Hot weather and chronic kidney disease of undetermined aetiology in Taiwan: nested case-control study from Changhua Community-based Integrated Screening programme

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BACKGROUND AND AIM: Chronic kidney disease of undetermined aetiology (CKDu) has been reported among workers under heat stress. Epidemiological evidence was lacking in Asian countries. We aimed to investigate the impacts of hot weather and farming occupation on CKDu in Taiwan. **METHODS:** We obtained the data from the annual screening program for chronic diseases in Taiwan's largest rice-farming county from May to October in 2005–2014. Working population aged 15–60 years was included. CKDu was defined as an estimated glomerular filtration rate < 60 ml/min/1.73m² at age under 60 years, with the following exclusion criteria which also applied for non-CKDu population: hypertension, diabetes, proteinuria, haematuria, or using Chinese herbal medicine. Ambient temperature at township level was obtained from Taiwan' Central Weather Bureau. We estimated the prevalence odds ratio (POR) of CKDu for changes in temperature, adjusted by education, type of occupation, urbanization, smoking, body mass index, and comorbidities.

RESULTS: There were 201 CKDu cases and 16,891 non-CKDu population. The prevalence of CKDu was 2.3% in the farmers and 0.9% in the non-farmers. The crude and adjusted POR of CKDu among farmers was 2.82 (2.16–3.69) and 1.67 (1.19–2.33) compared to non-farmers. In the month of health screening examination, monthly averages of ambient temperature (°C) were slightly higher for the CKDu cases (daily mean = 28.1 ± 1.3) than for the non-CKDu participants (daily mean = 27.9 ± 1.5). The crude and adjusted POR of CKDu per unit (°C) increase of ambient temperature was 1.13 (1.03–1.25) and 1.13 (1.02–1.25) for daily max, 1.17 (1.06–1.31) and 1.14 (1.02–1.27) for daily min, and 1.20 (1.07–1.33) and 1.17 (1.05–1.31) for daily mean temperature.

CONCLUSIONS: Hot weather and working as farmer might contribute independently to the risk of CKDu in Taiwan, and the two risk factors showed no synergic effect. CKDu risk factors other than heat exposure should be considered among Taiwanese farmers.

Keywords: chronic kidney disease of undetermined aetiology, Far East, heat stress, farmers, agriculture workers



ABSTRACT E-BOOK

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Climate » Temperature

Change in kidney function over 3 months among salt workers in Thailand

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BACKGROUND AND AIM: Thailand is located in a hot and humid zone. Outdoor workers are vulnerable to high heat exposure, especially agricultural workers. Salt workers are considered manual labor with prolonged physical exertion, and the harvest season is in the hottest period of the year. The objective of the present study was to investigate the changes of kidney biomarkers over a harvest season.

METHODS: Kidney biomarkers of 50 salt workers aged 18-60 were examined after work shift at the beginning of the harvest season and at the end of the harvest season (3 months later). The Wet Bulb Globe Temperature was used to measure heat exposure during workdays. Individual factors and work-related factors were assessed by questionnaires.

RESULTS: The median of heat index was 29.82°C at the beginning of the harvest season and increased to 33.89°C at the end of the season. Salt workers worked on average 5 hours continuously. Above 50% of them took a rest less than 2 times on working days. Approximately 48% of participants had a heavy workload which over the standard of exposure to heat and hot environment of Thailand (not over 30°C). The median of serum creatinine (Scr) and blood urea nitrogen (BUN) increased over time. The estimated glomerular filter rate (eGFR) decreased by 15.2 ml/min/1.73 m² over the harvest season. There were statistically significant changes over season in Scr (p-value = <0.001), BUN (p-value=0.004) and eGFR (p-value <0.001).

CONCLUSIONS: Kidney function of salt workers can substantially decrease in only 3 months during a harvest season. Recommendations and protections to salt workers have to be placed.

Keywords: Temperature, Heat exposure, Agricultural work



ABSTRACT E-BOOK

P-383

Climate » Temperature extremes and variability

Temperature related health burden in the Attica region, Greece, under two different climatic scenarios for the near and distant future

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BACKGROUND AND AIM: The gradual increase in ambient temperature and in the frequency and intensity of heat waves, related to climate change, may lead to premature deaths. Our study aimed to evaluate temperature-related deaths in the Attica region, Greece, under two climate change scenarios for the periods 2031-2050 and 2081-2100.

METHODS: We estimated the number of deaths from natural, cardiovascular and respiratory causes attributed to the change of temperature between a reference period (1991-2005), and two future periods (2031-2050 and 2081-2100) under two climatic scenarios (RCP4.5 -“medium” and RCP8.5 - “high”) using exposure response functions based on the literature. We also estimated the number of excess deaths due to heatwaves.

RESULTS: Under the RCP4.5 scenario, the mean annual number of deaths from natural causes attributed to the increased temperature during the warm season (April-September) was 2 times higher in the 2031-2050 period and about 2.5 times higher in the 2081-2100 period compared to the reference period (230, 95% CI: 207-253 deaths). Under the RCP8.5 scenario, the number of attributable deaths was 511 (95% CI: 461-560) and 1316 (95% CI: 1191-1439) for the periods 2031-2050 and 2081-2100, respectively. The excess number of deaths during heatwaves from 138 (95% CI: 118-159) in the reference period increased to 1145 (95% CI: 980-1314) under the RCP8.5 in the 2081-2100 period without taking into account population adaptation to climate change. The impact of increasing temperature was more severe on vulnerable populations, such as the elderly. The number of avoidable deaths due to increasing temperature in the cold season (October- March) did not compensate for the excess mortality in the warm season.

CONCLUSIONS: The increase in temperature as a result of climate change is a major public health issue and urgent policies to mitigate its effects are crucial.

Keywords: climate, environmental epidemiology, mortality, temperature, temperature extremes



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ABSTRACT E-BOOK



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Climate » Temperature

Assessment of effects of ambient temperature on respiratory mortality using different spatio-temporal methodological approaches in Attica prefecture, Greece

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BACKGROUND AND AIM: Previous studies support effects of short-term exposure to high temperatures on respiratory mortality mostly based on time-series analysis of city-wide data. We investigated the association of short-term exposure to high temperatures with respiratory mortality in the Attica prefecture in Greece, by municipality, in the warm period (April-September) during 2000-2016, comparing different methodological approaches to account for spatial differentiation.

METHODS: First, we applied municipality-specific Generalized Estimating Equations (GEE) models using municipality-specific thresholds (minimum mortality temperature, MMT) in the underlying U-shape association and adjusting for time-varying confounders. The results were combined using random effects meta-analysis. Secondly, we used a random intercept (per municipality) Poisson model, further adjusting for spatial covariates and temperature variability over the period. In both methods, the municipality-specific temperature-mortality association was estimated by a piece-wise linear function, constrained to join at the estimated threshold. Finally, we applied a municipality-specific Poisson regression allowing for overdispersion, using Distributed Lag Nonlinear Models (DLNM) to estimate the underlying association. A multivariate meta-analysis was applied to derive the cumulative exposure-response association over the analysis area.

RESULTS: An 8.2% increase (95%CI:6.8-9.7%) in respiratory mortality, all ages, was estimated per 1°C increase in the 4-days average of the mean temperature above the municipality-specific threshold using the GEE approach, whilst the increase was 5.1% (95%CI:4.4-5.8%) from the mixed model adjusted for spatial covariates and long-term variability. The estimated effect for an increase from the MMT (14.7°C) to the 99th centile (31.6°C), was 88% using DLNM, whilst the increase from the MMT (22.9°C) to the 99th centile of the 4-days average of the mean temperature (31.2°C) was 92% using GEE.

CONCLUSIONS: All methods support effects on respiratory mortality for increased temperature in the warm period of comparable magnitude. The effect is not attenuated when accounting for between area variability.

Keywords: Respiratory Outcomes, Modeling, Short-Term Exposure, Temperature, Mortality



ABSTRACT E-BOOK

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Climate » General

The Effect of Climate Variables on the Incidence of Cutaneous Leishmaniasis in Isfahan, Central Iran

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BACKGROUND AND AIM: In recent years, there have been considerable changes in the distribution of diseases that are potentially tied to ongoing climate variability. The aim of this study was to investigate the association between incidence of cutaneous leishmaniasis (CL) and climatic factors in an Iranian city (Isfahan) which had the highest incidence of CL in the country.

METHODS: CL incidence and climate data were inquired from April 2010 to March 2017 (108 months) for Isfahan city. Univariate and multivariate Seasonal Autoregressive Integrated Moving Average (SARIMA), Generalized Additive Models (GAM) and Generalized Additive Mixed Models (GAMM) were used to identify the association between CL cases and climate variables, and forecast CL incidence. AIC, BIC and residual tests were used to test the goodness of fit of SARIMA models; and R² was used for GAM/GAMM.

RESULTS: 5297 CL cases were recorded during this time. The incidence had a seasonal pattern and the highest number of cases were recorded from August to November. In univariate SARIMA, (1,0,1)(0,1,1)₁₂ was the best fit for predicting CL incidence (AIC=8.09, BIC=8.32). Multivariate time series regression (1,0,1)(0,1,1)₁₂ showed that monthly mean humidity after 3 months lag was inversely related to CL incidence ($\beta=-1.59$, $p=0.0072$, AIC=8.52, BIC=8.66). GAMM results showed average temperature with 2-month lag, average relative humidity with 4-month lag, monthly cumulative rainfall with 1-month lag and monthly sunshine hours with 1-month lag were related to CL incidence (R²=0.94).

CONCLUSIONS: The impact of climate variables on the incidence of Leishmania is not linear and GAM models that include non-linear structures are a better fit for prediction. In Isfahan, Iran, climate variables can greatly predict the incidence of CL and these variables can be used for predicting outbreaks.

Keywords: Time-series analysis; SARIMA; Leishmaniasis, Iran



ABSTRACT E-BOOK

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Climate » Temperature

Short-term effects of temperature on cardiovascular and respiratory mortality and its modification by air pollution in German cities

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BACKGROUND AND AIM: Extreme heat increases the risk of cardiovascular (CVD) and respiratory (RD) disease mortality and can furthermore interact with air pollution leading potentially to synergistic effects. Evidence in this field so far is still scarce, especially for Germany. We therefore aimed to investigate short-term effects of air temperature on CVD and RD mortality and potential effect modification by air pollution across Germany.

METHODS: The analysis was based on the 15 largest German cities. We applied a city-specific confounder-adjusted Poisson model. The temperature–mortality associations were estimated with a distributed lag non-linear model with 14-day lag and then pooled by a multivariate meta-analysis. We also carried out age- and sex- stratified analysis. Cold-and heat-effects are reported as Relative Risk (RR) at the 2.5th and 97.5th temperature percentile, respectively, relative to the cause-specific Minimum Mortality Temperature (MMT). Effect modification by different air pollutants will be analyzed using a tensor product between air temperature and the air pollutant; temperature estimates will then be extrapolated at low, medium, and high levels of pollutants.

RESULTS: We analysed 1,063,198 CVD and 183,027 RD mortality cases between 1993 and 2016. The MMT for CVD and RD were found to be 18.2°C and 17.4°C, respectively. The RR for heat-related RD was found to be significantly higher [1.43 (95% CI 1.33, 1.53)] than the cold-related RR [1.07 (0.98, 1.17)]. For heat, older age group >65y showed stronger effects for both RD and CVD. Similarly, the cold-related RR for CVD was higher in males [1.21 (1.16, 1.26)] than in females [1.10 (1.05, 1.15)].

CONCLUSIONS: Increases in the risk for both heat- and cold-related CVD and RD mortality were found. Pronounced higher heat- than cold-effects were seen for RD. Investigation on the synergistic effect of air temperature and air pollution, the two biggest climate change concerns, are crucial.

Keywords: Temperature, Air pollution, Mortality, Climate, Cardiovascular diseases, Short-term exposure



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Exposures » Water quality

Bioremediation treatment improves water quality for Nile tilapia ("*Oreochromis niloticus*") under crude oil pollution

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BACKGROUND AND AIM: Despite favorable publicity of bioremediation as an affordable technology for cleanup of crude oil, public concerns on ecological safety in the presence of residual oil remain a global challenge. In this study, effects of crude oil exposure at sublethal concentration (0.25% v/v) and bioremediation treatment were investigated on histology and biochemical parameters of organs (gills, liver, kidney, and brain) of juvenile Nile tilapia ("*Oreochromis niloticus*").

METHODS: Ten percent (10%) of mixed bacterial culture was used for bioaugmentation treatment. Ninety juvenile fish were used for study, and experiments were carried out in triplicates for three different groups. Malondialdehyde (MDA), an index of lipid peroxidation, was assayed as biomarker for oxidative stress. Activities of antioxidant enzymes (superoxide dismutase (SOD) and catalase (CAT)), level of non enzymatic antioxidant (reduced glutathione (GSH)), and activity of brain acetylcholinesterase (AChE) were assayed in selected fish organs as markers for environmental stressor. Histological examination of fish organs was done for all groups. Results of treated groups were compared with those of the control.

RESULTS: Levels of MDA significantly increased with significant inhibition of antioxidant enzyme activities in the polluted group. Activities of SOD, CAT, and AChE and levels of GSH in fish organs in the bioaugmentation group were similar to results obtained in the control. Remarkably, the bioaugmentation group showed minimal or no lesions which suggested the efficacy of bioremediation technique in alleviating crude oil toxicity and preserving normal physiology of fish.

CONCLUSIONS: This study provides deeper insights into the ecosafety of bioremediation treatment and can be extrapolated to other species of fish.

Keywords: Bioremediation, Crude oil, Histology, Nile tilapia, Oxidative stress, Toxicity



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Heatwave attributable deaths and emergency room visits in South Korea

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BACKGROUND AND AIM: The frequent heatwave has impacted populations' health in many countries. In 2016 and 2018, extremely high temperatures resulted in 17 and 48 heatstroke deaths and 2,108 and 4,478 emergency room (ER) visits, respectively, during the heatwave in South Korea. Because the reported number of heatstroke deaths is only a part of total deaths and ER visits associated with high temperature, we aimed to estimate attributable deaths and ER visits during heatwave episodes.

METHODS: We linked mortality, ER visit, and meteorological data in 16 regions in South Korea and estimated relative risk at or above a threshold of maximum temperature during summer using generalized linear regression models after controlling for temporal confounders. We computed overall deaths and cause-specific ER visits attributable to the heatwave in 2006-2018.

RESULTS: With 1.9% (95% Confidence intervals [CI], 1.3%, 2.4%) increase in all-cause mortality per 1°C increase in concurrent day's maximum temperature during summer, this study estimates 413 and 1,017 all-cause deaths associated with heatwaves in 2016 and 2018, respectively. We also observed more than 6,000 ER visits attributable to the heatwave in 2016, including 277 for kidney disease.

CONCLUSIONS: This study addresses attributable heatwave deaths and ER visits in South Korea and illustrates that the reports of heatstroke deaths and ER visits seriously underestimate the health impacts of heatwaves. Our findings may enable the implementation and reinforcement of government- and individual-level management strategies for heatwaves.

Keywords: health impact, heatstroke, heatwave, high temperature



ABSTRACT E-BOOK

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Respiratory and Allergic Outcomes » Respiratory outcomes

The effect of short-term temperature modified by air pollution on cardiorespiratory function

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BACKGROUND AND AIM: The combined effect of short-term exposure to temperature and air pollution on cardiorespiratory function is largely unknown. We investigated the short-term effect of ambient temperature when modified by air pollution on cardiorespiratory function.

METHODS: We investigated 420 elderly women from the German SALIA cohort during the 2012-2013 follow-up examination. The combined outcome of cardiorespiratory function was calculated as standardised (mean zero, standard deviation one) sum of the lung function z-scores for forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and systolic and diastolic blood pressure values, which were themselves standardised and transformed so that higher values reflect better cardiorespiratory function. The short-term temperature-air pollution effect on cardiorespiratory function was assessed over lag 0-4 days, with the air pollutant centred to the 25th and 75th quantile, using multivariable regression models with distributed lag non-linear models.

RESULTS: For low temperatures, cardiorespiratory function declined by -0.27 (95%CI: -0.83, 0.29) during low ozone (O₃) days, and -0.22 (95%CI: -0.88, 0.44) during high O₃ days. The opposite relationship was observed for high temperatures, with cardiorespiratory function increasing by 0.06 (95%CI: -0.62, 0.75) during low O₃ days, and 0.12 (95%CI: -0.45, 0.70) during high O₃ days, respectively. Additionally, cardiorespiratory function declined on low temperature days by -0.46 (95%CI: -1.24, 0.31) during low PM₁₀ days, and -0.50 (95%CI: -1.07, 0.08) during high PM₁₀ days; however, the effect of high temperatures on cardiorespiratory function when adjusted for the different PM₁₀ levels differed, with cardiorespiratory function decreasing by -0.05 (95%CI: -0.68, 0.58) during high PM₁₀ days, while increasing by 0.09 (95%CI: -0.59, 0.77) during low PM₁₀ days.

CONCLUSIONS: Temperatures were inversely associated with cardiorespiratory function in elderly women, with the effect size being more apparent for low temperatures. Strength varied according to air pollution levels, however results were not statistically significant.

Keywords: Temperature, Air Pollution, Cardiorespiratory, Climate Change, Cohort study.



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Temporal variation in temperature-mortality associations in Turin, Italy: a case of urban maladaptation to heat and cold

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BACKGROUND AND AIM: To date, the expectation that climate change driven by human activities will further exacerbate extreme temperature events in cities is of primary concern. However, little is known about the temporal variation of temperature-mortality associations among different demographic and socio-economic groups. The aim of this work is to investigate trends in heat and cold-related mortality risk and burden by sex, age, education and marital status, number of dwelling's occupants and causes of death in the city of Turin, Italy.

METHODS: We collected daily time-series data of temperature and mortality categorized by sex, age, education and marital status, number of dwelling's occupants and causes of death in Turin for the period 1982-2018. We applied standard quasi-Poisson regression models to data subsets of 20-year moving periods and estimated the temperature-mortality association with a distributed lag non-linear model (DLNM). Relative risk (RR), heat- and cold-attributable mortality were computed for winter and summer months.

RESULTS: Our findings provided evidence for a general increase in the RRs of mortality across the whole range of temperatures during the study period. Cold-attributable mortality experienced an upward trend in men and women, and heat-attributable slightly decreased for women. Results also showed an increase of RR and attributable mortality due to cold and heat by age, education and marital status and number of dwelling's occupant's. In relation to the causes of death, a general increase in cold-attributable mortality was found both for cardiovascular and respiratory diseases, while the trend for heat-attributable mortality was the opposite.

CONCLUSIONS: The overall increase in heat- and cold-related mortality risk and burden suggests a maladaptation to ambient temperatures in the city of Turin, despite the socioeconomic development and the improvement in health-care services over the last decades. Public health as well as urban planning strategies are urgently needed in Turin to adapt to extreme temperatures impacts.

Keywords: extreme temperatures, social inequalities, Italy, maladaptation, urban



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Wearable sensor-based air and skin temperature (micro)environments during summer: a post hoc randomized 2x2 cross-over trial analysis

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BACKGROUND AND AIM: The influence of elevated air temperatures recorded in various urban microenvironments in adversely impacting biologically relevant disease end points has not yet been extensively tackled. This *post hoc* analysis of the TEMP pilot trial, aimed to study the association between the 24-h personal air/skin temperature sensor measurements and the diary-based location type (indoors vs. outdoors) in various urban/rural microenvironments.

METHODS: A total of 37 participants were included in the analysis. Wearable sensors were used for personal air/skin temperature, activity (as a surrogate marker of physical activity), while a time stamped personal diary recorded indoor or outdoor activities. Temperature peaks during a 24-h sampling period were detected using a peak finding algorithm. Mixed effect logistic regression models were fitted for the odds of participant location type as a function of setting and either personal temperature values or number of temperature peaks.

RESULTS: Median [IQR] personal air temperature in indoor (micro)environments was lower than that in outdoors (28.0°C [26.4, 30.3] vs 28.5°C [26.8, 30.7], $p < 0.001$), while median skin temperature [IQR] was higher indoors vs. outdoors (34.81°C [34.0, 35.6] and 33.9°C [32.9, 34.8]) ($p < 0.001$). The number of both personal air/skin temperature peaks was higher indoors compared to outdoors (median [IQR] 3.0 [2.0,4.0] vs 1.0 [1.0,1.3], $p < 0.007$, for the skin sensors). A significant association between the number of temperature peaks and indoor location types was observed with both sensor measurements (OR=3.1; 95% CI: 1.2-8.2; $p = 0.02$ for air sensor and OR=3.7; 95% CI: 1.4-9.9; $p = 0.01$ for skin sensor), suggesting higher number of indoor air temperature fluctuations.

CONCLUSIONS: Amidst the global climate crisis, more population health studies or personalized medicine approaches that utilize continuous tracking of individual-level air/skin temperatures in both indoor/outdoor locations would be warranted, if we were to better characterize the disease phenotype in response to climate change manifestations.

Keywords: short-term exposure, climate, temperature extremes, temperature variability.



ABSTRACT E-BOOK

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Climate » Other (to be specified with keywords in the keywords section)

Spatio-temporal pattern and climatic determinants of Visceral Leishmaniasis in Italy

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BACKGROUND AND AIM: Historically, leishmaniasis in Italy was constrained to areas with Mediterranean climate. In the last 20 years, sand fly vectors and cases of human Visceral Leishmaniasis (VL) have been detected in Northern Italian regions, traditionally classified as cold areas unsuitable for sand fly survival. We aimed to study the spatio-temporal pattern and climatic determinants of VL incidence in Italy.

METHODS: National Hospital Discharge Register (HDR) records were used to identify incident VL cases between 2010 and 2017 (ICD-9-CM code: 085.0). Incident rates were computed for each year of study (N=8) and for each Italian province (N= 110). Temperature and precipitation data were obtained from the latest ERA5-Land database climate re-analysis (9 km of spatial resolution) and expressed as year and province-specific seasonal average temperature and cumulative precipitation. Incident cases were modelled with a Bayesian spatio-temporal conditional autoregressive Poisson models to quantify how disease risk was influenced by the climatic parameters.

RESULTS: We identified 1123 VL cases (Crude Incidence Rate: 2.4 cases /1,000,000 person-years). The highest incidence rates were observed in Southern Italy, although high incidence rates were observed also in some areas of Northern Italy. VL incidence resulted positively associated with air temperatures (Incidence Rate Ratios (IRR) for 1°C increase in winter average temperature: 1.17, 95% Credible Interval (CI): 1.13-1.19, IRR for 1°C increase in summer average temperature: 1.06, 95% CI: 1.00-1.13) and inversely associated with cumulative precipitation (IRR for 10 mm increase in summer cumulative precipitation: 0.99, 95% CI: 0.98-1.00).

CONCLUSIONS: The current findings indicate that VL is endemic in the whole Italian peninsula and that climatic factors, as air temperature and precipitation, might play a relevant role in shaping VL incidence. These results suggest also that climate change might affect the future spread of leishmaniasis.

Keywords: One-Health, Spatial Epidemiology, Climate-change, Vector-borne diseases, Environmental Epidemiology



ABSTRACT E-BOOK

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Outcomes » Other (to be specified with keywords in the keywords section)

Association between Low Ambient Temperature and Cardiorespiratory Hospital Admissions in Helsinki, Finland

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BACKGROUND AND AIM: The relationship between low ambient temperature and hospital admissions is less studied than between high temperature and hospital admissions. Therefore, this study aimed to investigate the association of daily wintertime temperature with cardiorespiratory hospital admissions in the Helsinki metropolitan area, Finland.

METHODS: Daily number of hospital admissions for 2001-2017 was obtained from the national hospital discharge register and weather information from the Finnish Meteorological Institute. Time-series quasi-Poisson regression models were fitted controlling for potential confounders such as time trend, weekday, holiday, air pollution, barometric pressure and an indicator for influenza count. A penalized distributed lag linear model with 21 days of lag was used to estimate the association of daily mean temperature with cause-specific cardiorespiratory hospital admissions, stratified by age-groups (All-ages, 18-64, 65-74 and ≥ 75), during winter months (December-March).

RESULTS: The first and 99th percentiles of daily temperature were -19.6 °C and 11.5 °C respectively. Decreased ambient temperature was associated with increased risk of hospitalization for myocardial infarction in the whole population (Risk Ratio [RR] for 1°C decrease in exposure: 1.015, 95% confidence intervals [CIs]: 1.001-1.030), and in the age group 65-74 (RR: 1.035, 95% CIs: 1.003-1.069). There was also an increased risk of hospital admission for chronic obstructive pulmonary disease (RR: 1.026, 95% CIs: 1.002-1.051) and to lesser extent for respiratory diseases in general (RR: 1.006, 95% CI: 0.995-1.017) in the oldest age (≥ 75).

CONCLUSIONS: Cold increases the need for acute hospital care due to both cardiovascular and respiratory causes during winter months.

Keywords: respiratory, cardiovascular, winter, hospital admissions, morbidity, weather



ABSTRACT E-BOOK

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Climate » Temperature

How ambient temperature affects mood: an Ecological Momentary Assessment study in Switzerland

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BACKGROUND AND AIM: Recent studies indicate that increasing temperatures could negatively affect mental health and lead to increased psychiatric hospitalizations. However, evidence on the potential mechanisms mediating this association is limited. Mood can act as a potential mediator. We aimed to investigate the short-term association between ambient temperature and daily mood in a cohort population in Lausanne, Switzerland.

METHODS: Participants from CoLaus|PsyCoLaus who completed the Ecological Momentary Assessment (2015-2017) were included. Data on several mood markers were collected four times daily through a cellphone. A principal component analysis was conducted to create an aggregate index of average daily mood (transformed into a binary variable indicating the presence of positive or negative mood). The effect of daily mean temperature (DMT) on mood was assessed using a mixed-effects model, and it was controlled for sleep, day of the week, season, sunshine duration and humidity. Stratified analyses were conducted by age, sex, and presence of major depressive disorder (MDD) or generalized anxiety disorder (GAD).

RESULTS: The study included a total of 946 participants. Overall, probability of having good mood increased by 2.4% (95%CI 0%, 4.5%) for each 1°C increase in DMT, instead increasing temperatures was associated with bad mood in participants with MDD (7.1%; 95%CI, -21.2%, 6.4%) and GAD (-5.7%; 95%CI -49.2%, 26.4%). Larger association estimates were found in males (4.8%; 95%CI 1.4%, 8.0%, vs 1.1%; 95%CI, -2.3%, 4.4% in females), while similar estimates were found for all age categories.

CONCLUSIONS: Our preliminary findings suggest that increasing temperatures could positively affect mood in the general population. This association seems to be reversed in individuals suffering from mental disorders, thus suggesting a possible explanation for the increased morbidity in psychiatric patients during heat exposure. This finding supports the need for specific public health policies to protect this vulnerable population from the consequences of a changing climate.



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Keywords: climate change, temperature, mood, mental health, psychiatric disorders, Ecological Momentary Assessment

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Climate » Temperature

Short-term exposure to temperature and all-cause and cause-specific mortality: a study in nine Belgian cities, 2010-2015

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BACKGROUND AND AIM: Accumulating epidemiological evidence indicates that high ambient temperatures increase the risk of death. This study aimed to examine the optimum temperatures in Belgium that correspond to minimum mortality, and quantify the relative risks of mortality from all natural causes, and cause-specific causes due to hot and cold non-optimum temperatures.

METHODS: A time-stratified case-crossover design fitted with a conditional quasi-Poisson regression model and distributed lag non-linear models were applied to estimate city-specific temperature-mortality associations in nine main Belgian cities, and a random-effect meta-analysis was conducted to pool the estimates. Over the period 2010-2015, a total of 307,859 deaths from natural causes were included. Separate analyses were performed for cause-specific mortality (ischemic heart disease, cerebrovascular, other cardiovascular, chronic obstructive pulmonary disease, other respiratory, and other natural). Analyses were controlled for relative humidity, holidays, long-term and seasonal trends.

RESULTS: Considering a cumulative effect of temperature over 21 days before death, both heat and cold were associated with increased mortality risks from all causes. Relative to the minimum mortality temperature (23.1°C, 86.3th centile of the temperature distribution), the pooled estimate of the mortality risk for cold temperature (at -1.7°C, the 1st centile) was 1.32 (95% CI: 1.21-1.44) and 1.21 (95% CI: 1.08-1.36) for hot temperature (at 31.3°C, the 99th centile). When considering a cumulative effect of temperature over 7 days before death, the effect was lower for cold temperature (1.04, 95% CI: 1.00-1.09) but higher for hot temperature (1.33, 95% CI: 1.25-1.41). Adjustment for air pollutants did not change the results. The shapes of the cause-specific related mortality showed various patterns with a clear effect of heat on mortality due to ischemic heart diseases.

CONCLUSIONS: This nationwide study provides a comprehensive picture of the non-linear associations between hot and cold temperatures related mortality from cause-specific and all natural causes, in Belgium.

Keywords: mortality, temperature, multi-city analysis, causes of death, dlnm



ABSTRACT E-BOOK

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Exposures » Occupational exposures

Prevalence and associated risk factors of intestinal parasites among street sanitation workers and work conditions at Gaza Municipality'

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BACKGROUND AND AIM: Street sanitation workers (SSWs) are a potential source of infection for many intestinal parasites and other enteropathogenic infections as well. The aim of the present study was to determine the prevalence of intestinal parasites carriers among SSWs at Gaza Municipality and focusing on the associated risk factors through their work.

METHODS: The study was performed from Sep 2014 to June 2015. Stool samples were collected from 199 SSWs aged between 18 to 65 years and were examined following standard parasitological methods including wet mount using saline and iodine and formal ether sedimentation technique. Demographic, environmental, behavioural and some risk factors were addressed through a questionnaire. SSWs were invited to attend four health education sessions.

RESULTS: Intestinal parasites were detected among 45/199 of the sanitation workers with a prevalence of (25.1%). Five species of protozoan or helminth infections were recorded, and the mixed infections were 2.5%. Where, most prevalent parasite among the SSWs is *E. histolytica* while *A. lumbricoides* showed the lower rate of infection. The highest parasitic infection was among 18-28 age group with a prevalence of 27.4%, but no significant difference was found ($P = 0.81$). Analysis of the results using the chi square test showed statistically significant results with the following symptoms: loss of weight ($P=0.058$). The daily risks/accidents challenging the SSWs during the work were identified. The SSWs has showed low adherence to use PPTs.

CONCLUSIONS: It is concluded that most of the SSWs are at high risk for intestinal parasites, exposed to daily accidents and hard work conditions.. It is recommended that health education in general should be increased to raise awareness in addition we are in need for constant epidemiological surveillance through periodical surveys parallel with development of healthcare towards the problem of parasitic infections.

Keywords: Intestinal parasites, sanitation workers, protection, Palestine



ABSTRACT E-BOOK

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Exposures » Occupational exposures

A cross-sectional study on the exposure of farmers to the risk of pesticides in Gaza Strip

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BACKGROUND AND AIM: Pesticides are one of the toxic/risky compounds to human, animal and plants. The objective was determine the exposure of farmers to different pesticidal risks during their work in the farms in Gaza Strip.

METHODS: A cross-sectional study involving 323 farmers and members of family farmers in Gaza strip was conducted using a questionnaire to collect data on sociodemographic characteristics, behavior and exposure, exposure of Relatives to pesticides toxicity/risk, health education, Behavior towards pesticides bottles disposal, history of previous injuries, self-reported symptoms.

RESULTS: The study showed low scoring in risk related study theme as total (35.4%). Also, the study showed that low risk scoring related to behavior and exposure (55.5%), exposure of relatives to pesticides toxicity/risk (67.8%). Decrease level of health education (23.4%), behavior towards pesticides bottles disposal (21.4%), history of previous injuries (24.4%) and self-reported symptoms (24.7%) were reported. It was found that total weighted mean of relatives to pesticides toxicity or risk is 62.5%. Also, more than half of farmers have behavior lead to increasing the exposure to risk pesticides. One way ANOVA and independent t-test showed that no statically significant differences in the weighted mean on the risk score related to the gender, marital status, governorates, occupations, education and years of using pesticides ($P > 0.05$). The total score of risk exhibited no significant correlation with age ($r = -0.067$ and $P = 0.231$), number of children in the same house ($r = 0.003$ and $P = 0.958$) and years of working in farming ($r = -0.022$ and $P = 0.693$).

CONCLUSIONS: High awareness regarding behavior of farmers toward dealing with pesticides, but with no practice/adherence for the precautions. Health educational sessions for the farmers about importance of wearing protective gears (ex. Gloves, nasal mask) should be launched.

Keywords: Pesticides, Gaza strip, farmers, exposure, behavior, risk.



ABSTRACT E-BOOK

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Methods » Occupational epidemiology

WULIRA APP mobile phone application to assess occupational hearing loss among industrial workers in Kampala, Uganda

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BACKGROUND AND AIM: Occupational hearing loss (OHL) is among the most common causes of disabling hearing loss. Pure Tone Audiometry (PTA) is not readily available in Uganda due to the high cost and operator dependence. However, a mobile phone-health innovation, Wulira App, with a sensitivity of 91.4% in the right ear and 88.4% in the left ear and a specificity of 93.2% and 91.5% in the right and left ear respectively, provides an easy to use, and reliable alternative screening tool for hearing loss. In this study, the prevalence and associated factors of OHL among industrial workers will be determined.

METHODS: We will conduct a cross-sectional study among industrial workers in Kampala. A total of 354 participants will be recruited systematically and screened for hearing loss using the Wulira App in a quiet room. Noise cancelling earphones will be used to minimize interference from any ambient noises. The study population will be described by exposure variables such as duration of work in the factory, age, sex, smoking, previous MDR-TB treatment. Categorical data will be presented as frequencies and percentages while continuous variables will be presented as means and standard deviations or medians and interquartile ranges. Proportions for categorical variables will be compared using the chi-square tests and Fisher's exact tests after testing for assumptions whereas means of continuous variables will be compared using Student t-test for normally distributed data and Mann Whitney U test for skewed data. Inferential statistics will be used.

RESULTS: Using a hearing threshold more than or equal to 26 dB as hearing loss, participants with OHL will be presented as proportions and classified according to the WHO classification of hearing loss.

CONCLUSIONS: Wulira App is easy to use tool for assessing OHL. Therefore, Wulira App could be adopted in clinical and work settings to screen and monitor for hearing loss.

Keywords: Occupational exposure, Occupational epidemiology



ABSTRACT E-BOOK

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Exposures » Socio-economic factors (non-chemical stressors)

Mapping socio-economic factors for environmental health studies in Wallonia: Transposition of the French Deprivation Index

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BACKGROUND AND AIM: Studying social disparities in health implies the ability to measure them accurately, to compare them between different areas and to follow trends over time. Some composite indicators to assess socio-economic factors in Belgium were developed in the past, but any update was not performed. Based on the method developed for the social deprivation index in France (the French Deprivation Index, FDep99), this work built a corresponding deprivation index in Wallonia, Belgium.

METHODS: The deprivation index, 'WDep', was developed at the municipalities level (the smallest administrative subdivisions of Belgium after the statistical sectors). The Walloon region is divided into 262 municipalities ranging from 6.8 to 215.4 km². The index was built as the first component of a population-weighted principal component analysis of four socioeconomic variables from the Belgian databases: (a) the median household income, (b) the proportion of high school graduates in the population aged 15 and over, (c) the proportion of blue-collar workers in the workforce and (d) the unemployment rate. The higher the WDep index, the greater the level of deprivation.

RESULTS: Maps of the WDep index were built for 2015, 2016 and 2017 and showed spatial variability through the territory. The three maps were highly correlated over time. Results were compared with two past composite indicators in order to check the external validity of the WDep in the Walloon context. The WDep was highly correlated to the two past indicators.

CONCLUSIONS: This work enabled building an easy and robust index, using open and reuse data in order to describe the socio-economic characteristics for each spatial unit and reproduce it yearly. The deprivation index proposed reflects a major part of spatial socioeconomic heterogeneity, in a homogeneous manner over the whole Walloon region. The index may be routinely used by healthcare authorities to observe, analyse, and manage spatial health inequalities.

Keywords: Socio-economic factors, Spatial statistics, Non-chemical stressors



ABSTRACT E-BOOK

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Methods » Community outreach

Living Labs and other participatory approaches applied to research on multiple environmental exposures and chronic risks

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BACKGROUND AND AIM: Participatory research in environmental health is still rare in France. The objectives of environmental health research, in general, can be very diverse (e.g.: identifying situations associated with risks estimating exposures and effects, testing the effectiveness of preventive actions) and related methods are diverse as well. Opportunities for greater implication of the civil society and related challenges differ at each step of research activities. These aspects need to be better known and shared collectively.

The LILAS project aimed to 1) co-construct, among institutional researchers, academics and civil society representatives, a mutual understanding of the main problematics and research methods in environmental health, their stakes for different actors, but also the requirements, strengths and limitations of these methods 2) identify expected benefits and points of vigilance related to stronger degrees of participation as part of such environmental health research projects.

METHODS: LILAS gathered institutional researchers, academics and civil society representatives interested in multiple exposures (chemical, radiological). Several meetings allowed to collectively



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identify different types of study (including environmental epidemiological studies) and reflect about the added value, limitations, and methodological principles related to the introduction of growing participation as part of such studies. An analysis matrix was co-created and filled by participants.

RESULTS: For different types of studies (studies for assessment of environmental exposures, identification of their determinants, interventions on these exposures, development of sensors, quantitative risk assessment, environmental epidemiological studies, experimental research, studies on the health of ecosystems...), the matrix lists expected benefits for several categories of stakeholders, fundamental methodological principles and practical constraints, advantages and limitations related to the use of participatory approaches (such as the living lab one) or more “classical” approaches.

CONCLUSIONS: LILAS has allowed, through a cross-acculturation process, to develop consolidated grounds for the co-construction of future participatory research projects on multiple environmental exposures.

Keywords: Key-words: Multiple exposures, participatory research, methods in environmental health research, Living Lab, co-creation,



ABSTRACT E-BOOK

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Exposures » Environmental disparities

Food insecurity, socio-environmental determinants, and child and adolescent malnutrition and dehydration in Manila, Philippines: A cross-sectional study

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BACKGROUND AND AIM: Urban poor children suffer from health disparities due to food insecurity and socio-environmental determinants, specifically poverty and inadequate water, sanitation, and hygiene (WaSH). Our study aimed to measure associations between these determinants and children's malnutrition and dehydration to identify risk factors of disease.

METHODS: We conducted a cross-sectional survey of 15 public schools in three cities of Metro Manila, Philippines: the city of Manila, Navotas, and Quezon City. We measured children's demographic information, food insecurity, and environmental exposures, including inadequate home WaSH and secondhand smoke, via questionnaire. We used anthropometry to measure stunting, severe thinness, thinness, overweight, and obesity according to the World Health Organization's Child Growth Standards. We measured dehydration, defined as a urine specific gravity (USG) of 1.020 or greater, via urine test strips. We measured the adequacy of school WaSH via inspection checklists.

RESULTS: We surveyed 828 children in grades 5, 6, 7, and 10. While 11% were stunted, over 32% did not have a "normal" weight. For example, 2.8% of children were severely thin, 5% were thin, 16% were overweight, and ~10% were obese. Almost 90% were dehydrated. Over 25% of children had low socioeconomic status. About 37% said that their parent's highest level of education was high school. About 17% reported having at least one under-age family member who was a child laborer. Almost 4% had no toilet, 8% had no faucet with running water, and ~27% had no refrigerator. Less than 4% said that food was often "unaffordable"; yet almost 25% have asked/begged for food.

CONCLUSIONS: Data analysis is in progress. Preliminary findings indicate severe socioeconomic deprivation in households and exposure to inadequate WaSH in schools and homes. During our presentation we will report logistic regression results describing associations between food insecurity, socio-environmental determinants, school and home WaSH, and children's malnutrition and dehydration.

Keywords: Exposures, children's environmental health, socio-economic factors, environmental disparities.



ABSTRACT E-BOOK

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Policy » Research translation to affect policy and practice

Engaging with stakeholders in hydrocarbons activities – the case of Vasilikos Energy Center in Cyprus

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BACKGROUND AND AIM: Worker and general population health risks associated with industrial activities surrounded by residential communities have always attracted attention. This study is focused on the engagement of the stakeholders associated with hydrocarbons activities in the main energy hub of Cyprus. The main objectives of this study were to: i) assess stakeholders' understanding, acceptance and (future) application(s) of exposome-based technologies and ii) evaluate their perceptions on environmental, safety and health risks related to hydrocarbons activities.

METHODS: A baseline assessment was developed for the Vasilikos energy center (VEC), a coastal heavy oil/gas industry zone in Cyprus. Six major groups of stakeholders and the representatives from each group were identified: local authorities, medium industries (including multi-national hydrocarbons companies), small-medium enterprises (SMEs), academia/professional associations, government and the general public residing in the communities surrounding the VEC. Semi-structured interviews (n=23), questionnaires (n=309), meetings (n=4) and workshops (n=2) were conducted with the stakeholders. Results from the interviews were processed through a thematic analysis, and results from the population survey (public) were analyzed using descriptive statistics.

RESULTS: Almost all stakeholders expressed the immediate need for the setup of an environment and health surveillance system for the VEC and its surrounding residential communities, including the need for systematic measurements of gaseous pollutant emissions in the area. Stricter policies by the government about licensing and monitoring of hydrocarbon activities and more frequent communication with the public and the mass media emerged, both as important needs. Finally, the usage of exposome concept has not been practiced by the industry/SMEs, but particularly the small-medium industries showed willingness to use it in the future, upon proper testing/evaluation of its utility.

CONCLUSIONS: It is warranted that the continuous and active collaboration among all involved stakeholders of the VEC and the surrounding populations would ensure the sustainable development of natural gas and oil activities in the Mediterranean region.

Keywords: hydrocarbons, perceptions, environment, public health, stakeholders, exposome



ABSTRACT E-BOOK

P-403

Omics Technologies » Metabolomics

The impact of occupational exposure to dioxins and dioxin-like compounds on the blood metabolome

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BACKGROUND AND AIM: Dioxins and dioxin-like compounds are a group of recognized environmental pollutants associated with an increase in all cancer combined. Evidence for specific cancer sites is more limited to non-Hodgkin lymphoma, an immune-related cancer. Our aim is to broaden our mechanistic understanding of metabolome alterations associated with dioxins and dioxin-like compounds, and link these metabolic changes to immunological markers.

METHODS: 139 workers from two chlorophenoxy herbicides factories, who had been exposed to dioxins and dioxin-like compounds more than 30 years before blood collection were included. Blood levels of 21 dioxins, dioxin-like furans and biphenyls were determined, and historical 2,3,7,8-tetrachlorodibenzo-p-dioxin levels were estimated using a one-compartment first order kinetic model. Plasma metabolites were measured using dual column liquid chromatography with high-resolution mass spectrometry. A metabolome-wide association study (MWAS), based on linear regression and 20% false discovery rate, was used to evaluate the relationship between metabolic features and exposures. Enrichment of biological pathways was investigated using Mummichog. Differential network analysis was applied to link changed metabolic features to immunological markers.

RESULTS: MWAS identified 1157 metabolic features associated with at least one dioxin species, with the majority associated with dioxin-like furans and biphenyls. Metabolic pathway enrichment identified 15 pathways associated with exposure, including pathways of de novo fatty acid biosynthesis, fatty acid activation, omega-3 fatty acid metabolism, fatty acids metabolism and linoleate metabolism, some of which have been previously observed in animal models and human studies exposed to dioxin-like compounds. Other lipid species, including glycerophospholipid, glycosphingolipid, leukotriene, androgen and estrogen were also identified. Besides inflammation mediators (arachidonic acid, prostaglandin, leukotriene), immunological markers were related to fatty acids and cell membrane lipids, which also participate in immune regulation and signaling.

CONCLUSIONS: Our results emphasize the metabolome-regulated potency of dioxin-like compounds, mainly on disruption of lipid metabolism especially fatty acids, and provide further plausibility for immunotoxicity mechanism in human.

Keywords: dioxin-like compounds, untargeted metabolomics, immunotoxicity, metabolic pathway enrichment



ABSTRACT E-BOOK

P-404

Methods » Community outreach

Obstetricians' engagement for successful recruitment of participants in a randomized controlled trial promoting healthful fish consumption during pregnancy

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BACKGROUND AND AIM: Human biomonitoring trials depend on the voluntary participation of citizens, who donate biological samples and personal information related to the investigated chemical exposures. Pregnant women are vulnerable to exposure to mercury, a potent developmental neurotoxicant. In Europe, the primary source of exposure to mercury relates to fish consumption. At the same time, fish consumption during pregnancy provides essential nutrients for optimal fetal brain and eye development. The benefits can outweigh the risks if suitable dietary advice is provided during pregnancy.

METHODS: Cyprus, a small coastal Southeastern European country, used national data of fish consumption and mercury occurrence in fish to develop the first ever recommendations for Cypriot pregnant women. These are tested in the European "HBM4EU-mom" randomized control trial



ABSTRACT E-BOOK

(10/2020 – 12/2021, Horizon2020 Programme Contract No.733032) with the involvement of 130 women of 18-45 years in a healthy singleton pregnancy, willing to eat fish. 15 trained obstetricians nation-wide recruit women under their care and take their hair sample during routine pregnancy appointments.

RESULTS: Within one month, 78 pregnant women, corresponding to 60% of the recruitment target, were successfully recruited and provided hair samples. Virtually all women invited to join the study, consent to participation. Some women provide their informed consent at the time of invitation, while others review the information for participants at home and return the completed certificate of informed consent at the next scheduled meeting. Based on current data, it is predicted that the recruitment target will be reached within two months total.

CONCLUSIONS: Recruitment of pregnant women and sampling by obstetricians is successful because it builds on the trust that the pregnant women feel towards their health care provider. It also overcomes obstacles due to the COVID-19 pandemic, creates educational opportunities for the doctors and facilitates the communication of personal results to the participants via their health care provider.

Keywords: Community-engaged research, Policy, Chemical exposures, Heavy metals, Exposure assessment, Pregnancy outcomes



ABSTRACT E-BOOK

P-405

Exposures » Occupational exposures

Waste Electrical and Electronic Equipment: Impacts of working conditions on health in Benin

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BACKGROUND AND AIM: E-waste workers are exposed to various health problems not clearly defined because practicing in the informal sector. In Benin, the burden of morbid conditions among e-waste workers is not known. This study aims to evaluate the impact of working conditions on their health in Cotonou, Benin.

METHODS: A cross-sectional and analytical study was conducted from November 2019 to October 2020 in Cotonou, using a stratified random sampling technique. The collectors, repairers and recyclers of e-waste were interviewed using a digital questionnaire on a tablet using the KoboCollect application. Binary logistic regression was performed using the stepwise degressive method to identify factors associated with the health status.

RESULTS: The study population consisted of 161 subjects, including one female. The mean age was 30 ± 10 years with extremes of 14 and 63 years. The majority (60.25%) were aged 25-49 years. The subjects worked in poor conditions and six out of ten (62.73%) did not wear any personal protective equipment. The prevalence of health conditions was 44% [36.4% - 52.1%].

The risk factors associated with the occurrence of a health condition were activities exposing to respiratory risks; lack of personal protection; membership in the reclaimer category; membership in the recycler category; exposure to adverse working conditions and low daily income.

CONCLUSIONS: The high prevalence of health conditions among e-waste workers in Cotonou, highlights the importance of addressing their health problems and implementing public health interventions in both primary and secondary prevention.

Keywords: working conditions, health, environment, e-waste, Benin



ABSTRACT E-BOOK

P-406

Exposures » Occupational exposures

Night shift work and biological ageing among hospital female nurses

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BACKGROUND AND AIM: The link between night shift (NS) work and biological ageing is supported by associations observed between NS work, increased risk of age-related diseases (e.g., cardiovascular diseases and cancer), and gene-specific methylation changes. We aim to verify whether NS work can influence biological age, estimated through a parsimonious epigenetic signature (proposed by Zbieć-Piekarska and colleagues).

METHODS: Forty-six female nurses of the Policlinico Hospital (Milan, Italy) working in NS for at least two years were matched by age and length of employment with 51 female colleagues not working in NS. Sociodemographic and work-related information was collected through a semi-structured interview. Work-related stress was assessed through the Effort Reward Imbalance (ERI) questionnaire. Each subject provided written informed consent and donated a 12 ml blood sample. Biological age was calculated considering the methylation pattern of five CpG sites in five genes (ELOVL2, C1orf132/MIR29B2C, FHL2, KLF14, TRIM59). Age acceleration was estimated by regressing biological age on chronological age and taking the residuals. Multivariate linear regression models were applied.

RESULTS: Biological ageing was not associated with working in NS or number of years in NS. Only subjects with overweight/obesity showed an increase in age acceleration per each year in NS ($\beta=0.46$, 95%CI: 0.05; 0.87, $p=0.03$, p -interaction=0.097). A similar pattern was observed for subjects experiencing work-related stress (ERI>1), with an age acceleration of 0.58 years (95%CI: 0.10; 1.06, $p=0.018$, p -interaction=0.056) per each year in NS. We observed a higher age acceleration ($\beta=0.66$, 95%CI: 0.03; 1.29, $p=0.041$) when considering both categories combined (BMI \geq 25 and ERI>1), even if no formal interaction was apparent.

CONCLUSIONS: Although based on a small number of subjects, our findings suggest an increased biological ageing only among hypersusceptible subjects. This finding is worth of further investigation, also in light of recent results suggesting a higher breast cancer risk in women with increased age acceleration.

Keywords: working schedule, epigenetics, biological ageing, DNA methylation, overweight/obesity, work-related stress



ABSTRACT E-BOOK

P-407

Policy » Research translation to affect policy and practice

Results of five years monitoring for *Toxoplasma gondii* infection in animals by the official Italian Zoonoses Informative System (SINZOO)

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BACKGROUND AND AIM: *T. gondii* is the fourth most important parasite in the world and second out of 14 foodborne pathogens in the USA and in Europe. Meat-borne transmission of *T. gondii* causes most of food-borne infections in Europe (EFSA-European Food Safety Authority). SINZOO is part of the Veterinary Informative System of the Italian Ministry of Health. It collects and transmit data to EFSA, published in the annual EFSA/ECDC summary reports on zoonoses. The aim of this study was to evaluate the effectiveness of SINZOO for epidemiological surveillance of toxoplasmosis in Italy.

METHODS: Among animal species tested in Italy between 2015 and 2019 the ones most commonly reared for human consumption (sheep, cattle, pig, goats) were selected, moreover wild boars, wild ruminants, cats.

RESULTS: Infection rates ranged from 0.73% in wild boars to 45.72% in sheep. Total number of tested animals ranged from 37 pigs in 2015 to 3449 sheep in 2018. Besides a relevant incidence among wild boars in 2018 (45%) and 2019 (32%), higher infection rates were more often reported among sheep and pigs. Between 2018 and 2019 67% of the overall analyses were carried out in one region (Sardinia), mostly on one species (sheep) and emerged from targeted research or clinical investigation. In fact in 2019 83.45% of analyses were performed following clinical suspicions while only 8.43% came from official controls, highlighting toxoplasmosis underestimation by the national veterinary health system.

CONCLUSIONS: Despite EFSA recognizes the relevance of toxoplasmosis, this is not included among zoonoses under mandatory notification, making animal epidemiological surveillance rather scarce and uneven. Data reported to SINZOO suggest that *T. gondii* is still a relevant hazard to monitor by meat inspection and in-farm survey, for effective epidemiological evaluations and appropriate public health interventions. This issue characterizes Italy and Europe, highlighting that toxoplasmosis monitoring should be made mandatory and with uniform rules.

Keywords: Incidence, Epidemiology, Policy and practice, Risk assessment, Foodborne diseases, Infectious diseases



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Mental health outcomes

Exposure to Ambient Air Pollution Before First Breath and Risk of Autism: a Population-Based Study in Tehran, Iran

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BACKGROUND AND AIM: Some recent human and animal studies have suggested that air pollution may affect the central nervous system and contribute to neurodevelopmental outcomes, such as autism spectrum disorder (ASD). We aimed to investigate the association between long-term exposure to ambient air pollution and increased odds of ASD among 2 to 10-year-old children.

METHODS: We conducted a case-control study in Tehran, Iran. Cases were 134 children born between 2004 and 2012 diagnosed with ASD whose mothers were resident in Tehran during their pregnancy, and controls were 388 children without ASD randomly selected from public schools and kindergartens. Land-use regression models were used to estimate their annual mean exposure to ambient particulate matter with aerodynamic diameter $\leq 10 \mu\text{m}$ (PM₁₀), sulfur dioxide (SO₂), benzene, toluene, ethylbenzene, p-xylene, o-xylene, m-xylene (BTEX), and total BTEX. Logistic regression was used for the analyses and adjusted for possible confounding variables.

RESULTS: The odds ratios per 1 unit increase in pollutants in the adjusted models were 1.00 (95% CI: 0.99, 1.01) for PM₁₀, 0.99 (95% CI: 0.99, 1.00) for SO₂, 0.96 (0.83, 1.11) for benzene, 1.00 (0.96, 1.04) for toluene, 0.95 (0.79, 1.16) for ethylbenzene, 1.00 (0.78, 1.27) for p-xylene, 1.09 (0.94, 1.27) for o-xylene, 1.01 (0.92, 1.12) for m-xylene, and 0.99 (0.97, 1.01) for total BTEX. We did not find the evidence of association between estimated annual mean exposure to above mentioned ambient air pollutants and increased odds of ASD in children. However, our findings might be due to some important limitations.

CONCLUSIONS: Further research with better control of confounding variables, improved spatiotemporal exposure estimates, and inclusion of other important markers of air pollution is recommended.

Keywords: Autism, Prenatal exposure, LUR, VOCs



ABSTRACT E-BOOK

P-409

Neurologic and Mental Health Outcomes » Mental health outcomes

Impact of COVID-19 on perceived risk and mental health among public transport users in a medium-sized metropolitan area in Spain

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BACKGROUND AND AIM: The COVID-19 pandemic has impacted the mental health of the population worldwide. However, little is known about the mental health impact on collectives such as health and essential workers or public transport users. Previous literature has shown how traveling in confined spaces with other people might lead to conditions of stress or anxiety. However, since most studies have focused on crime-related safety, more research is needed on the perceived risk of contagion and its association with transit users' mental health. The aim of this study is, first, to evaluate the impact of the COVID-19 pandemic on anxiety and depression levels of public transport users and, second, to explore the influence of these conditions on the perception of public transport safety.

METHODS: A random sample of public transport users (N=2,791) were surveyed at the main bus stations and stops in the main two cities of the Tarragona Metropolitan Region (Reus and Tarragona) between October 2020 and January 2021.

RESULTS: Preliminary results show how the number of public transport users that frequently felt sadness in the past weeks increased by 6.8 percentual points after COVID-19's outbreak (from 5.16% in 2019 to 12.0% in 2020), and those who frequently felt fear and anxiety increased by 13 points (from 5.8% in 2019 to 18.8% in 2020). Regarding their perceived risk of contagion, public transport was the space where they felt a higher risk (5.5/10), in contrast with their home (1.6/10). Public transport vehicles were the spaces within a trip where participants felt a higher threat of contagion (5.6/10) in comparison with stops at the origin (3.8/10) and at the destination (3.6/10).

CONCLUSIONS: Understanding the factors associated with the perception of virus-related safety such as COVID-19 is key for the retention of public transport users, which has become a major challenge for many cities around the world.

Keywords: Mental health outcomes, Socio-economic factors, Others: COVID-19



ABSTRACT E-BOOK

P-411

Neurologic and Mental Health Outcomes » Neurodegenerative outcomes

Greenness, cognitive impairment and dementia: a systematic review and meta-analysis

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BACKGROUND AND AIM: Many recent studies identified the benefits of green space exposure for the improvement of human health, especially mental health. The involved pathways could be increased physical activity, improved sleep quality, reduced stress and also increased social interaction. The relation between greenness and cognitive decline, however, is still uncertain.

METHODS: We searched epidemiological studies related to green space exposure and cognitive impairment and dementia in two electronic databases (PubMed and EMBASE) using terms related to residential greenness, including Normalized Difference Vegetation Index-NDVI, land cover, land use, green index, greenness, green space, urban park, urban green and recreational park, along with cognitive impairment, decline and dementia. A meta-analysis comparing the highest versus the lowest greenness exposure and risk of cognitive decline was performed using a random-effects model.

RESULTS: Out of 64 studies retrieved from the online search 11 studies were eligible for the review. The majority of included reports used satellied-derived NDVI, while the remaining studies used land cover maps to determine the greenness-related exposure areas. Cognitive impairment or dementia risk are calculated using different exposure types (greenness within a buffer, the areal radius, or greenness of census block) at subject residential address. Overall, summary risk ratio-RR showed no effect of greenness on cognitive decline (RR 0.99, 95% confidence interval-CI 0.91-1.07), whereas a slight indication of a beneficial effect of NDVI emerged (RR 0.96, 95%CI 0.90-1.03). Two studies that reported correlation coefficients only did not suggest an association between cognitive impairment and dementia measurement.

CONCLUSIONS: Overall, our study yielded limited evidence of a protective effect of greenness on cognitive decline. The rapid evolution of greenness definition over time and the limitations in exposure assessment, however, suggest the need to further investigate this issue in order to draw more reliable conclusions.

Keywords: Green space, Neurodegenerative outcomes, Environmental epidemiology



ABSTRACT E-BOOK

P-412

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

EXHES study reveals the impact of prenatal exposure to metals, PFASs, organophosphates, and organochlorines on early child development

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BACKGROUND AND AIM: Unraveling the exposome may be a cornerstone towards precision prevention in public health. The presented approach was applied to a cohort of 50 mother-child pairs in the framework of HEALS project.

METHODS: The links between in utero exposure to metals, PFOS, PFOA, organophosphates, and organochlorines, metabolic pathway deregulation, and clinically observed phenotypes were drawn through a urinary and serum untargeted metabolomics analysis using UPLC-Q-TOF/MS and NMR, followed by integrative bioinformatics and exposome-wide association algorithms. Spectral pre-processing was performed using the Bioconductor R packages XCMS and CAMERA. The databases HMDB, Metlin, and Lipid Maps, were used for metabolites identification. Enrichment and pathway analyses were performed using GeneSpring GX, which mapped significant biomarkers to known biochemical pathways based on the information contained in public databases (MetaCyc, Wikipathways, and KEGG). The Exposome-Wide Association Study (EWAS) approach was adopted to comprehensively and systematically associate multiple exposure factors discovering robust correlations with metabolites levels and dysregulated pathways.

RESULTS: Metabolite identification revealed that the total number of unique annotated metabolites in urine and serum samples analysis using LC-HRMS was 751, and 7830, respectively. The detected metabolites on serum samples were mapped on 246 pathways, while urinary metabolites on 163. According to EWAS analysis, birth weight is positively affected by S-Adenosylhomocysteine levels during the first trimester of pregnancy, and negatively associated with the levels of Citrulline, and DEAMPY, at delivery. In addition, higher exposure levels to Hexachlorocyclohexane (HCH), 2,2',4,5,5'-Pentachlorobiphenyl (PCB101) and 2,4'-DDT, can lead to height increasement. The same outcome is associated to citric acid levels. Head circumference is positively associated with exposure to 4,4'-DDT at the first trimester.

CONCLUSIONS: Overall, functionally coupling advanced bioinformatics algorithms applied on omics data with exposome-derived information on exposures and health indicators can support the high-dimension-biology-based association of environmental exposures and adverse health outcomes in early life.

Keywords: Exposome, Metabolomics, Birth outcomes



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Risk of attention-deficit/hyperactivity disorder and autism spectrum disorder in children associated with gestational levels of toxic metals and essential elements

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BACKGROUND AND AIM: Intrauterine exposure to toxic metals and deficient/excess levels of essential elements may adversely affect the uniquely sensitive developing human brain and contribute to risk of neurodevelopmental disorders in children. We investigated prenatal levels of toxic metals and essential elements and risk of attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) in children.

METHODS: We included 705 ADHD case, 397 ASD case and 1034 control children and their mothers from the Norwegian Mother, Father and Child Cohort Study (MoBa). Linkage with the Norwegian Patient Registry was used to identify cases. We measured toxic metals and essential elements in maternal whole blood sampled at week 17 of gestation: cadmium; cesium; cobalt; copper; lead; magnesium; manganese; selenium; zinc; total arsenic; and total mercury. Associations between individual metals/elements and odds ratio (OR) of ADHD or ASD diagnoses were investigated using multivariable adjusted logistic regressions with exposures categorized by quartiles (Q1-Q4; Q1 as reference). Also, the exposure-response relationships were examined in restricted cubic splines.

RESULTS: Several associations were identified, with many overlapping findings for the two diagnoses. Among the main findings were increased risk of ADHD with both low and high maternal levels of arsenic (nonlinear U-shape) and increased odds of ASD in arsenic Q2 [OR = 1.77 (CI: 1.26, 2.49)]. The highest levels of maternal cadmium were associated with increased risk of ADHD [Q4: OR = 1.59 (CI: 1.15, 2.18)] and ASD [Q4: OR = 1.57 (CI: 1.07, 2.31)]. Increased odds of both diagnoses were observed with the essential elements magnesium [ADHD: Q4: OR = 1.42 (CI: 1.06, 1.91), ASD: nonlinear U-shape] and manganese [ADHD: nonlinear U-shape, ASD: Q4: OR = 1.84 (CI: 1.30, 2.59)].

CONCLUSIONS: Although more studies are warranted, our findings suggest that even population levels of these compounds may adversely impact fetal neurodevelopment and constitute common risk factors for both ADHD and ASD.

Keywords: toxic metals, essential elements, prenatal exposure, neurodevelopmental disorders



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-414

Air pollution » Traffic-related

Temporal variations of ambient air pollutants and meteorological influences on their concentrations in Tehran during 2012–2017

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BACKGROUND AND AIM: In 2015, air pollution exposure was responsible for approximately nine million premature deaths; 16% of all deaths globally. In this study, we examined long-term air quality status in Tehran.

METHODS: Here the temporal variations (hourly, daily, monthly, seasonal, and annual) of key criteria air pollutants (PM_{2.5}, PM₁₀, NO₂, O₃, SO₂, CO) concentration and their relation to meteorological parameters, as well as annual trends of air quality index (AQI) were investigated based on real-time hourly measurements of twenty-one air quality monitoring stations (AQMSs).

RESULTS: Tehran citizens were consistently exposed to annual PM_{2.5}, PM₁₀ and NO₂ approximately 3.0–4.5, 3.5–4.5 and 1.5–2.5 times higher than the World Health Organization air quality guideline levels during the period. Except for O₃, all air pollutants demonstrated the lowest and highest concentrations in summertime and wintertime, respectively. The highest O₃ concentrations were found on weekend (weekend effect), whereas other ambient air pollutants had statistically significant ($P < 0.05$) daily variations in which higher concentrations were observed on weekdays compared to weekend (holiday effect). Hourly O₃ concentration reached its peak at 3.00 p.m., though other air pollutants displayed two peaks; morning and late night. Approximately 45% to 65% of AQI values were in the subcategory of unhealthy for sensitive groups and PM_{2.5} was the responsible air pollutant in Tehran. Amongst meteorological factors, temperature was the key influencing factor for PM_{2.5} and PM₁₀ concentrations, while nebulosity and solar radiation exerted major influences on ambient SO₂ and O₃ concentrations. Additionally, there is a moderate coupling between wind speed and NO₂ and CO concentrations.

CONCLUSIONS: Despite years of efforts for air quality improvement in Tehran, our results clearly confirm that ambient PM_{2.5} and PM₁₀ are still the most notable air pollutants in this city. This represents that traffic-related policy measures for air quality improvement were not sufficiently efficacious in Tehran, particularly concerning reducing PM_{2.5} and PM₁₀.

Keywords: Temporal trends, Criteria air pollutants, Meteorological parameters, AQI



ABSTRACT E-BOOK

P-415

Air pollution » Traffic-related

The Berlin-Brandenburg Air Study – a natural experiment investigating health effects from changes in airport-related exposures

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BACKGROUND AND AIM: The effects of ambient, air-borne ultrafine particles (UFP), particularly those originating from air traffic, on human health remain poorly understood. Using the simultaneous closing and opening of two airports in Berlin as a unique, natural experiment, we aim to investigate the effect of changing UFP exposure on health in schoolchildren, with a particular focus on aircraft-related UFPs.

METHODS: The Berlin-Brandenburg Air Study (BEAR) involves 800 elementary school children (ages 8-12) attending altogether 12-16 schools near the closing Tegel (TXL) airport, near the opening Berlin-Brandenburg (BER) airport, and in control areas (CTL) away from both airports and associated air corridors. Each child undergoes repeated school-based health examinations for lung function, cognitive function (attention and working memory), blood pressure, and quality of life. School-specific particle number concentrations and meteorology are measured daily. Along with other air pollutants and meteorology, size-fractionated UFP measurements are collected at two local monitoring stations. Daily source-specific UFP concentrations will be modeled on a fine spatial scale using a chemistry transport model for periods before and after the airport's relocation. We will analyze short-term effects of UFP as well as long-term effects on lung growth and cognitive development comparing growth trajectories across the three school areas.

RESULTS: Since early 2020, over 300 children in 7 schools (4 near TXL, 2 near BER, 1 in CTL) have completed their first examination. Due to the ongoing COVID-19 pandemic, the pattern of air traffic has changed and field work at the schools has been delayed. We have expanded the time frame and recruitment near BER airport, where we expect insightful comparisons between lockdown conditions and gradually increasing air traffic.

CONCLUSIONS: The BEAR study aims to increase understanding on health effects of aircraft-related UFPs, particularly for children's health and development. We present the study's methodological design and epidemiological background for this natural experiment.

Keywords: air pollution, children's environmental health, exposure assessment, methodological study design, particulate matter



ABSTRACT E-BOOK

P-416

Air pollution » Particulate matter

Ambient air pollution and cardiovascular diseases: an Umbrella review of systematic reviews and meta-analyses

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BACKGROUND AND AIM: The available evidence on the effects of ambient air pollution on cardiovascular diseases (CVDs) has increased substantially, including emerging evidence from low-and-middle income countries (LMICs). In this umbrella review we aimed to summarize the current epidemiological evidence from systematic reviews and meta-analyses linking ambient air pollution and cardiovascular diseases highlighting regional differences in evidence and vulnerable subpopulations.

METHODS: We performed a comprehensive search strategy through the electronic databases PubMed, Embase and Web of Science for articles published between 2010 and 2020. We included systematic reviews and meta-analyses that evaluated the association between ambient air pollution (particulate matter and nitrogen oxides) and multiple CVDs. The search was limited to articles in English and studies on humans. Data screening, quality evaluation using AMSTAR-2 critical domains and extraction were done in duplicate.

RESULTS: In preliminary results, our research strategy obtained 1112 hits and finally 70 articles were eligible for the review. The most common outcomes were: CVD-mortality/morbidity/hospitalizations (30 studies), stroke (13), atherosclerosis (10), blood pressure and hypertension (6), myocardial infarction (5), arrhythmias (4), cardiac arrest (2), and heart failure, ischemic heart diseases (1 each). Of the included reviews and meta-analyses, 33 examined only particulate matter, 4 studies examined only nitrogen oxides and 28 studies examined both pollutants. Overall, all studies found that increased levels of ambient air pollution were associated with increased CVDs.

CONCLUSIONS: This comprehensive umbrella review summarizes the current evidence concerning both long-term and short-term exposure to ambient air pollution and effects on multiple clinical CVDs. We will describe for which clinical conditions there is most evidence, evaluate the state of the science in/from LMICs and which groups are most vulnerable to the effects of air pollution.

Keywords: Air pollution, Particulate matter, Oxides of nitrogen, Cardiovascular diseases, Umbrella review



ABSTRACT E-BOOK

P-417

Air pollution » Traffic-related

Acute cardiovascular mortality in communities living near a major airport: mutual effects of fine particulate matter and nitrogen dioxide

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BACKGROUND AND AIM: Ambient air pollution is the leading cause of environmental mortality and morbidity worldwide. However, the individual contributions to acute mortality of traffic-related air pollutants such as nitrogen dioxide (NO₂) and fine particulate matter (PM_{2.5}) are still debated.

METHODS: We conducted a time-stratified case-crossover study for a study population located around Zurich airport in Switzerland, including 24,886 adult cardiovascular deaths from the Swiss National Cohort. We estimated the risk of cause-specific cardiovascular mortality associated with daily NO₂ and PM_{2.5} exposure at home using distributed lag models up to 7 days preceding death, adjusted for daily temperature, acute night-time aircraft noise, firework celebrations, and holidays.

RESULTS: Cardiovascular mortality was associated with NO₂; whereas the association with PM_{2.5} disappeared upon adjustment for NO₂. The strongest association was observed between NO₂ and ischemic stroke (OR = 1.55 per 10µg/m³, 95% CI = 1.20-2.00). Cause-specific analyses showed differences in terms of delayed effect: OR were highest at 1-3 days after exposure for most health outcomes but at lags of 3-5 days for heart failure. Individual and social vulnerabilities to NO₂ associated cardiovascular mortality also varied by health outcome, possibly highlighting the role of different behaviours and risk factors in these groups.

CONCLUSIONS: This study confirms the association between ambient, as a marker for primary emissions, and acute cardiovascular mortality in a specific setting around a major airport. Future research should further investigate the role of additional air pollutants including ultra-fine particles on cardiovascular disease to inform most efficient control measures.

Keywords: Air pollution (traffic-related), cardiovascular diseases



ABSTRACT E-BOOK

P-418

Air pollution » Traffic-related

Long-term exposure to source-specific particulate air pollution and mortality

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BACKGROUND AND AIM: Many studies have shown associations between particulate matter (PM) air pollution and total and cardiopulmonary morbidity and mortality. However, air pollution is a heterogeneous mixture from various sources, and it is less clear which types and sources that are the most harmful. We analyzed associations between long-term exposure to source-specific PM and total and cardiovascular mortality in population-based cohorts in three Swedish cities.

METHODS: Using high-resolution dispersion models of PM from different sources and address registries we assigned annual individual residential mean concentrations to participants in four cohorts in Gothenburg, Stockholm and Umeå for the years 1990-2011. Cause-specific mortality was assigned from death registries. Effects of the last five years of exposure on total natural and cardiovascular mortality was estimated using Cox regression models adjusted for possible confounders, and meta-analyzed including a random effect of cohort.

RESULTS: A total number of 7340 natural cause deaths and 2755 cardiovascular cause-specific deaths were observed among 68,679 participants during the study period. For total mortality there were positive associations with road traffic exhaust particles (HR 1.12, 95% CI 1.03-1.21) per 1 µg/m³, and road wear particles (HR 1.02, 95% C 1.01-1.04, per 1 µg/m³), but not with particles from residential heating. Adjustment for road traffic noise, or particles from residential heating, did not substantially affect the results for traffic-related PM. For cardiovascular mortality, there were positive but not statistically significant associations for PM from road traffic, residential heating, or other sources.

CONCLUSIONS: Mortality was associated with traffic-related PM, but less with air pollution from residential heating and other sources, in a multi-cohort study at low exposure-levels.

Keywords: particulate matter, traffic-related, mixtures, long-term exposures, noise



ABSTRACT E-BOOK

P-419

Air pollution » Particulate matter

Impact of SARS-CoV-2 on Ambient Air Particulate Matter in Tehran

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BACKGROUND AND AIM: The pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has indirectly produced both positive and negative effects on the environment, particularly in terms of air quality.

METHODS: Our study aimed to determine these effects in the city of Tehran by comparing the ambient PM_{2.5} and PM₁₀ levels recorded at 22 air quality monitoring stations during the outbreak (20 February–2 April 2020) with those from the corresponding period last year (20 February–3 April 2019).

RESULTS: Contrary to expectation, the average concentrations of both the PM_{2.5} and the PM₁₀ were markedly higher during the former, increasing by 20.5% and 15.7%, respectively, for the first month of the outbreak (20 February–19 March 2020) and by 23.5% and 20.0% for the subsequent Nowruz New Year holidays (from late March till early April), which resulted in overall increases of 20.5% and 16.5% for the entire period. The non-integrated responses to the pandemic, including the failure to close administrative centers and, in particular, the recommendation to maintain social distancing by reducing public transportation use (prompting citizens to travel by private vehicle), have worsened the ambient air quality in Tehran, providing an exceptional opportunity to evaluate the direct/indirect influence of air quality policies and emission control measures on PM_{2.5} and PM₁₀.

CONCLUSIONS: Because of the significant association between the lethality of coronavirus disease 2019 (COVID-19) and exposure to ambient air pollution, the rise in airborne PM_{2.5} during this outbreak may increase the mortality rate of SARS-CoV-2.

Keywords: SARS-CoV-2, COVID-19, Ambient air quality, PM_{2.5}, PM₁₀, Tehran.



ABSTRACT E-BOOK

P-420

Air pollution » Particulate matter

Prenatal exposure to PM₁₀ and changes in DNA methylation and telomere length in cord blood

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BACKGROUND AND AIM: Air pollution exposure in pregnancy can cause molecular level alterations associated with later disease susceptibility. We aimed to investigate changes in two molecular marker types, DNA methylation and telomere length, in cord blood in relation to gestational PM₁₀ exposure and to explore potential gestational windows of susceptibility.

METHODS: Cord blood epigenome-wide DNA methylation (N=384) and telomere length (N=500) were measured in children of the Italian birth cohort Piccolipiù using the Infinium Methylation EPIC BeadChip (Illumina) and qPCR, respectively. PM₁₀ exposure levels were estimated for different gestational periods based on maternal residential address, using advanced methods based on satellite data. Lag distributed models using weekly exposures were used to further confirm the identified exposure windows.

RESULTS: PM₁₀ exposure during the first gestational weeks was associated with DNA methylation of more than 100 unique CpGs, mapped to genes with relevant functions in cell replication, differentiation and response to environmental stressors. We were able to test half of the CpGs in an independent sample from the same cohort and six CpGs showed robust associations. PM₁₀ exposure during mid and later pregnancy was associated with shorter and longer telomeres, respectively.

CONCLUSIONS: The first weeks of pregnancy seems to be a particularly important PM₁₀ exposure window for DNA methylation that should be accounted for in future analyses, while exposure to PM₁₀ in mid and late pregnancy might be important for telomere length. DNA methylation and telomere length are fundamental regulators of cellular processes during early life, and their alterations could have major implications for later disease susceptibility.

Keywords: Environmental epidemiology, Particulate matter, Epigenomics, Telomere length



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-421

Air pollution » Traffic-related

Serum estimate of benzene, naphthalene and pyrene as measure of occupational exposure to vehicular air pollution

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BACKGROUND AND AIM: Exacerbation in respiration tract infections (RTI) and asthma is associated with exposure to vehicular emission in urban environment. Urban occupational exposure to dust and particulate matter has been shown to increase infections inside airway of human epithelial cells and evidence about rising asthma among occupations working on roadsides were reported.

METHODS: Hence, we studied 89 workers directly exposed to vehicular emission such as fuel-station attendants, construction workers, traffic police wardens and bus-drivers with an aim to assess RTI and asthma prevalence resulting from inhalation of air containing dust and vehicular pollutants. Unexposed office workers (n=44) were recruited as control cohort. Exposure was characterized as daily work hours and years associated with current profession.

RESULTS: Serum benzene, naphthalene and pyrene median concentrations were 4.5, 12.6, and 2.04 µg/L in exposed group and 0.54, 0.77, and 0.14 µg/L in unexposed cohort, respectively. Compared to self-reported dermal contact, the estimated concentrations were higher in fuel-station attendants related to spills of gasoline (p<0.05). After adjusting long work hours, 39% of exposures estimates exceeded the benzene threshold limit value for an 8-h time-weighted average of 1.6 mg/m³. Smokers appeared highly vulnerable to naphthalene (r=0.49, p<0.01) and pyrene (r=0.38, p<0.05) body burden among traffic police wardens and bus-drivers. Results of regression analysis showed asthma highly prevalent in construction workers (R²=0.53) followed by bus-drivers (R²=0.41). Compared to unexposed control group, RTI was found in 67% of the fuel-station attendants.

CONCLUSIONS: We conclude that except construction workers, inhalation and frequent skin exposure to naphthalene and pyrene is unavoidable in all occupational groups. Reducing working hours and job rotation coupled with use of protective equipment are suggested as intervention measures to reduce exposure for vehicular air pollution.

Keywords: Air pollution; pyrene, benzene, road-side workers; biomonitoring



ABSTRACT E-BOOK

P-422

Air pollution » Particulate matter

Lung and upper aero-digestive tract cancers and exposure to PM_{2.5} in the ICARE study (France)

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BACKGROUND AND AIM: Fine particulate matter (PM_{2.5}) was classified as carcinogenic by the International Agency for Research on Cancer, especially for lung cancer. Nevertheless, it is not known whether the association with lung cancer differs by histological subtype. Little is known on the association with upper aero-digestive tract (UADT) cancers. Our aim was to study association between exposure to PM_{2.5} and lung and UADT cancers and their different subtypes and sub-sites.

METHODS: We conducted a population-based case-control study in 10 French departments in 2001-2007, including 2,684 lung cancer cases, 1,985 UADT cancer cases and 3,481 controls frequency-matched on age and study area. Concentration of PM_{2.5} at the participants' address during the 10 years before recruitment was assessed using a chemistry transport model. Odds ratios (OR) and 95% confidence intervals (95% CI) were estimated using multiple logistic regression models adjusted for the relevant confounders. Analyses were conducted separately for the different histological lung cancer subtypes, and UADT sub-sites.

RESULTS: The OR per 1 µg/m³ increase in PM_{2.5} for lung cancer was 1.03 (95% CI, 1.00, 1.07). Odds ratio was 1.24 (95% CI, 0.95, 1.62) in the highest exposure quintile, compared to the first. The ORs per 1 µg/m³ were slightly higher for squamous cell carcinoma (783 cases, OR 1.04 (95% CI, 1.01, 1.07)) and small cell carcinoma (374 cases, OR 1.04; 95% CI, 1.00, 1.07), than for adenocarcinoma (1017 cases, OR 1.02; 95% CI, 0.99, 1.05)). The OR per 1 µg/m³ increase in PM_{2.5} of the UADT cancer was 0.99 (95% CI, 0.95, 1.03), and no difference by UADT sub-site emerged in our data.

CONCLUSIONS: The effect of PM_{2.5} on lung cancer risk may differ by histological subtype. No association with UADT cancer was observed.

Keywords: Cancer, Lung, Upper aero-digestive tract, Air pollution, Particulate matter, Case-control



ABSTRACT E-BOOK

P-423

Air pollution » Particulate matter

Ambient Black Carbon Particles Reach the Fetal Circulation

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BACKGROUND AND AIM: Mothers' exposure to ambient air pollution, including black carbon (BC), during pregnancy has been associated with several adverse birth outcomes. Although the presence of ambient combustion-related particulates was recently shown in the placental tissue of pregnant women, proof of placental translocation to the fetal circulation in a real-life human context is still lacking. Here, we screened human umbilical cord blood for the presence of BC as part of the combustion-derived particulate matter.

METHODS: Cord blood BC load was determined in the framework of the ENVIRONAGE (ENVIRONmental influence ON AGEing in early life) birth cohort study. We exploited the non-incandescence related white-light generation by carbonaceous particles following femtosecond pulsed illumination to screen whole cord blood samples from 60 newborns for the presence of BC particles in a biocompatible and label-free manner.

RESULTS: BC is identified in all screened blood samples, with an average (SD) particle count of 0.48×10^5 (0.29×10^5), 1.02×10^5 (0.76×10^5) and 2.87×10^5 (2.12×10^5) particles per mL cord blood for low ($n=20$), intermediate ($n=20$) and high ($n=20$) exposed mother-newborn pairs, respectively. Furthermore, the cord blood BC load is positively associated with the mothers' residential BC exposure during pregnancy ($n=60$; $r=0.72$; $p<0.0001$). Moreover, the carbonaceous nature of these particulates was confirmed.

CONCLUSIONS: Identification of BC particles in the fetal circulation shows that ambient particulates can be transported towards the fetus and represents a plausible explanation for the observed detrimental health effects from early life onwards.

Keywords: Air pollution, In utero exposure, maternal-fetal transfer, black carbon



ABSTRACT E-BOOK

P-424

Air pollution » Particulate matter

Long- and short-term air pollution exposure shortens telomere length in a population of hypersusceptible subjects

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BACKGROUND AND AIM: Reduction in telomere length (TL) has been documented in subjects affected by age-related diseases (e.g., cancer, cardiovascular diseases) and has been associated to oxidative stress and systemic inflammation, claimed also as potential mechanisms underlying health effects of air pollution exposure, especially particulate matter (PM). We aim to determine the effects of both short- and long-term exposure to PM $\leq 10\mu\text{m}$ (PM₁₀) on TL in a well-characterized population (SPHERE project).

METHODS: About 1,800 subjects with overweight/obesity were recruited in Milan (Italy) in 2010-2015, completed a questionnaire and donated a 15 mL blood sample. TL was measured (as T/S ratio) by real-time PCR. Each subject was assigned air pollution and meteorological daily data based on his/her residential address. Multivariate mixed-effects linear models with a random intercept on PCR plate were applied.

RESULTS: We observed a -2.8% change in TL [95% confidence interval (CI): -5.3; -0.8] per 10 $\mu\text{g}/\text{m}^3$ increase in PM₁₀ at the day of blood sampling (lag0). A similar pattern was apparent up to 12 days before recruitment (lag12), with the highest reduction observed at lag6 (-4.3, 95%CI: -6.9; -1.7). When considering moving averages of exposure levels in days preceding recruitment, we observed percent changes in TL ranging from -2.1 (lag0-1) to -8.5 (lag0-12). Long-term PM₁₀ exposure was associated to a -14.9% TL reduction (95%CI: -29.4; -0.5) per 10 $\mu\text{g}/\text{m}^3$ increase in annual average PM₁₀ levels. The association between short-term exposure and TL remained practically unchanged when we additionally adjusted for long-term exposure (-6.2%, 95%CI: -11.2; -1.3 at lag0-14).

CONCLUSIONS: Our results consistently show that both long- and short-term air pollution exposure shortens TL in a population of hypersusceptible subjects, thus shedding light on the potential mechanisms responsible for the excess of age-related diseases that is known to be associated with air pollution exposure.

Keywords: air pollution, particulate matter (PM), telomere length (TL), overweight, obesity, hypersusceptible



ABSTRACT E-BOOK

P-425

Air pollution » Traffic-related

Association between outdoor traffic air pollutants and spread of SARS-CoV-2 pandemic in Modena, Northern Italy

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BACKGROUND AND AIM: Italy was the first European country severely affected by the SARS-CoV-2 pandemic, especially during the first wave in the North of the country. In particular, Modena is a city of Emilia-Romagna which is a region entirely included in the Po valley, one of European areas characterized by the heaviest air pollution levels due also to its orography. Previous studies yielded at a regional level suggested that higher air pollutant levels may increase both SARS-CoV-2 infection and mortality.

METHODS: In this study, we further investigated the association between air pollutant exposure and spread of the SARS-CoV-2 using data collected from Modena municipality in the period February 2020-April 2021. We used traffic pollutant levels collected from an urban air quality monitoring station in the period January 2020-January 2021, including particulate matter (PM₁₀), nitrogen oxides (NO₂ and NO_x), benzene, and black carbon (BC). We used a random-effects linear regression model within panel data analysis over the study period and we computed beta correlation coefficients (beta) with 95% confidence interval-CI between mean daily pollutant concentrations and SARS-CoV-2 daily positive cases diagnosed in Modena.

RESULTS: We found a positive correlation between all traffic pollutants and SARS-CoV-2 cases, namely for PM₁₀ beta was 1.23 (95%CI 1.00-1.46), lower for NO_x (beta=0.66, 95%CI 0.56-0.75), and higher for NO₂ (beta=1.95, 95%CI 1.59-2.31), benzene (beta=41.41, 95%CI 36.23-46.59), and BC (beta=5.95, 95%CI 1.19-10.72).

CONCLUSIONS: Notwithstanding the limitations of use of aggregated data and potential the residual confounding, these findings seem to support the hypothesis that high levels of air pollution may favor the spread of SARS-CoV-2 infection, or alternatively that they reflect a higher mobility and number of social contacts that favor the spread of the infection.

Keywords: Air pollution, Traffic-related, Infectious diseases, Environmental epidemiology, Exposure assessment



ABSTRACT E-BOOK

P-426

Exposures » Water quality

Spatial relationship between well water arsenic and uranium in Northern Plains Native lands

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BACKGROUND AND AIM: Arsenic and uranium in unregulated private wells affect many rural populations across the US, including American Indian communities. The current EPA maximum contaminant level (MCL) is 10 µg/L for arsenic and 30 µg/L for uranium. Here, we evaluate the association between drinking water arsenic and uranium levels in three tribal regions in North Dakota and South Dakota participating in the Strong Heart Water Study.

METHODS: Well water samples were collected in 2014-2020. Metal concentrations from 441 wells were dichotomized by their MCL for a graduated visualization across the regions. Spearman correlations and region-specific semivariograms were computed. Spatial interpolation using inverse distance weighting was conducted by region.

RESULTS: Groundwater contamination was extensive; 29% and 7% of wells exceeded maximum contaminant levels for arsenic and uranium respectively. 81% of wells had both arsenic and uranium concentrations at one-tenth of their human-health benchmark (arsenic, 1 µg/L; uranium 3 µg/L). Well arsenic and uranium concentrations were uncorrelated ($r_s=0.06$); however, there appeared to be a spatial correlation of wells co-contaminated by arsenic and uranium associated with flow along a geologic contact.

CONCLUSIONS: Elevated arsenic and uranium in drinking water are common across Northern Plains Tribal Lands in the US. More than a third of all wells sampled contained either arsenic or uranium at levels exceeding the MCL, but co-contamination was more common in Region 3. These findings indicate the importance of measuring multiple metals in well water, and to understand underlying hydrogeological conditions. The underlying mechanisms for the prevalence of arsenic and uranium across Northern Plains Tribal Lands in the US, and in particular the occurrence of both elevated arsenic and uranium in drinking water wells in this region, demands further study.



ABSTRACT E-BOOK

Keywords: water quality, multi-pollutant, environmental disparities

P-427

Exposures » Water quality

Drinking Water Sources and Water Quality in the Agricultural Health Study

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BACKGROUND AND AIM: Drinking water contaminants have been associated with adverse health effects. However, little is known about exposures in agricultural communities where farm practices and well use may enhance exposures to specific contaminants. We describe the exposure assessment and exposure distributions for common drinking water contaminants by water source in an agricultural population.

METHODS: We used questionnaire data from the Agricultural Health Study (AHS), a cohort of licensed pesticide applicators (mostly farmers) and their spouses in Iowa (IA) and North Carolina (NC) to ascertain drinking water source at enrollment (1993-1997). For users of public water supplies (PWS), we linked participants' geocoded addresses to monitoring data for regulated contaminants, including five haloacetic acids (HAA5), total trihalomethanes (TTHM), and nitrate-nitrogen (NO₃-N). For private well users, we estimated nitrate levels using previously developed random forest models based on well depth, land use, soil characteristics, nitrogen inputs, and other relevant factors.

RESULTS: We assigned drinking water source for 84% (N=74,919) of AHS participants; approximately 70% in IA and 75% in NC used private wells. Median nitrate concentrations (mg/L NO₃-N) in PWS were higher in IA (0.8, interquartile range (IQR): 0.2-3.1) than NC (0.5, IQR: 0.5-0.6), while median concentrations of HAA5 (µg/L) and TTHM (µg/L) were higher in NC (HAA5: 12.1, IQR: 3.8-33.4; TTHM: 35.4, IQR: 8.8-54.7) than IA (HAA5: 4.3, IQR: 3.0-10.5; TTHM: 13.0, IQR: 3.7-32.3). Private well nitrate concentrations in IA (1.5, IQR: 0.8-4.9) and NC (1.9, IQR: 1.4-2.5) were higher than in PWS. A larger proportion of private wells exceeded the 10mg/L regulatory limit in IA (12%) than NC (<1%).

CONCLUSIONS: Drinking water nitrate levels were higher for private well users and in IA PWS, while TTHM and HAA5 levels were higher in NC PWS. This work will facilitate future analyses of the health effects of drinking water contaminants in the AHS.

Keywords: Water quality, Exposure assessment, Environmental epidemiology



ABSTRACT E-BOOK

P-428

Exposures » Water quality

Water as a relevant source of inorganic arsenic exposure in U.S. cities

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BACKGROUND AND AIM: Water arsenic represents a health concern for US residents served by community water systems (CWS) exceeding the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 10 µg/L, and for residents reliant on unregulated private wells. Little is known on the contribution of CWS arsenic exposures below the MCL, particularly in urban areas. We evaluated whether water arsenic is a relevant source of urinary arsenic in urban settings in the Multi-Ethnic Study of Atherosclerosis (MESA).

METHODS: We examined the association of CWS arsenic with urinary arsenic concentrations (µg/L) for 910 MESA participants from Baltimore, Chicago, Los Angeles, New York City, St. Paul, MN, and Winston-Salem, NC. We assigned three-year population weighted averages of CWS arsenic concentrations using 2006-2008 EPA data (before MCL implementation) to participants by zip code. Dietary information and urinary samples were collected in 2000-2002. Urinary arsenic species were measured using HPLC-ICPMS. We accounted for seafood intake using a residual based method. Linear models adjusted for race/ethnicity, income, smoking status, diet (rice) and urinary creatinine to account for urine dilution.

RESULTS: CWS arsenic levels ranged from < 0.5 µg/L (LOD) in several cities to 3.05 µg/L in Chicago (median 0.44 µg/L). CWS arsenic was positively correlated ($p < 0.05$) with urinary inorganic arsenic (Spearman's rho 0.11), dimethylarsinate (DMA) (0.09), monomethylarsonate (MMA) (0.16) and their sum (0.10). In adjusted models, a 1 µg/L change in CWS arsenic was associated with 1.29 (95%CI 1.01, 1.64) higher inorganic arsenic and 1.19 (1.03, 1.38) higher MMA. The association with DMA, sum of inorganic and methylated species was not statistically significant.

CONCLUSIONS: Drinking water arsenic is a relevant source of exposure and internal dose in US urban areas, determined by urinary arsenic biomarkers. Research is needed to determine health implications of chronic exposure to water arsenic below the MCL, including vulnerable subpopulations.

Keywords: arsenic, drinking water, exposure assessment, environmental epidemiology



ABSTRACT E-BOOK

P-429

Exposures » Water quality

Water Safety Plan: Importance of including epidemiological data in risk assessment in drinking water supply

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BACKGROUND AND AIM: The World Health Organization - WHO, through the first volume of the third edition of the GDWQ (WHO, 2004), published in September 2004, recommended that management entities of public water supply systems develop security plans (PSA) to guarantee water quality, incorporating risk assessment and management methodologies, as well as good system operation practices. PSA is an instrument with a preventive approach, with the objective of ensuring safe water, including minimizing contamination in the spring, eliminating, or removing contamination through water treatment and preventing (re) contamination in the distribution system. The requirements for preventive management, aiming at water safety must encompass five main components:

1. Health based on goals and an assessment of epidemiological and health issues;
2. Evaluation system to determine if the supply of drinking water is within the parameters that meet the health goal;
3. Operational control of the drinking water supply control measures;
4. Management plans documenting the evaluation and monitoring system, describing actions to be taken under normal and emergency conditions;
5. Independent surveillance system that checks if it is operating correctly.

AIM: To analyze the standardization of waterborne morbidities, forms of analysis and the proposal for inclusion in the PSA with an epidemiological approach to health.

METHODS: Descriptive study. We analyzed reports made available by the UN and the Ministry of Health of Brazil. 8 PSA in Brazil, were analyzed to assess whether epidemiological data were included

RESULTS: It was identified that only three PSA included SUS hospital morbidity data, which were from the municipalities of Cordeirópolis, Ipeúna and Santa Barbara D'Oeste

CONCLUSIONS: There is a need for standardization of waterborne morbidities, forms of analysis and proposal for inclusion in PSA considering an epidemiological approach to health in LAC countries and especially Brazil, emphasizing the importance of epidemiology in PSA.

Keywords: Water quality, Waterborne diseases, Environmental epidemiology, Policy and practice



ABSTRACT E-BOOK

P-430

Exposures » Water quality

Human Health Risk Assessment by exposure to arsenic through groundwater in a rural area of Canelones, Uruguay

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BACKGROUND AND AIM: In Uruguay, safe drinking water is supplied to 94% of the population by the state company. However, some rural areas didn't have this "official" water supply and people drink water from their own wells, that couldn't be properly controlled.

Groundwater quality has been the focus of Medical Geology multidisciplinary research studies in Uruguay, being Arsenic (As) one of its main concerns for health impacts in regions where As levels are higher than WHO recommendations (<10 µg/L).

The aim of this work was to assess the health risk related to As exposure through drinking water in a small Uruguayan population located in Canelones department.

METHODS: The study was performed in San Antonio (1650 rural inhabitants) where we studied 30 private wells with As levels over 10 µg/L. Health risk was estimated with exposure frequency and exposure duration to these wells' water. The As levels in water were used to calculate the As average daily dose (ADD). The risk was represented by the hazard quotient (HQ) and the cancer risk (CR). HQ was estimated for dermatological manifestations, using As toxicity reference dose of 0.0003 mg/kg/day. Health risk situation was assumed when HQ levels were >1. Cancer risk (CR) was calculated using the cancer slope factor of 1.5 mg/kg/day⁻¹. Values between 10⁻⁴ y 10⁻⁶ are considered safe.

RESULTS: Ten percent of the wells had a HQ greater than 1 if the water is consumed by the residents daily for ten years.

The CR was higher than 10⁻⁴ if 10 years of residence was assumed, so 93 % of the wells are no safe and the population had an increased cancer risk.

CONCLUSIONS: These results showed that more studies linking groundwater As levels and rural population consumption, should be carried out to address risk assessment and health management including biomonitoring of arsenic in urine of exposed population.

Keywords: Water quality, Arsenic long-term exposure, Risk assessment, Environmental epidemiology



ABSTRACT E-BOOK

P-431

Other » Other (to be specified with keywords in the keywords section)

Use of a protective antimicrobial coating to reduce the microbial load in public transportation – a real-scenario study

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BACKGROUND AND AIM: The need to disinfect and sanitise private or public spaces, as a consequence of the pandemic caused by the Sars-Cov-2 virus, has raised new questions and demands in the sanitary field, including new cleaning and sanitising practices. Public transportation is one of the sectors most impacted by this new reality. The greatest cause for concern in terms of infection risk is related to the high flow and close contact between individuals and the constant sharing of surfaces. In fact, human pathogens have been detected on surfaces highly touched in public transportation. In this study, the antimicrobial activity of the Progen Guard Technology 24H coating (CTEQ - Indústria Química, Portugal) on surfaces of public buses during their normal daily operating period was investigated.

METHODS: Three different buses circulating in Santo Tirso (north of Porto Metropolitan Area, Portugal) between October and December 2020 were part of this study. Swab samples were taken from three surfaces treated with the product and from three untreated surfaces (treated and untreated doorbell buttons, ceiling-mounted handles, stanchions) immediately after product application and every 24 h for 4 days. Immediately after collection, samples were transported to the laboratory and enumeration of total aerobic microorganisms at 30 °C was performed.

RESULTS: For the analyzed parameter and the investigated surfaces, it was concluded that the application of Progen Guard Technology 24H significantly reduces the total microbial load on surfaces immediately after application (86.3% to 98.8%) and for at least 24 hours (72.7% to 98.7%) in a real context - naturally contaminated surfaces and non-controlled conditions.

CONCLUSIONS: These are promising results concerning the prevention of the spread of contaminants in public spaces. This antimicrobial coating deserves to be further investigated in other real-life scenarios where environmental microbial contamination is a cause for concern (e.g., healthcare settings).

Keywords: Non-chemical stressors, microbes, Infectious diseases



ABSTRACT E-BOOK

P-432

Respiratory and Allergic Outcomes » Allergies

Rationale, design and preliminary results of a panel study investigating six health effects of airborne pollen: the EPOCHAL study

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BACKGROUND AND AIM: While airborne pollen is widely recognized as a seasonal cause of sneezing and itchy eyes, its systemic health effects on pulmonary function, cardiovascular health, sleep quality, and cognitive performance are less well-established. Further, it is likely that the public health impact of pollen may increase in the future due to two trends in the last decades: higher population prevalence of pollen sensitization as well as earlier, longer, and more intense pollen seasons, attributed to climate change. No observational study in adults has studied dose-response relationships between pollen concentration and health yet. Most studies did not confirm allergy status objectively, lacked statistical power, or were highly restrictive in their inclusion criteria, and therefore not representative of the real-world allergic population.

METHODS: This work describes an overview of epidemiological research on pollen and health so far, outlining the rationale and research design of the EPOCHAL study (Effects of Pollen on Cardiorespiratory Health and ALLergies). EPOCHAL aims to relate ambient concentrations of different pollen species to six specific health outcomes. In a panel of 400 allergic and non-allergic individuals, heart rate variability and blood pressure (cardiovascular outcomes), lung function and airway inflammation (pulmonary outcomes), performance in various cognitive domains, allergic symptom severity as well as sleep and health-related quality of life are being measured repeatedly (6-16 times) over 6 weeks.

RESULTS: Participant recruitment has started in March 2021 and preliminary results will be available. We aim to uncover and characterize dose-response relationships between different allergenic species of pollen and health, while evaluating concentration thresholds, linearity and plateaus. We will further explore vulnerable population subgroups, defined by sensitization profiles, demographics and comorbidities such as asthma.

CONCLUSIONS: A gain of knowledge in pollen-health outcome relationships is critical to inform future environmental and health policies, provide better symptom forecasts and improve personalized prevention and medicine.

Keywords: Allergies, environmental epidemiology, cardiovascular diseases, respiratory outcomes, greenspace, climate



ABSTRACT E-BOOK

P-434

Methods » Molecular epidemiology

15-F2t-Isoprostane during the lifespan: from children to middle age

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BACKGROUND AND AIM: 15-F2t-Isoprostane is a product of arachidonic acid non-enzymatic oxidation by free radicals. Validated in animal and clinical models, it is a golden standard tool for the oxidative status assessment. The aim of this study is to assess how this biomarker levels could vary during the lifespan.

METHODS: The 15-F2t-Isoprostane urinary concentration was measured in 889 subjects aged between 7 and 69. The analyses were performed by ELISA kit. The levels of 15-F2t-Isoprostane were normalised by creatinine (Kinetic Jaffé method). The analysis was performed considering 10-year age classes: <10 years, 10-19 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years, 60-69 years.

RESULTS: The average 15-F2t-Isoprostane levels were 4.41 ± 4.69 ng/mg creatinine. The descriptive analysis reveals an apparent reduction in the age-class 11-19 years (2.78 ± 2.54 ng/mg creatinine). The average predicted values for the age classes resulting from a GLM analysis are: <10 years: 3.72 ng/mg creatinine ($p < 0.001$, 95%C.I. 2.87-4.58); 10-19 years: 2.78 ng/mg creatinine ($p < 0.001$, 95%C.I. 2.25-3.31); 20-29 years: 4.08 ng/mg creatinine ($p < 0.001$, 95%C.I. 3.04-5.12); 30-39 years 5.09 ng/mg creatinine ($p < 0.001$, 95%C.I. 4.20-5.98); 40-49 years 4.98 ng/mg creatinine ($p < 0.001$, 95%C.I. 4.35-5.60); 50-59 years: 4.28 ng/mg creatinine ($p < 0.001$, 95%C.I. 3.68-4.88) and 60-69 years: 5.23 ng/mg creatinine ($p < 0.001$, 95%C.I. 3.83-6.62).

CONCLUSIONS: Oxidative stress biomarkers levels are currently studied in various populations due to their increase in pre-clinical stages of diseases that could be related to lifestyle, environmental or occupational exposures. The main evidence consists in the reduction in the concentration of 15-F2t-isoprostane in adolescence, which leads to an interruption of the constant increase in oxidative stress over the years. The knowledge of how the 15-F2t-Isoprostane levels change during the lifespan and the assessment of the trend-shape of this phenomenon are crucial to better understand the meaning of this biomarker in molecular epidemiology research.

Keywords: Long-term exposure, Environmental epidemiology, Molecular epidemiology



ABSTRACT E-BOOK

P-435

Exposures » Water quality

Factors impacting adoption of point-of-use activated carbon faucet mount water filters

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BACKGROUND AND AIM: Point-of-use (POU) water filters are a cost-effective measure for reducing exposure to waterborne lead; yet widespread filter adoption has not been achieved in the United States (U.S.). To promote sustained adoption of POU, we have to understand the contextual, psychosocial, and technological factors which motivate, facilitate or impede POU adoption. This study aims to identify factors impacting adoption of POU filters through field testing, researcher observations, resident surveys, and consumer reports.

METHODS: A mixed-methods study was conducted to collect data via open ended surveys, interviews, and observations before and after a POU field-study (n=25). The study protocol, informed consent procedures and data collection instruments were approved by the Louisiana State University Health Institutional Review Board (IRB #10069).

RESULTS: An important contextual factor impacting POU adoption was water quality, specifically, the presence of iron particulates, which resulted in clogged filters. Filters were also reported to be too cumbersome to use, didn't work, or they were reported to be too expensive. The most widely reported problems were: the flow rate was too slow for daily use (39%), and the filter was too big for convenient use in shallow sinks (33%). There was some incorrect usage as well- 47% ran hot water through the filter. Factors that were important in filter selection were availability of replacement cartridges, and system durability.

CONCLUSIONS: Officials promoting POU during lead in water crises and for routine employment should ensure that POU technologies selected will work effectively under community water quality conditions, and that community supply chains exist. Information should be communicated in plain language format and include visual cues, maintenance instructions, and relevant translations. Residents should be allowed to select from a variety of household-compatible technologies, including pitcher filters; and assistance with POU installation should be offered where needed.

Keywords: POU, water filter, consumer survey, Pb, lead, household



ABSTRACT E-BOOK

P-436

Exposures » Water quality

Racial and ethnic disparities in community drinking water quality: a five-state assessment

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Environmental Working Group

BACKGROUND AND AIM: Drinking water quality in the U.S has been a growing concern for decades. There is substantial evidence of regulatory violations and the presence of chemical and microbial contaminants that are detrimental to public health in drinking water supplies, but research on water quality disparities is limited. Here, we examined the water quality and demographic characteristics of populations served by community water systems (CWS) in five states: California (CA), New Jersey (NJ), North Carolina (NC), Pennsylvania (PA), and Texas (TX).

METHODS: Water quality data for community water systems (CWS) were obtained from the EWG's Tap Water Database for 2010-2017. State specific CWS service area boundaries were overlaid with census tract areas allowing community demographics to be linked to water quality data. Demographic characteristics of the CWS-served population were estimated by proportionally assigning census tract demographic data to the CWS by area and summing across that system. The overall water quality metrics were examined against the racial and ethnic groups served and stratified by system size. Water quality was estimated as a function of the average concentrations of major contaminants: nitrate, arsenic (As), trihalomethanes (THM4), and the cumulative cancer risk (CCR) due to 23 carcinogenic drinking water contaminants.

RESULTS: CWS that served proportionally more Hispanic people, regardless of system size, in CA and TX had the overall highest average concentration of nitrates. For NJ, PA, and NC, there were racial/ethnic disparities in the average concentration of As, nitrate, and THM4 in drinking water served by different system sizes. The average CCR also differed across states with risk ranging from 1×10^{-4} to 9×10^{-4} .

CONCLUSIONS: This study findings indicate the need for federal, state, and local agencies to target racial and ethnic disparities in different regions and communities while seeking solutions to chemical contamination in the U.S drinking water.

Keywords: Water quality, risk assessment, multi-pollutant, environmental disparities



ABSTRACT E-BOOK

P-437

Exposures » Other (to be specified with keywords in the keywords section)

Environmental presence of uranium and exposure to uranium and thorium in children living in Alcalá de Henares (Spain)

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BACKGROUND AND AIM: Hair can be used to assess chronic exposure to natural radionuclides, as their presence can be much higher than in other human biomatrices. The aim of this study was to determine the environmental presence of uranium-238 (U) in Alcalá de Henares (Spain), and to assess the exposure to this radionuclide and thorium-232 (Th) in a representative group of children.

METHODS: Scalp hair was collected from 120 children (6 to 9-years-old; 50 boys, 70 girls). U and Th were monitored by ICP-MS after appropriate removal of exogenous contamination with Triton X-100. Additionally, U was monitored in 70/167 topsoil samples sampled across all different urban parks in the city. Data was processed using 'NADA' statistical package.

RESULTS: The limits of detection in hair were (in µg/g): U (0.0008) and Th (0.006). Uranium was detected in all the hair samples monitored, Thorium was only detected in 4.2%. Concentrations are provided as median and IQR for U [0.011 (0.007, 0.019)], and 97.5th percentile for Th (0.008). Levels of U were significantly higher ($P < 0.001$) in hair from girls (0.018 vs. 0.012). The concentrations of both radionuclides in children's hair were of the same order of magnitude as those reported in the literature in non-exposed individuals. Levels of U were also slightly lower to those recently reported in hair from children living close to a chlor-alkali plant in the village of Flix (Catalonia, Spain). Similarly, U was detected in all topsoil samples monitored in Alcalá; median and percentiles are provided in mg/kg: 1.79 (1.20, 2.32); a concentration which is much lower than the recommended Soil Screening Value (15.5 mg/kg).

CONCLUSIONS: The presence of U in evaluated topsoils would not require further site-specific evaluations as this does not represent a risk for its citizens. Children living in this city show a minimal environmental exposure to U and Th.

Keywords: Radionuclides, uranium, human hair, monitoring, Spanish children, exposure.



ABSTRACT E-BOOK

P-438

Exposures » Other (to be specified with keywords in the keywords section)

Assessing the environmental urban exposure to erbium and gadolinium in a healthy group of Spanish adolescents

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BACKGROUND AND AIM: High-technology rare earth elements (REEs) are contaminants of emerging concern. We conducted a study to determine the environmental presence and exposure to two REEs frequently (Gadolinium; Gd) and not frequently (Erbium; Er) studied in topsoils and a teenage population group living in Alcalá de Henares (Spain).

METHODS: Scalp hair was collected from 96 adolescents (13-16 years-old; 28 boys and 68 girls) born and residing in Alcalá. Er and Gd were analysed by ICP-MS after appropriate removal of exogenous contamination using Triton X-100/bath sonication. Additionally, both REEs were monitored in 70/167 topsoil samples randomly sampled from different urban parks across the city. Data was processed using statistical methods applied to censored data available in the 'NADA' statistical package.

RESULTS: The limits of detection in hair and soils, respectively, were (in µg/g): Er (0.0004; 0.0005) and Gd (0.001; 0.0007). Both REEs were detected only in a few hair samples monitored: Er (8.2%) and Gd (1%). Owing to the high levels of censored data obtained, high sample percentiles were determined by means of the methods available in 'NADA'. 95th percentile and range for Er in scalp hair in µg/g was 0.001 (<0.0004-0.001); meanwhile the range for Gd was <0.001-0.002 µg/g. However, both REEs were detected in all topsoil samples monitored; median and percentiles in mg/kg are: Er 0.93 (0.64, 1.06), Gd 2.95 (2.07, 3.46).

CONCLUSIONS: Our results could suggest that Alcalá's teenage population would have not been significantly exposed to Er and Gd, as hair has been suggested a good matrix to quantitatively measure the absorption of REEs from environmental exposure. However, the high environmental presence and distribution of these two REEs detected in soils from Alcalá might represent a potential health risk for the population in the long-term owing to the increasing anthropic uses of REEs.

Keywords: Erbium, gadolinium, human hair, monitoring, Spanish teenagers, exposure.



ABSTRACT E-BOOK

P-439

Exposures » Water quality

Estimating the Occurrence of Arsenic in Residential Drinking Water and Population with Potential High Arsenic Exposure in Texas

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BACKGROUND AND AIM: Exposure to arsenic from drinking water raises a public health issue due to its prevalence and potential health effects. The purpose of this study was to assess the occurrence of arsenic levels in residential drinking water and estimate the population potentially exposed to high arsenic levels from consuming drinking water in Texas.

METHODS: Data of arsenic testing in both public water systems (PWS) and domestic wells in 254 Texas counties were obtained from the Texas Commissions of Environmental Quality and the Texas Water Development Board to estimate the average arsenic concentration and number of populations potentially exposed to levels above the maximum contamination level (MCL), 10 µg/L over last 10 years. Additionally, the logistic regression model was fitted to estimate the odds of exceeding an MCL by region, water source, well depth, aquifer type, and social vulnerability index.

RESULTS: In PWS, 2% of the sites had arsenic over an MCL with a maximum average level of 83.8 µg/L. The odds of an MCL violation were significantly higher in water systems sourced from groundwater and in rural and socially vulnerable areas. However, in private wells, 9.2% of the wells showed water arsenic levels greater than an MCL with average levels up to 569 µg/L. The wells 50-200 feet in depth, sourced from Ogallala and Gulf Coast Aquifers, and in socially vulnerable areas showed significantly higher detections of arsenic levels greater than the MCL. It was estimated that 323,741 people in 74 counties were potentially exposed to arsenic in residential drinking water over the MCL.

CONCLUSIONS: Our results facilitated the evaluation of the current arsenic contamination in drinking water and the identification of areas of potential high arsenic exposure. Broader water screening and biomonitoring to determine the burden of arsenic exposure are required to protect public health in these areas.

Keywords: Arsenic, Drinking Water, Water Quality, Environmental Health



ABSTRACT E-BOOK

P-440

Reproductive Outcomes » Female reproductive outcomes

Hair mercury levels, dietary intake of omega-3 fatty acids and ovarian reserve among women attending a fertility center

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BACKGROUND AND AIM: We investigated the association of hair mercury (Hg) levels with antral follicle count (AFC), as a marker of ovarian reserve, and evaluate whether this relationship differed among women with high vs. low intake of long chain omega-3 polyunsaturated fatty acids (n3PUFA).

METHODS: We included 295 women attending an academic fertility center (2007-2016) who had data on hair Hg levels (assessed using a Direct Mercury Analyser), n3PUFA intake (estimated using a validated food frequency questionnaire) and AFC (assessed by transvaginal ultrasonography and abstracted from electronic medical records). Poisson regression models adjusted for potential confounders were used to evaluate the association of hair Hg levels (divided into tertiles, and as above vs below EPA reference (1ppm)) with AFC. Associations were also evaluated after stratification by n3PUFA intake (≤ 0.124 vs. > 0.125 %calories/week).

RESULTS: Women's median hair Hg level was 0.55 ppm (range=0.01-8.51 ppm), with more than 30% > 1 ppm. Hair Hg was positively related to AFC after adjusting for age, BMI, smoking status, infertility diagnosis, and alcohol intake. However, associations became attenuated after further adjustment for intake of calories and n3PUFA. The positive associations of hair Hg and AFC were observed only among women with high n3PUFA intake. Specifically, women who consumed > 0.125 %calories/week of n3PUFA had a mean AFC of 11.9, 13.2 and 14.5, respectively, across increasing tertiles of hair Hg ($p=0.002$). Similar results were found when hair Hg was divided as above vs below EPA reference (mean AFC=12.7 vs. 14.6, $p=0.002$).

CONCLUSIONS: In women from a fertility clinic, positive associations of hair Hg with AFC may be reflective of beneficial effects of n3PUFA on ovarian reserve rather than a beneficial effect of Hg per se. Our findings highlight the importance of considering diet when exploring Hg effects on women's reproductive health.

Keywords: Heavy metals, food/nutrition, female reproductive outcomes.



ABSTRACT E-BOOK

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Reproductive Outcomes » Female reproductive outcomes

Cumulative phthalate exposure and risk of hot flashes within the Midlife Women's Health Study

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BACKGROUND AND AIM: Hot flashes are intermittent and disruptive sensations of heat in the upper body and can have a significant impact on quality of life in perimenopausal women. Low estrogen levels are associated with an increased risk of hot flashes. Phthalates are endocrine disrupting chemicals of widespread exposure, with some metabolites having estrogenic properties; however, few studies have evaluated the association between phthalate concentrations and hot flash occurrence, especially across multiple years in perimenopausal women.

METHODS: The Baltimore Midlife Women's Health Study recruited women aged 45 and 54 years (2007 – 2015), collecting data on self-report of hot flash outcomes and biospecimens for laboratory analyses, including urinary phthalate metabolite concentrations. We employed generalized linear mixed models (GLMMs), with phthalate measures operationalized as cumulatively averaged geometric means updated for each year, to conduct mixed effects logistic regression and calculate odds ratios (ORs) for risk of ever-experiencing hot flashes and hot flash severity (dichotomized as none or mild vs moderate or severe), adjusting for participant characteristics as potential confounders.

RESULTS: A total of 758 participants provided up to 4 years of follow-up data. At baseline, 343 (45.8%) women reported ever experiencing a hot flash and 225 (30.1%) reported experiencing moderate or severe hot flashes. In adjusted models, only the sum of personal care product phthalate metabolites (Σ PCP, the sum of monoethyl phthalate (MEP), mono-n-butyl phthalate (MBP), and mono-isobutyl phthalate (MiBP)) updated over the 4-year study period was associated with moderate and severe hot flashes (OR: 1.18; 95%CI: 1.01 – 1.38). No other individual phthalate metabolite or summary measure was associated with ever experiencing hot flashes or hot flash severity.

CONCLUSIONS: Higher concentrations of phthalates from PCPs were associated with experiencing moderate or severe hot flashes across the perimenopausal period. Reducing exposure to phthalates from PCPs may help to reduce risk of moderate/severe hot flashes in middle-aged women.

Keywords: phthalates, endocrine disrupting chemicals, reproductive outcomes



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Reproductive Outcomes » Female reproductive outcomes

An evidence mapping approach to support hazard identification for polychlorinated biphenyl (PCB) mixture exposure and female reproductive endpoints

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BACKGROUND AND AIM: Evidence mapping can facilitate the organization and review of complex databases. Here, we utilize evidence mapping to survey and explore human and animal studies of female reproductive effects of PCB mixture exposures and to identify whether the database is sufficient to support human health hazard identification.

METHODS: We developed a Population, Exposures, Comparators, and Outcomes (PECO) statement to direct screening and categorization. Study information was extracted into literature inventory tables and organized by outcome. To identify outcomes promising for human health hazard identification and explore the strength of the database, we considered the following: size of outcome-specific database, study design, biological significance of the outcome, and exposure biomarker.

RESULTS: We identified over 200 human and animal studies that evaluated PCB mixture exposures and reproductive effects in females over a variety of life stages and exposure scenarios. Most human studies quantified PCB exposure using blood, which integrates exposure over all routes. The most commonly measured outcomes in human studies were endometriosis, reproductive hormones, and gestational length; most of these were evaluated in cohort or case-control studies. All of these outcomes are biologically significant and clearly measurable. In animals, the most commonly measured outcome was impacts on female fertility; these studies utilized a dam-only exposure scenario, which eliminates potential confounding by male exposure status that could exist in human studies of similar outcomes. Many outcomes were measured in both humans and animals (e.g., hormonal status, pubertal development, gestation length), which can facilitate hazard identification and assessment of coherence across these lines of evidence.

CONCLUSIONS: Through evidence mapping, we have identified numerous female reproductive outcomes that have been evaluated in studies of PCB-exposed humans and animals. The database of PCBs and female reproductive effects in both humans and animals is sufficient to support future hazard identification.

Keywords: Reproductive Outcomes, Female, Chemical exposures, Mixtures



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ABSTRACT E-BOOK



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Reproductive Outcomes » Female reproductive outcomes

The role of reproductive hormones and anovulation in moderating the relationship of phthalates with fecundability

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BACKGROUND AND AIM: Phthalates are endocrine disruptors that may inhibit folliculogenesis and we previously observed a relationship of metabolites of DEHP, DEP and BzBP with reduced fecundability. Estrogen supplementation may additionally mitigate phthalate-associated follicular atresia. Thus, we aimed to evaluate whether the impact of phthalates on achieving pregnancy was modified by their relationship with endogenous reproductive hormones and anovulation.

METHODS: The EAGeR trial (2007-2011) enrolled 1,228 women attempting pregnancy with a history of pregnancy loss and followed them for up to 6 menstrual cycles or throughout pregnancy if they became pregnant. Twenty phthalate metabolites were measured in a 3-day pooled urine sample at the beginning of the first menstrual cycle of follow-up. Hormone levels were assessed during the follicular phase, ovulation and the luteal phase in the first two cycles. Cycles were considered anovulatory in the absence of a surge in luteinizing hormone (LH). Generalized estimating equations assessed risk of anovulation and generalized linear models change in hormone levels, adjusting for urinary creatinine and individual characteristics. Modification of the relationship of DEHP, DEP, and BzBP with fecundability by quartiles of estradiol was evaluated using discrete-time Cox proportional hazards models, incorporating interaction terms.

RESULTS: We observed no clear relationship between phthalates and anovulation. Phthalates were associated with lower levels of estradiol and higher levels of follicle-stimulating hormone across the menstrual cycle, and higher pregnanediol and LH in the luteal phase. We observed the strongest association of metabolites of DEHP and DEP with fecundability among women in the lowest quartile of estradiol during the follicular phase (e.g. DEP fecundability odds ratio [FOR] 0.70, 95% CI 0.55, 0.91 for quartile 1 vs. FOR 0.95, 95% CI 0.76, 1.18 for quartile 4, p-interaction = 0.036).

CONCLUSIONS: Reproductive hormones may play a role in the relationship of phthalates with fecundability among couples trying to conceive.

Keywords: Phthalates, Female reproductive outcomes



ABSTRACT E-BOOK

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Reproductive Outcomes » Female reproductive outcomes

Urinary Metal Mixtures and Hormone Levels during the Menopausal Transition: the Study of Women's Health Across the Nation (SWAN)

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BACKGROUND AND AIM: Epidemiologic studies on associations between metal exposures and sex hormones in women have been limited, and results have been mixed. We assessed associations of urinary metals concentrations with longitudinal serum levels of follicle-stimulating hormone (FSH) and estradiol (E2).

METHODS: We examined data from 1,355 women aged 45-56 years at baseline (1999-2000), followed through 2017, from the Study of Women's Health Across the Nation. Baseline urinary concentrations of 15 metals (arsenic, barium, cadmium, cobalt, cesium, copper, mercury, manganese, molybdenum, nickel, lead, antimony, tin, thallium, and zinc) were determined. Serum levels of FSH and E2 were measured repeatedly over 17 years of follow-up. Linear mixed effects models were used to evaluate associations between individual metals and hormone levels. The least absolute shrinkage and selection operator (LASSO) penalized linear mixed effects models were used to evaluate associations between metal mixtures and hormone levels. An environmental risk score (ERS) was used to integrate metal mixture effects from LASSO results.

RESULTS: After adjustment for confounders, one standard deviation increase in log-transformed baseline urinary metal concentrations were associated with 3.53% (95% CI: 0.42%, 6.73%) higher levels of FSH for cadmium, 5.61% (95% CI: 2.50%, 8.82%) higher levels for lead, and 3.06% (95% CI: -5.87%, -0.17%) lower levels for cobalt. For E2 levels, one standard deviation increase in log-transformed urinary metal concentrations were associated with 2.88% (95% CI: -5.31%, -0.38%) lower levels for mercury, 5.20% (95% CI: -7.56%, -2.78%) lower levels for lead, and 2.44% (95% CI: -4.74%, -0.09%) lower levels for tin. The ERS was associated with higher FSH and lower E2 levels.

CONCLUSIONS: Results from this prospective cohort study of midlife women suggested that metals, including lead, cadmium, mercury, cobalt, tin, and metal mixtures were associated with serum FSH and E2 levels, consistent with findings that metal exposures affect reproductive aging.

Keywords: metals, mixtures, estradiol, follicle-stimulating hormone, cohort study



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ABSTRACT E-BOOK



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Reproductive Outcomes » Female reproductive outcomes

A Prospective Cohort Study of Neighborhood Deprivation and Fecundability

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BACKGROUND AND AIM: Decades of inequitable policies have yielded disparities in neighborhood quality, and living in a deprived neighborhood is consistently associated with worse health outcomes, including reproductive health. We hypothesize that neighborhood deprivation is associated with decreased fecundability, a sensitive marker of fertility with many health implications.

METHODS: In a preconception cohort study (Pregnancy Study Online, PRESTO) of participants residing in the United States, we examined associations between the Area Deprivation Index (ADI, a metric of neighborhood socioeconomic disadvantage), and fecundability (per-cycle probability of conception). Nationally, ADI is a census block level variable that ranks neighborhoods from 1 (least deprived) to 100 (most deprived). State-level ADI is a standardized measure on a 1-10 scale. We followed 6,576 female participants who were trying to conceive from enrollment until reported pregnancy or a censoring event (fertility treatment initiation, end of pregnancy attempt, loss to follow-up, or 12 menstrual cycles of attempt time), whichever came first. We restricted analyses to women with ≤ 6 cycles of attempt time at enrollment and classified participants using baseline addresses by national and within-state ADI rankings. We used proportional probabilities regression to estimate fecundability ratios (FR) and 95% CIs for the associations between ADI and fecundability.

RESULTS: National rankings in our cohort showed a median ADI score of 36 (4.1% with the worst scores: 91-100); within-state rankings yielded a median of 4 for (6.3% with the worst score: 10). In unadjusted models, FR comparing highest with lowest ADI deciles was 0.91 (95% CI: 0.75-1.05) for national rankings and 0.78 (95% CI: 0.66-0.92) for within-state rankings. For each decile increase in ADI, the FRs were 0.98 (95% CI: 0.97-1.00) and 0.98 (95% CI: 0.97-0.99) for national and within-state rankings, respectively. Adjusted models for age yield similar results.

CONCLUSIONS: These findings provide some of the first evidence that neighborhood deprivation is associated with decreased fecundability.

Keywords: Reproductive Outcomes, Female, Socio-economic factors, Built environment, Environmental disparities



ABSTRACT E-BOOK

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Reproductive Outcomes » Female reproductive outcomes

Personal exposure to particulate matter air pollution and outcomes of ovarian stimulation: a pilot study in Massachusetts, US

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BACKGROUND AND AIM: Higher exposure to ambient air pollution has been associated with lower fertility in women including specific adverse effects on ovarian steroidogenesis and folliculogenesis; however, no previous studies have measured personal exposure to air pollution which quantifies a woman's real exposure levels.

METHODS: We enrolled nine women undergoing a fresh, autologous assisted reproductive technology (ART) cycle at the Massachusetts General Hospital Fertility Center 2018-2019. At the woman's baseline ultrasound appointment (cycle day 3), they were given an AirBeam2 monitor, which measures three size fractions of particulate matter (PM₁, PM_{2.5}, and PM₁₀), a smartphone, and a 3-day activity diary. Women collected exposure data for the following 72 hours. Between cycle day 11 and 16, women underwent oocyte retrieval and information was collected on number of total and mature oocytes retrieved. Multivariable generalized linear models were used to evaluate associations between personal PM exposures and ovarian stimulation outcomes.

RESULTS: Women collected PM data for an average (minimum, maximum) of 33.7 (8.4, 64.4) hours during ovarian stimulation. Their median (interquartile range [IQR]) exposure to PM₁, PM_{2.5}, and PM₁₀ was 0.4 (4.1), 2.3 (5.5), 3.7 (8.3) $\mu\text{g}/\text{m}^3$, respectively. After adjusting for age, stimulation protocol, infertility diagnosis, and average temperature exposure, an IQR increase in average exposure to PM₁, PM_{2.5}, and PM₁₀ during cycle days 3 to 5 was associated with -26.8% (95% CI -37.6, -14.2%), -47.9% (95% CI -61.6, -29.1%), and -43.8% (95% CI -57.3, -26.0%) fewer oocytes retrieved, respectively. An IQR increase in PM₁, PM_{2.5}, and PM₁₀ exposure was also associated with -18.4% (95% CI -33.9, 0.6%), -38.2% (95% CI -58.5 -8.1%), and -34.0% (95% CI -53.8, -5.6%) fewer mature oocytes retrieved, respectively.

CONCLUSIONS: In this small pilot study of women undergoing ART in Massachusetts, higher personal exposure to PM during ovarian stimulation was associated with poorer oocyte yield.

Keywords: Air pollution, Particulate matter, Reproductive Outcomes, Short-term exposure, Environmental epidemiology



ABSTRACT E-BOOK

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Reproductive Outcomes » Male reproductive outcomes

Association of serum peripubertal organochlorine chemical concentrations and blood lead levels with pubertal progression in a cohort of Russian boys

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BACKGROUND AND AIM: Dioxins, polychlorinated biphenyls (PCBs) and lead are widespread environmental pollutants. Peripubertal exposure is associated with altered age of pubertal onset and sexual maturity in boys, but its impact on pubertal progression is unknown.

METHODS: The Russian Children's Study is a prospective cohort of 516 boys residing in an industrial city historically contaminated with organochlorine pollutants, who were enrolled in 2003-2005 and followed annually from ages 8-19 years. At enrollment, blood was obtained to quantify serum dioxin-like toxic equivalents (TEQs), non-dioxin-like PCBs (NDL-PCBs) and blood lead levels (BLLs). At enrollment and annually thereafter, we assessed boys' pubertal Tanner stage and testicular volume (TV) via Prader orchidometer. To distinguish subgroups with similar pubertal trajectories, we applied group-based trajectory modeling to TV from ages 8-19 years. We used multinomial logistic regression to model the association of peripubertal serum TEQs, NDL-PCBs and BLL with pubertal progression subgroups.

RESULTS: This Russian cohort had lower prevalence of obesity and higher serum organochlorine chemicals relative to other pediatric populations. We identified three pubertal trajectories: slower, moderate and accelerated. Higher peripubertal serum TEQs were associated with decreased odds of being in the accelerated (OR 0.56, 95% CI 0.32-0.99) or slower (OR 0.85, 95% CI 0.53-1.35) trajectories versus the moderate, but with increased odds of being in the slower trajectory versus the accelerated (OR 1.51, 95% CI 0.82, 2.79). However, higher NDL-PCBs were associated with increased odds of being in the accelerated trajectory, versus the moderate (OR 2.56, 95% CI 0.91-7.20) or slower (OR 3.31, 95% CI 1.07, 10.25). Higher BLLs were associated with increased odds of being in the slower trajectory versus the accelerated (OR 1.48, 95% CI 0.89, 2.45) or moderate (OR 1.21, 95% CI 0.83, 1.75).



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CONCLUSIONS: Boys with higher peripubertal serum dioxins, NDL-PCBs and lead may have either accelerated or slower pubertal progression, depending on the specific exposure.

Keywords: Biomarkers of Exposure, Endocrine disrupting chemicals, Children's environmental health, Male, Reproductive outcomes, Modeling

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Reproductive Outcomes » Female reproductive outcomes

In-utero exposure to polybrominated biphenyl (PBB) and menstrual cycle function in adulthood

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BACKGROUND AND AIM: There is evidence that in-utero exposure to PBBs, and similar chemicals, are associated with several adverse reproductive health outcomes including altered pubertal timing; however, less is known about the effects of in-utero exposure to PBBs on menstrual cycle function and reproductive hormone levels in adulthood.

METHODS: For this menstrual cycle study, we recruited reproductive-aged women in the Michigan PBB Registry who were not pregnant, lactating, or taking hormonal medications (2004-2014). A total of 42 women who were born after the PBB contamination incident (1973-1974), who were only exposed in-utero, were included in this analysis. We estimated in-utero PBB exposure using maternal serum PBB measurements taken after exposure and extrapolated to time of pregnancy using a PBB elimination model. Women were followed for up to 6 months during which they provided daily urine samples and completed daily diaries. The urine samples were assayed for estrone 3-glucuronide (E13G), pregnanediol 3-glucuronide (Pd3G), and follicle stimulating hormone (FSH).

RESULTS: Women in our study were, on average, 27.5 (SD:5.3) years and contributed 4.9 (SD:1.9) menstrual cycles of follow-up. Compared to women with low in-utero PBB exposure (≤ 1 ppb), women with medium (>1.0 - 3.0 ppb) and high (>3.0 ppb) exposure had significantly higher maximum 3-day mean Pd3G levels during the luteal phase. Specifically, the age- and creatinine-adjusted maximum 3-day mean luteal phase Pd3G levels (95% CI) in increasing categories of in-utero PBB exposure were 9.2 (4.6,13.9), 14.8 (11.6,18.0), and 16.1 (12.9,19.3) $\mu\text{g}/\text{mg}$. There were no significant differences in average cycle length, follicular or luteal phase cycle length, bleed length, or creatinine-adjusted E13G or FSH levels by category of in-utero PBB exposure.

CONCLUSIONS: Higher exposure to PBB in-utero was associated with increased progesterone levels across the luteal phase, however, most other menstrual cycle characteristics were largely unassociated with in-utero PBB exposure. Given our modest sample size, our results require cautious interpretation.

Keywords: Endocrine disrupting chemicals, Reproductive Outcomes, Chemical exposures, Environmental epidemiology, Long-term exposure



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Reproductive Outcomes » Male reproductive outcomes

Associations between indoor temperature and noise and semen parameters among participants in the US-based general population Growing Up Today Study

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BACKGROUND AND AIM: Multiple environmental exposures have been suggested as important determinants of decreases in semen quality. However, very little is known regarding the impacts of non-occupational noise and indoor temperature exposures. Our aim was to explore these associations in a general population cohort of young men in the United States.

METHODS: Participants were members of the prospective Growing Up Today Study. Exposures to noise, temperature, and relative humidity were collected every 5 minutes for 90 days in the main room of each home with a NetAtmo weather station. Semen samples collected at home were sent by express shipping to the Massachusetts General Hospital Andrology Laboratory; sperm concentration and morphology were assessed via computer-aided and manual methods. Associations per interquartile range (IQR) were assessed in three-exposure generalized linear models, adjusted for age, race, and body mass index.

RESULTS: The first 82 participants were included in analyses (average age 35.6 years). The average sperm concentration was 56.5 (SD=36.9) M/ml and the percent normal morphology was 4.5% (SD=2.1). The average 90-day average noise level was 62.5 dB (SD=8.0), temperature was 22.0°C (SD=1.9) and relative humidity was 54.0% (SD=8.2). There was little evidence that the exposures were associated with sperm concentration (-1.91, 95%CI:-12.44, 8.63 per 9.83dB of noise; -3.73, 95%CI: -14.93, 7.46



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per 2.53°C; 9.25, 95%CI: -0.78, 19.27 per 9.63% relative humidity) or % normal morphology (0.04, 95%CI: -0.58, 0.66 per 9.83dB of noise; -0.59, 95%CI: -1.23, 0.05 per 2.53°C; 0.04, 95%CI: -0.53, 0.61 per 9.63% relative humidity).

CONCLUSIONS: In this cohort of general population US men, temperature, humidity, and noise in the 90 days before producing a semen sample were not associated with measures of semen quality. The impact of these exposures may be limited to sensitive time windows.

Keywords: Noise, Temperature, Relative Humidity, Reproductive Outcomes, Male, environmental epidemiology



ABSTRACT E-BOOK

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Outcomes » Cardiovascular diseases

Effects of an LPG stove intervention on gestational blood pressure: findings from Household Air Pollution Intervention Network randomized controlled trial

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BACKGROUND AND AIM: Cooking and heating using solid fuels can cause dangerous levels of exposure to household air pollution (HAP). HAPIN is an ongoing randomized controlled trial aimed at assessing the impact of a liquified petroleum gas (LPG) cookstove and fuel intervention on HAP exposure and health among householders in India, Guatemala, Peru and Rwanda that rely chiefly on solid cooking fuels. Given the potential impacts of HAP exposure on cardiovascular outcomes during pregnancy, we seek to characterize the relationship between personal exposures to HAP and gestational blood pressure (GBP) among pregnant women.

METHODS: The trial enrolled approximately 800 pregnant women between 9 and 20 gestational weeks (GW) from each participating country (N=3195) and randomly allocated half to an intervention group that received an LPG stove and fuel throughout the duration of their pregnancy; control group members received no intervention at trial launch. We continuously monitor intervention fidelity and adherence. We assess repeated 24-hour personal exposure to PM_{2.5}/BC/CO and gestational systolic blood pressure (SBP) and diastolic blood pressure (DBP) at on enrollment and at two follow-up visits at 24-28 GW and 32-36 GW. Effects of the intervention on gestational SBP and DBP will be reported using both an intention-to-treat (ITT) and exposure-response analysis.

RESULTS: Preliminary data from stove use monitoring shows nearly exclusive use of the intervention during the follow-up period. Preliminary data from personal exposure monitoring shows a substantial exposure contrast between intervention and control arms, with PM_{2.5} below the WHO interim target-1 level of 35 µg/m³, compared with the pre-intervention median of 84.5 µg/m³. Analysis of intervention effects on SBP and DBP are being finalized and will be presented.

CONCLUSIONS: This study will add new evidence to the field of HAP exposure and BP among women during pregnancy, a critical window for health over the life course in both mother and child.

Keywords: Household Air Pollution, Gestational Blood Pressure, Randomized Controlled Trial, Liquified Petroleum Gas



ABSTRACT E-BOOK

P-451

Reproductive Outcomes » Female reproductive outcomes

Association between residential green space and menstrual cycle characteristics among North American women

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BACKGROUND AND AIM: Exposure to green space (natural vegetation) has been linked to improved reproductive outcomes, potentially through behavioral, psychological, and physiological mechanisms. However, there has been no study of the role of green space in gynecologic health. We examined the association between residential green space and menstrual cycle characteristics in a cohort of reproductive-aged women.

METHODS: We performed a cross-sectional analysis within Pregnancy Study Online (PRESTO), a web-based prospective cohort study of women aged 21-45 years who reside in the United States or Canada. We included 7,733 women who enrolled during June 2013-April 2019. We geocoded their residential addresses and calculated annual maximum normalized difference vegetation index (NDVI) at 30 meter resolution within 250 meters around their residences to quantify green space exposure. Women reported on menstrual cycle regularity, cycle length, bleed length, heaviness of bleed, and intensity of menstrual pain. We used log-binomial regression models to estimate prevalence ratios (PRs) and 95% confidence intervals (CIs), adjusting for sociodemographic, lifestyle, and neighborhood characteristics, including population density and census tract median household income.

RESULTS: The median (interquartile range) NDVI within 250 meters was 0.64 (0.52, 0.74). Low residential green space was associated with a higher prevalence of long bleeds (≥ 6 days) and severe period pain (medication and bed rest required). The PRs comparing the lowest levels of green space (NDVI < 0.2) with the highest levels of green space (NDVI ≥ 0.8) were 1.43 (95% CI: 0.99, 2.08) for long bleeds and 1.71 (95% CI: 1.01, 2.89) for severe period pain. However, there was little evidence of dose-response associations. Other menstrual cycle characteristics were not appreciably associated with NDVI.

CONCLUSIONS: Women with the lowest residential green space were more likely to have long menstrual bleeds and severe menstrual pain, indicating a potential role for green space in menstrual health.

Keywords: reproductive outcomes, green space, built environment, epidemiology



ABSTRACT E-BOOK

P-452

Policy » Research translation to affect policy and practice

Overview of Environmental Health in Latin American: Information for joint action between countries and Promoting Environmental Health and Equity

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BACKGROUND AND AIM: According to WHO 25% of global deaths and 28% of deaths among children under five are due to modifiable environmental factors. Ischemic heart diseases, chronic respiratory diseases, cancers and unintended injuries top the list. People in low- and middle-income countries bear the greatest burden of disease. Several cities are experiencing similar situations, but seek individualized discussions and solutions.

AIM: To survey, analyze and present sources and reports made available by various institutions on environmental health aspects in Latin American countries.

METHODS: Official sources from various Latin American countries were surveyed, as well as general reports from regional and international institutions such as: Economic Commission for Latin America and the Caribbean - ECLAC, PAHO, Global Burden of disease, CIDACS, Atlas HDI - United Nations Organization. We considered here 43 countries. The period of the reports considered was from 2017 to 2019.

RESULTS: We found 30 regional reports - LAC and 132 data sources / reports for the total of countries. Brazil was the country that presented the largest data coverage. Various institutions produce data, national information on sanitation, air pollution, climate change. Few address greenspaces. The data show that countries are different, and point to all countries: 38% of the population in Latin America and the Caribbean is vulnerable. 80% of the population lives in urban areas. Only 37% of all legislators and senior officials are women. 40% of people living in the region feel safe. GDP spending at LAC ranges from 11.7% (Cuba) to 1.2% (Venezuela). A total of 15.5 million people still defecate in the open

CONCLUSIONS: Stimulating research activities and debating public policies in the countries of Latin America jointly can contribute to positive impacts on quality of life. The ISEE Latin American and Caribbean chapter can enrich these actions.

Keywords: Policy and practice, Socio-economic factors, Environmental epidemiology



ABSTRACT E-BOOK

P-453

Policy » Research translation to affect policy and practice

Inequalities in Health Promotion and Equity: Environmental data in Brazil to Discuss the Health of the Black Population

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BACKGROUND AND AIM: Brazil received 4.86 million Africans enslaved between the years 1501-1900, concentrated the largest contingent of enslaved labor in the colonial period and was the last country in the West to abolish slavery. 56.10% of the population is declared black, this important part of the population is the most affected by the environment. The development contexts of the black population are affected by the repercussions of structural, institutional and daily racism. Social determinants of health influence the occurrence of inequities that are expressed in the accumulation of specific experiences of illness related to the characteristics of life and exposure to different risk factors. **AIM:** To translate and characterize health data of the black population related to environmental, development and health aspects.

METHODS: Descriptive studies. Data for the period 2010-2018 were collected from the main health information systems in Brazil: IBGE, DATASUS.

RESULTS: According to the data analyzed, in 2017 the hospitalization rate for health problems related to the environment and basic sanitation in the black population was 2.17% and in the white population, 1.33%. Life expectancy at birth in 2010 was 70.26 years, for whites = 78.6 and blacks = 75.78. In 2018, they lived on less than US\$ 1.90 a day, 8.8% of blacks and 3.6% of whites. 32.9% of the black population lived on less than US\$ 5.50 a day while the percentage reached 15.4% of the white population. Regarding mortality from chronic diseases, diabetes is 50% more frequent in black women. The rate (100,000) of hypertensive disease is 30% higher in the population declared to be black and also more severe.

CONCLUSIONS: The black population is exposed to unequal conditions in Brazil. The discussion of the available data related to environmental exposure, according to the characteristics of the population, contributes to the proposal of policies to face social inequalities.

Keywords: Environmental disparities, Environmental justice, Children's environmental health,



ABSTRACT E-BOOK

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Policy » Other (to be specified with keywords in the keywords section)

Social-distancing Fatigue: Evidence from Real-time Crowd-sourced Traffic Data

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BACKGROUND AND AIM: To mitigate the COVID-19 pandemic and prevent overwhelming the healthcare system, social-distancing policies such as school closure, stay-at-home orders, and indoor dining closure have been utilized worldwide. These policies function by reducing the rate of close contact within populations and results in decreased human mobility. Adherence to social distancing can substantially reduce disease spread. Thus, quantifying human mobility and social-distancing compliance, especially at high temporal resolution, can provide great insight into the impact of social distancing policies.

METHODS: We used the movement of individuals around New York City (NYC), measured via traffic levels, as a proxy for human mobility and the impact of social-distancing policies (i.e., work from home policies, school closure, indoor dining closure etc.). By data mining Google traffic in real-time, and applying image processing, we derived high resolution time series of traffic in NYC. We used time series decomposition and generalized additive models to quantify changes in rush hour/non-rush hour, and weekday/weekend traffic, pre-pandemic and following the roll-out of multiple social distancing interventions.

RESULTS: Mobility decreased sharply on March 14, 2020 following declaration of the pandemic. However, levels began rebounding by approximately April 13, almost 2 months before stay-at-home orders were lifted, indicating premature increase in mobility, which we term social-distancing fatigue. We also observed large impacts on diurnal traffic congestion, such that the pre-pandemic bi-modal weekday congestion representing morning and evening rush hour was dramatically altered. By September, traffic congestion rebounded to approximately 75% of pre-pandemic levels.

CONCLUSIONS: Using crowd-sourced traffic congestion data, we described changes in mobility in Manhattan, NYC, during the COVID-19 pandemic. These data can be used to inform human mobility changes during the current pandemic, in planning for responses to future pandemics, and in understanding the potential impact of large-scale traffic interventions such as congestion pricing policies.

Keywords: Traffic-related, Infectious diseases, Environmental epidemiology, Policy and practice



ABSTRACT E-BOOK

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Policy » Research translation to affect policy and practice

Differences Between US EPA and EU related to PFAS/PFOS Contamination: Implications for Clean-up and Policy

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BACKGROUND AND AIM: The US EPA has no national regulatory authority for per- and polyfluoroalkyl (PFAS/PFOS) classes of nonstick 'Teflon' compounds. The biggest US suppliers were Dupont/Chemours and 3M; in the EU they were 3M, Miteni, and Daikin. By contrast to the US, the European Union (EU) has published guidance providing safe exposure and clean-up levels for soil and water. With new EPA leadership, we seek to understand what levels of safety and clean-up might be adopted.

METHODS: We examined the environmental health literature to comprehend where new national standards may be set, and how those differ from EU. PFAS/PFOS are persistent in the environmental and no longer manufactured. The C 8 Science panel linked workplace exposure to PFAS/PFOS to testicular and kidney cancer, elevated cholesterol, liver and chronic kidney disease, reduced fertility, thyroid and hormone problems, and immune dysfunction.

RESULTS: Currently there are no EPA maximum concentration levels (MCL) for water. There was 2019 Congressional attempt to regulate Teflon chemicals under Superfund; to categorize PFAS/PFOS as hazardous substances. Because there was no agreement on the level of clean-up of military firefoam PFAS, it was left out of the legislation. Therefore, US states set differing notification and drinking water remediation levels ranging from 1 to 140 ppt; states of MI, NJ, NY, and CA have been leaders in defining regulatory levels. The EU 2021 Drinking Water Directive mandates a 0.5 µg/l limit, and EU Chemicals Agency has developed standards for food, packaging, soil, and the workplace.

CONCLUSIONS: A big issue will be the cost of remediation. We note the major producer corporations are also where best clean-up technologies are housed. The new EPA will account for the impacts of PFAS/PFOS on worker and disadvantaged communities. Although it will require a balancing of safe remediation and cost, we predict regulatory concentrations will be between 10 to 40 ppt.

Keywords: PFAS, policy and practice, international collaboration



ABSTRACT E-BOOK

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Policy » Research translation to affect policy and practice

Bouncing forward: Knowledge Translation for policy making in response to the COVID-19 and climate change co-emergencies

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BACKGROUND AND AIM: UN Secretary General, Antonio Guterres claimed early on in the pandemic that, without appropriate actions from multiple sectors, the social and economic devastation caused by climate change will be greater than that of COVID-19 (Fearnow, 2020). Climate change exacerbates existing health inequalities and has been described as “the greatest global health opportunity of the 21st century” (Watts et al., 2016). These inequalities are being further compounded by the pandemic. It is important that public health professionals are involved when designing mitigation and adaptation strategies, in partnership with policy makers and other stakeholders (Costello et al., 2009).

METHODS: The webinar series “Learning and Relearning for Planetary Health: Lessons from a Pandemic” offers a collection of session recordings and presentation documents. This webinar series is a product of the SFU Planetary Health research group, along with scholars, industry professionals, community advocates and practitioners. Between April 15, 2020 and June 24, 2020, the presenters covered a range of topics regarding the relationship between the COVID-19 pandemic, planetary health, climate change and human health (in eleven sessions). The webinars explored policy options to “bounce forward and not back” into a post-COVID future; focusing on actions that transform the way we live and improve health for all, as we face the overarching threat of climate change.

RESULTS: Knowledge Translation is the process of sharing research findings to multiple stakeholders in order to inform policy decisions. In order to broaden the learning of non-academic audiences, we have created a toolkit that presents key discussion points and recommendations from the webinars in a variety of formats.

CONCLUSIONS: The toolkit is also a platform to communicate climate action opportunities and strategies emerging from the COVID-19 pandemic to policy makers. The toolkit includes policy briefs, a webpage, infographics, and op-eds that expand the reach of the knowledge presented in the webinar series.

Keywords: Climate, Policy and Practice, COVID-19, Knowledge Translation



ABSTRACT E-BOOK

P-457

Exposures » Food/nutrition

Methylmercury: A Human Biomonitoring Study of Portuguese Women of Childbearing Age

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BACKGROUND AND AIM: Methylmercury (MeHg) is a toxic compound that undergoes bioaccumulation in the aquatic food chain. Predatory fish species are an important human exposure source. Portugal has the highest consumption of fishery products in the European Union (EU), above the EU and world average. The main target of MeHg is the central nervous system and the prenatal period represents a period of greatest vulnerability regarding neurodevelopmental effects on the foetus. Human biomonitoring (HBM) allows direct exposure assessment of human exposure to chemical compounds. Total mercury (THg) concentration in blood is usually considered an appropriate biomarker for estimating short-term internal exposure to MeHg in individuals with regular fish consumption.

The aim of the present study was to evaluate the exposure of Portuguese women of childbearing age to MeHg through HBM.

METHODS: Three hundred Portuguese women of childbearing age (25 to 44 years) were randomly selected among the participants in a cross-sectional epidemiological study carried out in Portugal (INSEF) in 2015. THg content was determined in whole blood samples by thermal decomposition and amalgamation atomic absorption spectrophotometry (TDA/AAS).

RESULTS: Two samples had THg levels below LOQ (0.5 µg/L), and in the remaining (n=298), THg levels ranged from 0.6 to 35.0 µg/L. About 52% of the samples had values below 5 µg/L, a HBM value below which no adverse health effects are expected. However, 48% of samples revealed levels above 5 µg/L and therefore presented risk of adverse health effects. Blood mercury concentration values were higher in older women, in higher education level and residents in the Autonomous Region of Madeira, with statistically significant differences compared to the other groups (p<0.05).

CONCLUSIONS: This study reinforces the need to develop and implement in Portugal strategies regarding risk communication focused on the selection of fish species with lower MeHg concentration in order to reduce human exposure to this compound.

Keywords: Biomarkers of exposure, Exposure assessment, Food/nutrition, Heavy metals, Risk assessment



ABSTRACT E-BOOK

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Exposures » Food/nutrition

Interface between Food Security and Human Health

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BACKGROUND AND AIM: Food is as old as humans and is so important to the existence and sustenance of humans and other living organisms that God created food before He created the eaters. There is a subtle interplay between food security and health, this nexus interplays from availability and access to food, to healthy lifestyle. The paper focused on connection between food security and health with the view to identifying causes of food insecurity, its effects on health and the use of Moringa Oleifera and Chanca Piedra to solve the identified health challenges.

METHODS: The respondents for this study were purposively selected within Bida, Nigeria. 50 respondents were randomly sampled for interview and questionnaire administration after using the two medicinal plants to improve nutrient level and ease discomforts like headaches, diabetes, kwashiorkor and menstrual pain. The research design used is Worldview approach, which is considered suitable for situation-specific agreements in the use of cultural information, when delineating between indigenous and academic requirements. The paper incorporates Indigenous Environmental Knowledge (IEK) to ensure more people benefit from community knowledge on flora uses that differ from the academic perception.

RESULTS: The study revealed an improvement in users' health after administering the herbs. It also revealed that 78% of respondents attested to using Moringa for nutrient deficiency cases, with 4g dose, morning and evening for three months, however, 22% of respondents claimed it was not applicable to them. The study further revealed that 70% and 20% of respondents used Moringa and Chanca respectively at 5g dose morning and evening for twenty-four hours to relief migraine.

CONCLUSIONS: The study recommended active citizen participation in planting Moringa and Chanca in individual homes, empty urban spaces as organised neighbourhood medicinal gardens under community self-help projects to enhance food security, improve the urban landscape, and advance the public planning issue.

Keywords: Chanca Piedra, Food security, Health, Moringa Oleifera, Public Planning



ABSTRACT E-BOOK

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Exposures » Food/nutrition

Development of Novel Microalgae and Lactic Acid Bacteria Formulations with Enhanced Vitamin B12 Content

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BACKGROUND AND AIM: Hypocobalaminemia is a global condition with several health implications. Since humans acquire vitamin B12 from dietary sources, microbiological alternatives have been developed by the food industry to reverse its deficiency. Lactic acid bacteria (LAB) were already reported as potential cobalamin producers and the capacity of the microalgae *Chlorella vulgaris* to uptake exogenous cobalamin from the environment was also documented. Therefore, a combination of those microorganisms can be used to formulate novel enriched foods. In this context, this work aimed to develop a combined LAB and *C. vulgaris* lyophilized product with increased cobalamin content and assess its stability over storage.

METHODS: In Allmicroalgae production facility, *C. vulgaris* is regularly grown industrially at tubular photobioreactors. LAB were isolated from the *C. vulgaris* photobioreactor's microbiota and isolates of interest were selected according to their capacity to synthesize cobalamin. Bacteria were individually inoculated and grown in organic medium formulations N (yeast extract 15 g/L) and Fh (yeast extract 2.5 g/L). Isolated LAB and *C. vulgaris*, directly obtained from the photobioreactor, and grown in organic medium, were combined and lyophilized. The cobalamin content in the freeze-dried powder was quantified by ELISA and the survival of LAB during frozen and freeze-dried storage was determined.

RESULTS: The results showed that the addition of *Pediococcus pentosaceus* L51 resulted in an increased vitamin B12 content in the freeze-dried microalgae. *C. vulgaris* demonstrated a protective effect on *Lactococcus lactis* E32, *Lactobacillus brevis* G31 and *P. pentosaceus* L51 survival during frozen storage. However, the opposite was verified during the storage of freeze-dried mixtures. Furthermore, *P. pentosaceus* L51 suffered the lowest viability loss.

CONCLUSIONS: Therefore, *P. pentosaceus* L51 has a high potential to be used in the development of a microalgal formulation with enhanced cobalamin content. Nonetheless, adjustments must be performed in the lyophilization process to prevent the unfavourable *C. vulgaris* effect on LAB survival.

Keywords: Food/nutrition, Microbes/microbiome, Health co-benefits



ABSTRACT E-BOOK

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Outcomes » Obesity and metabolic disorders

Impact of maternal nutritional status during pregnancy on the associations between persistent organic pollutants and childhood overweight

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BACKGROUND AND AIM: Growing evidence has shown that prenatal exposure to environmental pollutants, such as persistent organic pollutants (POPs), may contribute to childhood metabolic disorders and overweight. However, little is known about the influence of maternal nutritional status on such associations.

The main objective of this study was to identify those nutritional biomarkers that may influence the associations between prenatal exposure to POPs and overweight at 7 years.

METHODS: We analysed data from the birth cohort INMA, relying on blood biomarkers from the first trimester and anthropometrical measurements of children at 7 years. The most representative biomarkers of organochlorine compounds (OCs) and perfluoroalkyl substances (PFAS) were included, as well as nutritional biomarkers for vitamins, polyunsaturated fatty acids (PUFAs) and dietary antioxidants. Complete datasets with minimal imputation were established for OCs-PUFAs (n=557), POPs (OCs and PFAS)-antioxidants (n=684) and OCs-vitamins (n=1272). The statistical framework included a screening phase to identify interactions using three complementary algorithms: Gradient Boosting Machines, Glnet, and Bayesian Kernel Machine Regression. Identified interactions were further characterized using generalized additive models and multivariate regression models.

RESULTS: Most consistent interactions across screening models were found between OCs and vitamins [e.g. hexachlorobenzene (HCB) and vitamin B12] and between perfluorooctanesulfonic acid (PFOS) and antioxidants (e.g. γ -tocopherol). The overall effect of mixtures was positive and the associations between POPs and overweight were mostly strengthened at highest tertiles of selected vitamins or antioxidants in a non-monotonic fashion. For instance, overweight risk associated with HCB was increased at highest vitamin B12 tertiles [e.g. Tertile 2 vs Tertile 1, odds ratio 95% confidence interval 1.7 (1.2, 2.4) p interaction= 0.004].

CONCLUSIONS: Maternal nutritional status during pregnancy may influence the effect of prenatal exposure to POPs on childhood overweight. Further research is needed to confirm those findings and to explore the presence of underlying mechanisms that may support the biological plausibility of these findings.

Keywords: Obesity and metabolic disorders, Mixtures, Biomarkers of exposure, Food/nutrition



ABSTRACT E-BOOK

P-462

Outcomes » Obesity and metabolic disorders

Association of selenium exposure with insulin resistance and β -cell function in middle age and older adults

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BACKGROUND AND AIM: While selenium (Se) is an essential nutrient, some human studies showed an association between increased Se exposure and diabetes. However, studies evaluating the role of Se in insulin resistance and beta cell function are limited. We evaluated the cross-sectional association of Se exposure with homeostasis model assessment of insulin resistance (HOMA-IR) and β -cell function (HOMA-B), two established predictors of diabetes susceptibility. Because this relationship may change with age, we conducted the analyses among middle age and older adults separately.

METHODS: We included 1161 participants from the Aragon Workers' Health Study (AWHS) and 915 from Seniors-ENRICA-2 (SEN-2) study. All participants were diabetes-free. Se exposure was measured in blood for AWHS and in serum for SEN-2. HOMA-IR and HOMA-B were calculated using fasting glucose and insulin levels.

RESULTS: Median age in the AWHS and SEN-2 were 52 and 70 years, respectively. Median levels of blood and serum Se in AWHS and SEN-2 were 214 and 115.5 $\mu\text{g/L}$, respectively. In AWHS, the geometric mean ratio (GMR, 95% confidence interval) comparing the 90th and 10th percentiles of Se distribution was 1.07 (0.99, 1.15) for HOMA-IR and 1.14 (1.06, 1.24) for HOMA-B. In SEN-2, the corresponding GMR (95% CI) were 1.10 (1.00, 1.21) for HOMA-IR and 0.93 (0.84, 1.03) for HOMA-B. In a subsample of 611 AWHS participants with available follow-up the shape of the dose-response of selenium with prospectively measured HOMA-IR and HOMA-B was consistent compared to the cross-sectional dose-response.

CONCLUSIONS: The positive association of Se with HOMA-IR in both studies suggests that high levels of Se exposure are related with increased insulin resistance. Alternatively, the positive association of Se with HOMA-B in middle aged adults from AWHS but not in older adults from SEN-2, might suggest



ABSTRACT E-BOOK

that increased insulin resistance induces compensatory increased β -cell function in younger ages, being this compensatory capacity decreased with aging.

Keywords: Epidemiology, obesity and metabolic disorders, exposures

P-464

Exposures » Microbes/Microbiome

Disinfection effectiveness of supermarkets to comply with COVID-19 prevention guidelines in Kampala Capital City and Mukono Municipality, Uganda

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BACKGROUND AND AIM: Whereas the Ministry of Health instituted infection prevention and control (IPC) guidelines in Supermarkets in Uganda to slow down COVID-19 spread, assessments on the extent of compliance with these guidelines has not been done. This study assessed compliance to the COVID-19 prevention guidelines among supermarkets in Mukono municipality and Kampala Capital City, Uganda.

METHODS: An explanatory sequential mixed methods study was conducted. Assessment of compliance with COVID-19 infection prevention and control guidelines was conducted using an observation checklist in 229 supermarkets in Kampala city and Mukono municipality. A total of 168 swabs from commonly touched surfaces in 17 supermarkets were aseptically collected to assess cleaning and disinfection effectiveness with *E. coli* as the indicator organism.

RESULTS: Almost all, 95.2% (218/229) of the supermarkets had hand washing facilities placed at the entrance. Of the 168 sampled surfaces, 10 yielded positive results to *E. coli* and 7 isolates showed antimicrobial resistance. The contaminated surfaces were pay counters (3, 3.33%), shelves (2, 2.22%) and shopping baskets (2, 2.22%) while trolleys and fridge doors were uncontaminated. Mini supermarkets yielded 4(4.44%) isolates while medium sized yielded 3(3.33%) isolates.

CONCLUSIONS: This study revealed low compliance with COVID-19 guidelines, which required instituting mandatory preventive measures such as hand hygiene and regular disinfection. This study suggests the need for the health authorities to sensitise more on COVID-19 and strengthen enforcement of these guidelines.

Keywords: COVID-19, COVID-19 guidelines, supermarkets, Uganda



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-465

Policy » Research translation to affect policy and practice

Climate Change Adaptation Plan from Environmental Health approach for Antioquia (Colombia) in 2021

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BACKGROUND AND AIM: Recognizing the threats associated with climate change and variability, the department of Antioquia declared a Climate Emergency in accordance with the actions promoted by the Agreement of Paris (COP21). One of the actions enacted on this declaration is the formulation of the Climate Change Adaptation Plan from the Environmental Health Component for the department of Antioquia.

This Plan is aimed at identifying and promoting adaptation and resilience actions according to the needs identified for each subregion of the department, in order to reduce and anticipate the health effects that are related to climate change and variability.

METHODS: A mixed qualitative and quantitative research design is conceived to carry on a diagnosis of the territory, the identification of problems and needs, prioritization and formulation of adaptation and resilience actions from environmental health to face climate change and variability.

RESULTS: The analysis carried out allowed to make an approximation to the recognition of the effects of climate change and variability on the health of the population, hydro-meteorological threats; the need to establish environmental health as an important approach to generate an Intersectoral and Interinstitutional articulation, through capacities strengthening and thematic dialogues with the actors in the territory. A methodological input for the analysis of vulnerability in health to climate change and variability was implemented, that allows identifying strengths and needs in order to formulate strategies that reduce vulnerability according to local reality.

CONCLUSIONS: Faced with the needs identified for the department of Antioquia from Environmental Health and the recognition of the effects generated by climate change and variability and associated hydrometeorological threats, it is intended to foster the formulation and implementation of priority measures and actions for adaptation to climate change from environmental health in the Municipal Health Plans, to improve the current conditions of the health system for the well-being of the population.

Keywords: Climate, Policy and practice, Community outreach, Science communication, Mixtures analysis



ABSTRACT E-BOOK

P-466

Policy » Other (to be specified with keywords in the keywords section)

Air quality and health information systems in Latin America and Caribbean: ¿are they a proxy of social disparities between countries?

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Universidad de Antioquia

BACKGROUND AND AIM: Poor air quality is one of the main public health problems around world and it's the fourth risk factor for death. For 2019, 6.7 million deaths were attributed to it. Among countries in the same region, local air pollution and its impacts show unequal management due to socioeconomic disparities.

Assuming that the presence of "Air Quality and Health Information Systems" (AQHIS) can be a proxy for environmental public health management at the national level, this research compared some socioeconomic characteristics between countries with and without AQHIS in the Latin American and Caribbean region.

METHODS: A descriptive study was carried out between 2018 and 2019, in which socioeconomic, environmental and health characteristics were analyzed. The information was obtained from free access databases, that were found in online repositories of multilateral institutions (UNESCO, UNDP, Inter-American Development Bank, World Bank and PAHO). A univariate analysis for each characteristic studied were made and they were compared between countries as they had or not AQHIS.

RESULTS: According to official pages environmental or health authority, 26% of countries in the region had AQHIS, only three analyzed health indicators in relation to air quality phenomenon. Differences between the countries with and without AQHIS regarding the number of inhabitants were found, reporting a greater number of people in those with an information system ($p= 0.000$), and higher proportion of cities with more than one million inhabitants (92.3% vs. 10.8%, $p = 0.000$). A lower average of years of schooling was reported in countries with AQHIS ($p = 0.22$). Similar findings were found for other socioeconomic indicators.

CONCLUSIONS: Differences were identified for some socioeconomic indicators in relation to the existence of AQHIS in the region. An analysis of the regional context is necessary to understand how this indicator could reflect some social disparities in environmental health.

Keywords: Information System, Air Pollution, Health, Latin America and Caribbean region



ABSTRACT E-BOOK

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Policy » Research translation to affect policy and practice

Traffic-related pollutants and human health within the interstate-10 Claiborne Corridor: land use implications

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BACKGROUND AND AIM: This community-triggered investigation aims to characterize environmental conditions, population exposures and disease rates for neighborhoods along Interstate-10 (the Claiborne Corridor) in New Orleans, Louisiana, U.S. The goal of this work is to address concerns expressed by the neighborhood group Claiborne Reborn (CR) as they relate to health and environmental impacts of recently proposed land use plans for the overpass.

METHODS: Potential and prevailing environmental health conditions were characterized based on reviews of available site-specific environmental and health data, limited site-specific air quality and noise pollution monitoring, and a review of published studies investigating health impacts of high traffic conditions.

RESULTS: Exposure routes of greatest potential concern, based on the available data, include: inhalation of fine particulate air emissions from I-10 and road traffic by residents, workers, children and homeless; inhalation and ingestion of soil lead by children frequenting nearby parks, homes, daycares or schools; and regular noise pollution impacting area residents, workers, children and homeless. Adverse health impacts that are significantly associated with existing levels of hazards that were either measured or modeled in the area include respiratory and cardiovascular diseases.

CONCLUSIONS: The aim of this project is to provide data upon which stakeholders can base decisions. Land use recommendations are evaluated and discussed within the context of their potential implications on the prevailing environmental, exposure and health conditions.

Keywords: Traffic, pollution, interstate, land use, research translation, policy



ABSTRACT E-BOOK

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Exposures » Microbes/Microbiome

Biological contamination due to microsporidia in urban soils: an emerging risk?

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BACKGROUND AND AIM: Topsoils can be a source of emerging opportunistic and zoonotic parasites. Children and immunodeficient individuals can be accidentally exposed to microsporidia spores when spending time in urban parks and recreational areas. The aim of this study was to determine the presence and distribution of human-related microsporidian species in urban/industrial areas in Alcalá de Henares (Madrid Region, Spain).

METHODS: 227 topsoil samples were collected July 2017 across different urban (n=155) and industrial (n=60) areas in Alcalá, and in a public garden in the city centre (n=12). DNA was extracted from concentrated pellet by disrupting the spores using Fast-Prep for Soil, followed by SYBR Green real-time PCR for simultaneous detection of *Enterocytozoon bieneusi* and *Encephalitozoon* spp. (*E. intestinalis*, *E. hellem* and *E. cuniculi*).

RESULTS: Real-time amplification with MsRTf1/MsRTr1 primer set and differential melting curve analysis confirmed presence of *E. bieneusi* (n=9; 5 urban, 4 industrial), and *Encephalitozoon* spp. in 22 of the soil samples: three *E. cuniculi* (2 urban, 1 industrial); ten *E. intestinalis* (8 urban, 2 industrial); nine *E. intestinalis/E. hellem* (6 urban, 3 industrial). Microsporidia spores were not found in any of the samples monitored in public gardens. Urban animals have been suggested to play a role in the distribution of these emerging parasites through their droppings. Thus, similar studies carried out in Madrid city have detected microsporidia in animal faeces collected from public parks but not in their soils, which highlights the significance of our study.

CONCLUSIONS: Our results indicate a moderate prevalence and distribution of human-related microsporidia in soils in Alcalá, which could represent a public health concern. Interventions to protect the public might be necessary as the presence/distribution of these biothreats could be higher, as potential false-negative results due to low DNA parasite concentration and/or the presence of environmental PCR inhibitors should be considered.

Keywords: Microsporidia, urban topsoils, human risks, biological contamination



ABSTRACT E-BOOK

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Exposures » Microbes/Microbiome

Is *Enterocytozoon bieneusi* threatening the food chain in Bombali District, Sierra Leone?

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BACKGROUND AND AIM: Ebola survivors are at increased risk of mortality and require specific countermeasures to protect their compromised health. The aim was to investigate the presence of *Enterocytozoon bieneusi*, an emerging pathogen that causes chronic diarrhoea in immunocompromised individuals, in animals that are going to be used for human consumption across Bombali District (Sierra Leone), which has one of the highest number of notified Ebola survivors.

METHODS: DNA was extracted from thirty-four fresh animal faecal samples collected in 2019 from three locations (animal market, slaughterhouse and pig slaughterhouse) in Bombali district, Sierra Leone, using Fast-Prep for Soil[®] kit. PCR inhibitors were removed using a QIAquick PCR kit (Qiagen) following manufacturer's instructions. SYBR Green real-time polymerase chain reaction technique was used for specific detection of *E. bieneusi* according to previous methodologies.

RESULTS: *E. bieneusi* was detected in eight samples, five from farm animals (four pig and one cow) and three from dogs collected directly from the ground in these locations. However, *E. bieneusi* was not detected in faeces collected from chickens (n=5) and goats (n=3). This pathogen has been reported in pigs in the literature, highlighting a potential risk for humans. Spores were detected in faeces from a range of different animal species in all areas monitored, indicating a high presence and distribution of *E. bieneusi* in this district in Sierra Leone.

CONCLUSIONS: Our study confirms the presence and circulation of *E. bieneusi* in farm animals in Bombali District (and their environments), which require appropriate interventions to tackle this biothreat. Implementation of appropriate cleaning and food processing protocols at the slaughterhouses/markets would be required due to the high presence of spores of *E. bieneusi* found (23.5%), in conjunction with hygiene awareness when processing meat particularly for sensitive populations, such as Ebola survivors.

Keywords: Makeni, Sierra Leone, microsporidia, {*E. bieneusi*}, animal faeces, food.



ABSTRACT E-BOOK

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Exposures » Microbes/Microbiome

Annual presence and distribution of human-pathogenic *Acanthamoeba* spp. in River Soar, Leicester, UK

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BACKGROUND AND AIM: *Acanthamoeba* spp. can act as opportunistic parasites and are becoming a serious threat to human health due to the resistance of their cysts to harsh environmental conditions and water treatment practices. Owing to the lack of knowledge about *Acanthamoeba*'s epidemiology in England, the aim of the present work was to study, over one year, the presence and circulation of this opportunistic parasite in the River Soar, which crosses Leicester city (England) and attracts large numbers of users.

METHODS: Water samples were collected from nine different locations following the course of the river through the city per season (n=45) from Summer 2017-Summer 2018, following protocol 1623 described by US EPA. Samples were concentrated using IDEXX® Filta Max system following manufacturer's instructions. DNA extraction from concentrated water was performed with FastDNA® Spin Kit. A triplex real-time TaqMan PCR assay was performed to detect *Acanthamoeba* spp., using established methodologies.

RESULTS: *Acanthamoeba* spp. was detected in 17 water samples: 4 in each season from Summer to Winter 2017, two in Spring 2018 and three in Summer 2018. These free-living amoebas were discovered in each sampled location, which highlights a moderate to high circulation of *Acanthamoeba* in the River Soar throughout a year, without seasonality, despite significant changes in the water flow rate and temperatures recorded in the river and in Leicestershire. This river is rich in wildlife, which might play a role in the presence/circulation of *Acanthamoeba* spp.

CONCLUSIONS: To our knowledge, this is the first report reporting the presence and circulation of *Acanthamoeba* spp. in an English river throughout a complete year. The presence of *Acanthamoeba* spp. in this river could represent a risk for human health, for example rowers, which is present throughout the whole year. Therefore, this risk should be tackled as the incidence of *Acanthamoeba* keratitis has increased in recent years in England.

Keywords: {*Acanthamoeba*} spp., River Soar, environmental presence, human risk.



ABSTRACT E-BOOK

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Chemical exposures » Mixtures

Polyhalogenated aromatic hydrocarbon exposure mixture and risk of papillary thyroid cancer in active-duty U.S. military: A nested case-control study

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BACKGROUND AND AIM: Exposure to endocrine-disrupting chemicals has been implicated in increasing incidence of papillary thyroid cancer (PTC). The evidence of associations between PTC risk and exposure to polyhalogenated aromatic hydrocarbons (PHAHs), including polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), and organochlorine pesticides (OCPs), is largely limited to single-pollutant studies. We aimed to investigate the relationship between a PHAH exposure mixture and PTC risk.

METHODS: We conducted a case-control study nested within the Department of Defense (DoD) cohort including 742 histologically-confirmed PTC cases (54% male) diagnosed 2000-2013 and 742 individually-matched controls. PHAHs were measured in pre-diagnostic sera collected 1994-2010. We used quantile g-computation to estimate the joint effect of a PHAH mixture on PTC risk, adjusting for body mass index and military service branch. Quantile g-computation is appropriate for matched case-control study design and allows the direction of weights among mixture components to vary. Our PHAH mixture included 24 lipid-corrected congeners (four PBDEs, 14 PCBs, five OCPs, and one polybrominated biphenyl).

RESULTS: Mean age at PTC diagnosis was 35 (\pm 8) years. On average, serum samples were collected nine years before PTC diagnosis. Overall, a one-quartile increase in the PHAH mixture was non-significantly associated with 11% increase in PTC risk (95%CI=0.81-1.50). PCB-180 and PCB-118 contributed the largest total mixture weights in the positive direction, while PCB-153, PCB-187, and PBDE-100 contributed the largest total mixture weights in the inverse direction. The risk among women was elevated (OR=1.33; 95%CI=0.79-2.23), while it was relatively null among men (OR=0.90; 95%CI=0.60-1.37).

CONCLUSIONS: Our study suggests that exposure to a large mixture of ubiquitous environmental pollutants is non-significantly associated with PTC risk in a young active-duty military population. However, that risk may be higher for women than men.

Disclaimer: The views expressed here are the authors' and do not necessarily reflect official policies/positions of USU, the DoD, or the CDC.



ABSTRACT E-BOOK

Keywords: Endocrine disrupting chemicals, Environmental epidemiology, Mixtures analysis

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Chemical exposures » Mixtures

Perfluoroalkyl substance mixtures and cardio-metabolic outcomes in highly exposed male workers in the Veneto Region: a mixture-based approach

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BACKGROUND AND AIM: Perfluoroalkyl substances (PFAS) have been consistently associated with cardio-metabolic traits, associations of combined exposures to multiple PFAS with health outcomes in highly exposed populations have been poorly investigated. The aim of the present study was to examine these associations in male workers.

METHODS: We considered a population of 232 male employees who had worked in a factory located in Trissino (Veneto, Italy), which produced PFAS and other chemicals during 1968-2018. Twelve serum PFAS were measured by HPLC-MS during 2018-2020; four (PFOA, PFOS, PFHxS and PFNA) were quantifiable in at least 50% of samples. Non-fasting serum total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured. The associations between PFAS mixtures and each outcome were assessed through weighted quantile sum (WQS) regression model, taking into account potential confounders.

RESULTS: Among the PFAS, PFOA was detected at the highest level, with a median concentration of 80.75 ng/mL and maximum levels up to 13,000 ng/mL. We observed that each quartile increase in the WQS index was associated with an increase in the levels of TC (β : 9.05, 95% IC: 2.04-16.05), LDL-C (β : 6.79, 95% IC: 0.51-13.07) and SBP (β : 2.64, 95% IC: 0.49-4.79). No effect of PFAS exposure on HDL cholesterol and DBP emerged. WQS analyses revealed a major contribution of PFNA and PFHxS for the cholesterol levels, although the main exposure was due to PFOA. PFOS and PFOA emerged as chemicals of concern regarding the association with SBP.

CONCLUSIONS: We found strong positive association between a mixture of four PFAS and total cholesterol levels in particular. Within the mixture PFNA and PFHxS were the most influential. Further work will adjust for other possible confounding factors and apply other approaches to assess chemical mixtures.

Keywords: PFAS, Mixtures, Cardiovascular disease, Chemical exposures, Occupational exposures



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-473

Chemical exposures » Other (to be specified with keywords in the keywords section)

HBM4EU-MOM: intervene to raise awareness to specific dietary recommendations and reduce prenatal exposure to mercury

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BACKGROUND AND AIM: Mercury and its compounds are toxic and are among the substances of higher concern globally. Toxicity depends on mercury compounds, route of exposure and duration. The European population is mostly exposed to organic mercury (methylmercury) due to fish consumption; while exposure to inorganic and elemental mercury is largely associated with dental amalgams, accidental spills of elemental mercury and food produced in contaminated sites.

Previous studies have shown that mercury levels in European population are higher in countries with higher fish consumption. However, because of the beneficial nutrients they provide, fish are an essential component of the human diet. In order to reduce exposure and avoid adverse health effects, it is extremely important to balance the risks and benefits of eating fish, especially in vulnerable groups such as pregnant women.

Most European countries do not have official guidelines for the consumption of fish during pregnancy, and even if these guidelines exist, they are often not communicated to pregnant women in an appropriate way. As such, under the European Human Biomonitoring Initiative (HBM4EU) an intervention study – HBM4EU-MOM – is being developed in five European countries with high fish consumption (Cyprus, Greece, Iceland, Portugal, Spain) to help reduce prenatal exposure to mercury, while ensuring the nutritional benefits of fish by developing and raising awareness to specific recommendations for fish consumption during pregnancy.



ABSTRACT E-BOOK

METHODS: This presentation will highlight the work already performed, including the harmonized development of the intervention and support materials to be implemented in the five countries.

RESULTS: Preliminary results on the implementation of the developed intervention and its evaluation using Human Biomonitoring will also be presented.

CONCLUSIONS: This study's results will support the definition of policies to protect human health in vulnerable populations.

HBM4EU has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 733032.

Keywords: Heavy metals, Chemical exposures, Exposure assessment, Food/nutrition, Biomarkers of exposure, International collaboration



ABSTRACT E-BOOK

P-474

Chemical exposures » Other (to be specified with keywords in the keywords section)

Dietary acrylamide and risk of specific subtypes of cancer: a dose response meta-analysis of epidemiological studies

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BACKGROUND AND AIM: Acrylamide is a probable carcinogen in humans. The main source of exposure to acrylamide in the general population is through diet. We performed a systematic literature review and dose-response meta-analysis of epidemiological studies evaluating the associations between dietary intake and specific subtypes of cancers.

METHODS: A systematic literature search following PRISMA guidelines was conducted using Pubmed, Scopus and Web of Science until October 2020. Eligible studies included adults, assessment of dietary acrylamide ($\mu\text{g}/\text{day}$), risk estimates for increasing exposure to acrylamide, and cancer incidence.

Quality of papers was assessed using the NIH's Quality Assessment Tools for Observational Cohort and Case-Control Studies. We employed random-effects models comparing the highest versus the lowest intake of acrylamide and using the one-stage approach for dose-response meta-analysis.

RESULTS: Out of 835 studies screened 28 studies were eligible for this meta-analysis. A total of 1 109 365 (mean age 60 years, range 45-70 years) participants were included, of which 61957 developed cancer. The mean follow-up period was 15.1 years (range 7.3-33.9). Mean estimated dose of acrylamide intake across studies was 22.6 $\mu\text{g}/\text{day}$. Pooled HR showed that high intake of acrylamide (35 $\mu\text{g}/\text{day}$) vs low intake (10 $\mu\text{g}/\text{day}$) was associated with increased risk of hematological malignancies (summary HR: 1.4 95%CI:1.03-1.23). Dose-response meta-analysis showed evidence of linear association. No clear associations were noted between high intake of acrylamide (vs low) and esophageal, stomach, pancreatic, lung, renal, bladder-urothelial, and prostate cancers. Similar results were observed in the smoking stratification analysis

CONCLUSIONS: From this dose-response meta-analysis of epidemiological studies investigating the association between dietary intake of acrylamide and specific subtypes of cancer, high intake of acrylamide was noted to be associated with increased risk of hematological malignancies. Further studies based on human biomonitoring data are needed to clarify the relationship of dietary acrylamide and cancers in humans.



ABSTRACT E-BOOK

Keywords: acrylamide, dietary exposure, neoplasms, epidemiological studies, Systematic Review

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Chemical exposures » Mixtures

The Associations of Prenatal Exposure to Dioxins and Dioxin-Like Polychlorinated Biphenyls with Neurodevelopment at 6 Months of Age: Multi-pollutant Approaches

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BACKGROUND AND AIM: Prenatal exposure to endocrine disrupting chemicals, including polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (DL-PCBs), has been hypothesized to have detrimental impact on neurodevelopment. However, the effect of prenatal exposure to dioxin and DL-PCB mixtures on neurodevelopment remains largely inconclusive. Therefore, we aimed to elucidate the associations of in utero exposure to a dioxin and DL-PCB mixture with infant neurodevelopment by applying novel multi-pollutant methods.

METHODS: The concentrations of individual dioxin and DL-PCB isomers were measured in maternal peripheral blood during pregnancy in the Sapporo cohort, Hokkaido Study on Environment and Children's Health. The mental and psychomotor development of the study participants' six-month-old infants were assessed using the Bayley Scales of Infant Development-2nd Edition (n=210). To determine both the joint and individual associations of prenatal exposure to dioxin and DL-PCB mixtures with infant neurodevelopment, Bayesian Kernel Machine Regression (BKMR) and quantile-based g-computation models were performed.

RESULTS: Suggestive, but not significant, inverse associations were observed between prenatal exposure to a dioxin and DL-PCB mixture, and infant psychomotor development in the both BKMR and quantile g-computation models. In contrast, we found no association of dioxin and DL-PCB mixtures with mental development. These mixture methods consistently indicated 2,3,7,8-TCDD and 23'44'55'-HxCB(#167) as the most influential dioxin and DL-PCB congener on mental and psychomotor development, respectively. When group-specific posterior inclusion probabilities were evaluated, BKMR revealed in utero exposure to PCDFs and mono-ortho DL-PCBs as the more important contributing factors to early mental and psychomotor development, respectively, compared with the other dioxin or DL-PCB groups. No evidence of non-linear relationships or interactions among the chemical mixtures was detected.

CONCLUSIONS: Employing the novel statistical methods for chemical mixture analysis, we demonstrated limited evidence of inverse associations of prenatal exposure to dioxins and DL-PCBs with infant psychomotor development, but not with mental development.



ABSTRACT E-BOOK

Keywords: Chemical mixtures, Dioxins, Polychlorinated biphenyls, Neurological development, Bayesian Kernel Machine Regression, Quantile g-computation

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Chemical exposures » Other (to be specified with keywords in the keywords section)

Role of *in vitro* exposure to TiO₂ nanoparticles in human colorectal carcinoma cells cytotoxicity

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BACKGROUND AND AIM: Titanium dioxide nanoparticles (TiO₂-NPs) are a revolutionary material that are widely used in several application fields. However, their large demand has raised many concerns about the risk of TiO₂-NPs toxicity in living organisms. Although several studies showed toxic effects of TiO₂-NPs on ecosystems, there are few or inconsistent evidences about the possible effects on human health of nanoparticle form (1-100 nm). The biological effect of Titanium dioxide (TiO₂) on gastrointestinal tract as a possible adverse effect as been not yet clarify. In particular, the contribution of TiO₂-NPs fractions to proliferative effects on tumour cells is debated. In the present study the exposure to three different Titanium chemical forms (ionic Ti, 60 nm TiO₂-NPs and TiO₂ food additive E171) was explored in human colorectal carcinoma cells (HCT116 and Caco-2).

METHODS: Viability was assessed by MTT assay. Western Blot analysis was employed to evaluate the expression of cleaved Caspase-3 and total/cleaved PARP proteins. Colony-forming assays were performed to evaluate the cells proliferation after 7-day culture without Ti chemical forms.

RESULTS: The data showed that the exposure to all three forms of Titanium decreased Caco-2 and HCT-116 cell viability in a dose dependent manner compared to untreated control after 72 hours, with a statistically significant effect starting from 1 mg/L for E171 and ionic Ti, and from 10 mg/L for TiO₂-NPs. However, western blot analyses showed that the decrease of cells growth was unrelated to apoptosis. Moreover, after removing each Titanium chemical forms, cell proliferation resumed normally

CONCLUSIONS: The results of the present study highlight that despite ionic Ti, TiO₂-NPs and E171 affect cell viability, all the Ti chemical forms did not induce apoptosis. However, the resuming of cell proliferation after removing the particles support the notion that a better insight of the TiO₂-NPs bio-effects is required, to promote a safer use practices of nanomaterials.

Keywords: Titanium dioxide, Nanoparticles, Apoptosis, Caco-2 cells, HCT116 cells



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Chemical exposures » General

Repeated Measures of County Level Toxic Releases are Associated with Increased Circulatory Disease Mortality

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BACKGROUND AND AIM: Cardiovascular disease (CVD) is the leading cause of death from environmental exposures. Although exposure to PM_{2.5} is an established risk factor for CVD, the contribution of other hazardous pollutant exposure to CVD is less clear.

METHODS: To examine the relationship between environmental exposures and CVD, we used the publicly available Toxic Release Inventory data and age-adjusted circulatory disease mortality rates from the National Center for Health Statistics between 2002 and 2012. We built longitudinal mixed models using an aggregate quantity-based exposure and risk-based exposure, the county sum and the risk sum, respectively. The county sum is the sum of all chemicals released in pounds in each county, each year, independent of the chemical toxicity. The risk sum is the sum of the product of each chemical release in pounds and the inverse of the reportable quantity of the chemical. To identify the potentially toxic chemicals associated with circulatory disease mortality rates in a cross-section of the data, in year 2012, we used the variable selection elastic net approach. Models were adjusted for county percent male, percent White, percent Hispanic, and percent less than a high school diploma earned, median household income, alcohol, smoking, frequency of National Priority List Superfund sites, and PM_{2.5}.

RESULTS: For every 25% increase in annual county sum, we found a 2.8% (1.2, 4.4; p-value=0.0006) increase in circulatory disease mortality rate. In addition, for every 25% increase in annual risk sum, there was a 3.0% (95%CI 1.3, 4.6; p-value=0.0003) increase in circulatory mortality. The elastic net model identified that five out of 467 potentially toxic chemicals: bromoform, dichlorobromomethane, dichlorotrifluoroethane, nitrophenol, and thallium may be contributing to excessive CVD mortality.

CONCLUSIONS: These results identify 5 reactive chemicals of concern and suggest that county-wide releases of toxic chemicals may be significant contributors to CVD mortality.

Keywords: Cardiovascular diseases, Mortality, Multi-pollutant, Air Pollution



ABSTRACT E-BOOK

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Chemical exposures » Mixtures

Prenatal metal mixtures and early childhood lung function

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BACKGROUND AND AIM: Individual metal exposures have been linked to child lung health, however associations with prenatal metal mixtures has not been described. We employed a novel statistical approach to examine associations between prenatal exposure to 18 metals and child lung function.

METHODS: Analyses included 135 mothers and children enrolled in the longitudinal PRogramming of Intergenerational Stress Mechanisms (PRISM) pregnancy cohort. Urinary metals were analyzed in prenatal maternal spot urine with inductively coupled plasma-mass spectrometer-triple quadrupole. Children performed impulse oscillometry (IOS) at age 4 years; IOS z-scores adjusted for age, sex, race/ethnicity and height and weight. We employed Bayesian Weighted Quantile Sum (BWQS) regression to examine associations between prenatal metal mixture exposure and IOS z-scores, adjusting for gestational age at spot urine collection, urinary creatinine, maternal education and gestational age at delivery. Sex-specific effects were explored.

RESULTS: Sixty three percent (N=84) and 36% (N=48) of children self-reported Black and Hispanic ethnicity, respectively. Children were aged a median 4.2 years (IQR 3.7, 4.9) at the time of IOS and 52% (N=70) were male. In adjusted models, prenatal metal mixtures were associated with increased R5 (R5 z-score $\beta = 0.26$, 95% credible interval, CI, 0.01, 0.49) and R20 (R20 z-score, $\beta = 0.29$, 95% CI 0.00, 0.57), measures of total and large airway resistance, respectively. BWQS metal mixture weights identified that for both R5 and R20, Nickel, Lead, Barium, and Antimony had the largest proportional weights; Cadmium and Copper had larger weights for R5 while tin and manganese had larger weights for R20. Girls were more vulnerable to the effects of metal mixtures on R5 while boys were more vulnerable to effects on R20.

CONCLUSIONS: Prenatal metal mixture exposures were associated with impaired airway mechanics at age four years, with a suggestion of a sex-differential response.

Keywords: Prenatal, metal mixtures, lung function



ABSTRACT E-BOOK

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Chemical exposures » Mixtures

Are "clean" cosmetic products really clean?

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BACKGROUND AND AIM: As a result of increased demand for environmental and health-conscious cosmetics, retailers have increasingly marketed their products using terms such as "clean" or "non-toxic". Sephora, a popular beauty retailer, implemented a clean seal system to verify their products' ingredient statuses for consumers. This study aims to compare the toxicity concerns of clean and non-clean products at Sephora by using the EWG Skin Deep framework.

METHODS: EWG's Skin Deep framework was used to rank products based on their cancer, allergy and immunotoxicity, developmental and reproductive toxicity, and use-restriction concerns, with lower scores indicating a cleaner product (ranging 0-10). The distributions of EWG scores among clean and non-clean products were investigated, stratified by different types of products (fragrance, hair, makeup, or skincare). A multivariable linear regression model was further applied to evaluate the association between EWG scores and clean seals, adjusting by types of products, level of toxicity concerns, etc.

RESULTS: 356 products were sampled, including 180 (50.56%) clean products and 176 (49.44%) non-clean products. Clean products yielded a higher percentage of low hazard ingredients and a lower percentage of moderate and high hazard ingredients compared to non-clean products. EWG scores are positively correlated with the levels of toxicity concern for cancer, allergy and immunotoxicity, and use restrictions, respectively. Clean products are also associated with a lower EWG score by 0.71 in the regression model. Fragrance products are most hazardous, with a 2.42 increase in EWG score.

CONCLUSIONS: Products under the binary "clean beauty" labelling system at Sephora may not necessarily capture the nuances of EWG's ten-point scoring system. It may be insufficient for consumers to solely rely on the presence of the clean seal when purchasing beauty products. Further research and increased data availability from EWG's database are necessary to better understand the disparities between the product scores in EWG and their Sephora label.

Keywords: cosmetic products, EWG, Sephora, clean products



ABSTRACT E-BOOK

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Chemical exposures » Mixtures

Population-based biomonitoring of exposure to persistent and non-persistent organic pollutants in the Grand Duchy of Luxembourg: results from hair analysis

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BACKGROUND AND AIM: Environmental exposure of humans to pollutants has been associated with adverse health outcomes. The assessment of human exposure to pollutants were often performed using biological fluids, but increasing interest was also observed for hair analysis. However, no study based on hair analysis has so far documented exposure in groups representative of the general population, with extended range of age, socio-demographic aspects, education, etc. in both men and women. We aimed to assess human exposure via hair analysis to persistent organic pollutants (POPs) and non-persistent pesticides in a representative sample of the general adult population in Luxembourg.

METHODS: We measured concentrations of 34 persistent and 33 non-persistent organic pollutants from 11 chemical families (e.g., polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), organochlorine pesticides (OCPs), organophosphate pesticides (OPPs) and pyrethroid pesticides (PYRs)) in hair samples collected from 497 participants from the general adult population in Luxembourg during 2007-2008.

RESULTS: We detected 24 persistent and 29 non-persistent organic pollutants, with 17 pollutants being detected in more than 50% of hair samples. Each participant in this study had detectable levels of at least 10 of the pollutants analyzed, and 50% of participants had 19 or more. Significant correlations were often found between pollutants from the same family, with the strongest being found between two PYR metabolites, trans/cis-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane-carboxylic acid and 3-phenoxybenzoic acid. Sex, age and/or body mass index were significantly associated with 15 out of the 17 frequently detected pollutants.

CONCLUSIONS: Our results suggest the simultaneous exposure to numerous different pollutants among our study population. This research contributes to the establishment of reference range concentrations for these chemicals in the hair matrix.

Keywords: Exposure assessment, Pesticides, Biomarkers of exposure, Environmental epidemiology



ABSTRACT E-BOOK

P-481

Chemical exposures » Other (to be specified with keywords in the keywords section)

The value of Human Biomonitoring to assess chemical exposure and support policies: perceptions of the European population

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BACKGROUND AND AIM: The development of Human Biomonitoring (HBM) surveys is highly dependent on the cooperation and engagement of the individuals being sampled. As such, in the context of the European Human Biomonitoring Initiative (HBM4EU) an online citizen survey was conducted in Europe to gain insights into the perceptions of the population about HBM and exposure to chemicals.

METHODS: The survey was undertaken between September 2020 and February 2021 and was available in the languages of all 30 HBM4EU-participating countries (EU, associated countries, Israel) through the HBM4EU website. Dissemination was done by the HBM4EU country representatives (National Hub Contact Points).

RESULTS: Responses were received from 5391 participants. Around half were 35-54 years old and the majority were female, with higher education and employed. Concerning the perception of the respondents on HBM, the majority considers it should be done (81.7%), even if the chemicals are considered well managed. Most participants consider it a reliable method (84.0%) that should be performed more often (87.3%) and be more coordinated either at a European (86.2%) or at a national level (83.7%). The large majority of the respondents thinks that HBM results are important to evaluate the chemical exposure of the population (96.2%), to study the health impact of chemical exposure (96.3%) and to support the development of health policies (94.9%). The respondents also consider HBM results highly relevant to raise awareness and promote understanding of the impact of chemical exposure amongst the general population (94.3%), health professionals and policy makers.

CONCLUSIONS: The use of HBM as a tool to assess human exposure to chemicals, allowing its management and health protection, was well perceived by respondents across Europe. Furthermore, the need for more studies conducted in a coordinated way was indicated. Future work should comprise population groups less represented here and should also attempt to understand how perceptions change over time.



ABSTRACT E-BOOK

Keywords: International collaboration, Chemical exposures, Community-engaged research, Community outreach, Science communication

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Chemical exposures » Pesticides

The capability of Roundup to distort Zinc functionality in bivalve mollusk in the ex vivo and in vivo exposures

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BACKGROUND AND AIM: One of the common effects of herbicide Roundup (Rn, commercial formulation of glyphosate) is its adhesive activity towards metal ions. Zinc (Zn) plays the crucial role in plural biochemical reactions. The aim of this study was to elucidate the ability of Rn to distort Zn functionality in the ex vivo and in vivo exposures of bivalve mollusk.

METHODS: In the ex vivo exposures, the digestive gland of *Unio tumidus* was exposed during 17 h to Rn (0.08 - 3.0 μ M of glyphosate), 3.0 μ M of Zn or Zn chelator TPEN (Tp) and their combinations ZnTp or ZnRn. In the in vivo exposures, the mussels were exposed to Rn (40 and 80 nM) during 14 days. The level of Zn in the tissue (Znt) and metallothioneins (Zn-MT), metallothioneins (MTSH) and glutathione (GSH&GSSG) concentrations, total antioxidant capacity (TAC), lysosomal membrane integrity (NRR test) and caspase-3 activity were determined.

RESULTS: In the ex vivo exposures, the most consequent changes were indicated at 3 μ M of Rn as the oxidative injury (decreased TAC and GSH levels). Similarly, in the in vivo exposures, the pro-oxidative effect of Rn was indicated at 80 nM. However, in the ex vivo exposure to ZnRn, the Znt or caspase-3 activity were not distorted, unlike under the effect of TPEN which caused opposite effects to Zn: decreased Znt and Zn-MT, increased caspase-3 activity. In the in vivo exposures, 80 nM of Rn caused a distortion of metallo-thiolome due to increased levels of insufficiently metalated MTSH and decreased Znt. The toxicity of Rn in the ex vivo and in vivo exposures was confirmed by the loss of lysosomal membrane integrity.

CONCLUSIONS: Roundup does not affect directly the intracellular Zn functionality, unlike TPEN, but can distort it via the thiols oxidation.

Keywords: Bivalve mollusc, Roundup, Zinc, Metallothionein



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Intervention efficacy in reducing childhood lower respiratory infections and indoor fine particulate matter among US households with wood heating stoves

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BACKGROUND AND AIM: Millions of rural United States (US) households are heated with wood stoves that can lead to high indoor concentrations of fine particulate matter (PM_{2.5}). Wood stove use is associated with lower respiratory tract infection (LRTI) in children, the leading cause of childhood hospitalization in the US. In the Kids Air Quality Interventions for Reducing Respiratory Infections (KidsAIR) study, we assessed the impact of low-cost interventions on childhood LRTI and indoor PM_{2.5} in rural homes with wood stoves.

METHODS: KidsAIR was a parallel three-arm (education, portable air filtration unit, control), post-only randomized trial in households from Alaska, Montana, and Navajo Nation with a wood stove and one or more children under five years of age. We tracked LRTI cases for two consecutive winter seasons and measured indoor PM_{2.5} over a six-day period during the first winter. We assessed results using two frameworks: intervention efficacy on LRTI and PM_{2.5} (intent-to-treat) and association between PM_{2.5} and LRTI (exposure-response).

RESULTS: There were 61 LRTI cases from 14,636 child-weeks of follow-up among 454 children. In the intent-to-treat analysis, children in the education arm (Odds ratio: 1.0; 95% Confidence Interval [95%CI]: 0.4, 2.7) and air filtration arm (Odds ratio: 1.2; 95%CI: 0.5, 3.3) had similar odds of LRTI versus control. Geometric mean PM_{2.5} concentrations were similar to control among education arm (14% higher; 95%CI: -11, 45) and air filtration arm (13% lower; 95%CI: -32, 11) households. In the exposure-response analysis, odds of LRTI were 1.5 times higher (95%CI: 1.0, 2.1) per interquartile range increase in mean indoor PM_{2.5}.

CONCLUSIONS: We did not observe meaningful differences in LRTI or indoor PM_{2.5} in the air filtration or education arms versus control. The exposure-response analysis provides further evidence that biomass air pollution adversely impacts childhood LRTI. Our results highlight the need for novel, effective intervention strategies in households heated with wood stoves.

Keywords: Children's environmental health, Respiratory outcomes, Environmental epidemiology



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Air pollution » Particulate matter

The role of village spillover and stove use on wintertime outdoor PM_{2.5} in villages transitioning to clean heating in China

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BACKGROUND AND AIM: In an effort to improve ambient air quality, the Beijing government is requiring that households in the municipality transition, at the village-scale, from coal-burning stoves to electric-powered heat pumps and natural gas boilers for household heating. Wintertime air quality in this region is subject to meteorological clustering and air pollution emissions from rural residential space heating with coal-burning stoves. Thus, to better understand how large-scale policies like the one being implemented perform, we conducted a village level analysis of outdoor air pollution patterning, accounting for meteorology, coverage of the policy, and home heating energy use.

METHODS: We analyzed 283 1-week outdoor fine particulate matter (PM_{2.5}) samples from 30 villages in 2 Beijing districts across 2 winter field seasons. In the first winter season (2018-2019) households in all 30 villages were heating with coal-burning stoves, whereas in the second season (2019-2020) households in 10 of those villages had ceased using coal for space heating and instead used electric heat pumps (treated). PM_{2.5} samples were analyzed for mass, black carbon (BC) and trace elements. Elemental and BC concentrations were included in a source apportionment model to identify the sources of elements in these villages.

RESULTS: Median (interquartile range) PM_{2.5} concentrations (µg m⁻³) for treated villages were 31.2 (21.2) for season 1 and 29.7 (25.5) for season 2. For untreated villages, median concentrations were 28.8 (11.7) and 24.8 (19.0) for seasons 1 and 2, respectively. To contextualize the PM_{2.5} mass and source apportionment results, we discuss how these concentrations vary with respect to meteorological clustering, density of nearby treated and untreated villages, and self-reported and objective measures of home heating energy use.

CONCLUSIONS: Our analysis and findings provide a framework and insights regarding influential factors that should be considered when assessing the effectiveness of similar household energy interventions.



ABSTRACT E-BOOK

Keywords: source apportionment, household energy transition, coal combustion, trace elements

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Air pollution » Particulate matter

Personal Exposure to PM_{2.5} In-Utero and Birthweight in the MADRES Pregnancy Cohort

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BACKGROUND AND AIM: In-utero exposure to particulate matter with aerodynamic diameter less than 2.5 μ m (PM_{2.5}) in the 3rd trimester has been linked with low birth weight and childhood obesity risk, especially in Hispanic populations. However, previous results have been mixed, likely due to measurement error introduced by estimating personal exposure from ambient data. We investigated the effect of total personal PM_{2.5} exposure on birthweight and whether it differed by indoor vs outdoor origin in the MADRES cohort study.

METHODS: Personal PM_{2.5} exposure was measured in 206 pregnant women in the 3rd trimester using 48-hour integrated, filter-based sampling. Linear regression was used to test the association between personal PM_{2.5} exposure and birthweight, adjusting for gestational age, parity, race, maternal age, diabetes, and smoking. Interactions of PM_{2.5} with indoor sources, home ventilation or time spent indoors tested whether the effect of total PM_{2.5} on birthweight varied by predominant origin of PM_{2.5}.

RESULTS: Participants were predominately Hispanic (79.8%) with mean (SD) gestational age of 39.0 (1.5) weeks, age of 28.2 (6.0) years, and pre-pregnancy BMI of 28.8 (6.8) kg/m². Mean 48 hour 3rd trimester PM_{2.5} exposure was 24.5 (41.3) μ g/m³ and mean birthweight 3,292.9 (493.2) grams. Total personal PM_{2.5} was not associated with birthweight (β = 0.28, 95% CI: -1.93 – 2.49, per 1-unit increase in PM_{2.5}). However, the effect of PM_{2.5} varied by window opening (none or little of the time: 3.09 (-0.67, 6.86) vs most or all of the time: -1.48 (-4.22, 1.27), interaction p=0.052) and marginally by time spent indoors per day (<12 hrs: -1.28 (-4.50, 1.95), 13-18 hrs: 1.19 (-4.02, 6.39), 19+ hrs: 3.32 (-0.86, 7.49), interaction p=0.234).

CONCLUSIONS: While we did not find a significant association between total prenatal personal PM_{2.5} exposure and birthweight, we did find evidence that outdoor source contributions to personal PM_{2.5} exposure were more strongly associated with lower birthweight.

Keywords: air pollution, particulate matter, birth outcomes, pregnancy outcomes, epidemiology



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Global urban temporal trends in fine particulate matter (PM_{2.5}) and attributable health burdens

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BACKGROUND AND AIM: With much of the world's population residing in urban areas, an understanding of city-level air pollution exposures can inform mitigation approaches. Prior studies of global urban air pollution have not considered trends in air pollutant concentrations nor corresponding attributable health burdens.

METHODS: We use high-resolution annual average PM_{2.5} concentrations, epidemiologically derived concentration response functions, and country-level baseline disease rates from the Global Burden of Disease Injuries and Risk Factors (GBD) 2019 Study to estimate population-weighted PM_{2.5} concentrations and attributable cause-specific mortality in ~13,000 urban centers between 2000 and 2018.

RESULTS: We estimate that the mean urban population-weighted annual average PM_{2.5} was 42 µg/m³ (range=1-150 µg/m³) in 2018, relatively unchanged compared to 2000 (40 µg/m³, range=1-154 µg/m³), though four times the World Health Organization's (WHO) guideline for annual average PM_{2.5} (10 µg/m³). Approximately 86% of urban inhabitants (2.5 billion) people live in urban areas exceeding the WHO guideline in 2018, with only 15% (1,994) of cities meeting the WHO annual average guideline concentration at any point during the study period. While regional averages of urban PM_{2.5} concentrations decreased, we find considerable heterogeneity between urban areas. We find demographic changes drove PM_{2.5}-attributable health burdens, resulting in an increase in PM_{2.5}-attributable deaths in cities on average in all regions except Europe.

CONCLUSIONS: We found the majority of the world's urban population lived in areas with unhealthy levels of PM_{2.5} between 2000 and 2018. While global averages in urban areas were relatively unchanged during this period, there is considerable heterogeneity between urban areas both for PM_{2.5} exposures and attributable health burdens. We found increasing PM_{2.5}-attributable health burdens despite decreases in PM_{2.5} concentrations, speaking to the need for much more dramatic improvements to air quality in order to reduce health burden as a result of the other public health levers contributing to non-communicable disease rates.

Keywords: Air pollution, risk assessment, urban trends



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Racial-ethnic Disparities in PM_{2.5} Exposure in California: Differences by Season and Daily Pollution Level

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BACKGROUND AND AIM: Prior research documents racial-ethnic disparities in exposure to fine particulate matter (PM_{2.5}). We aimed to investigate two temporal aspects of those disparities, for California: (1) by season of year; (2) for days with high PM_{2.5} concentrations (e.g., during wildfires) versus other days.

METHODS: We retrieved PM_{2.5} concentrations at all regulatory monitors (n = 176) across California during 2016-2020, and calculated the annual and seasonal PM_{2.5} concentrations, as well as concentrations for highly polluted (≥ 35 $\mu\text{g}/\text{m}^3$) versus other days. We obtained demographic information for each Census block group (hereafter neighborhoods) where a monitor was located. Block groups with a racial-ethnic minority group ranked as the top 25th percentile in California were classified as a neighborhood of that group; remaining block groups were labeled as “most”. We quantified exposure disparities by racial-ethnic group, poverty rate, age group, and disadvantaged neighborhoods for each temporal period using linear mixed models.

RESULTS: Measured annual average PM_{2.5} levels were 2.2 $\mu\text{g}/\text{m}^3$ (95% CI: 0.4, 3.9) and 3.4 $\mu\text{g}/\text{m}^3$ (2.1, 4.8) higher in Hispanic and disadvantaged neighborhoods, respectively, than in most neighborhoods. In winter, PM_{2.5} levels were 3.4 $\mu\text{g}/\text{m}^3$ (1.3, 5.4) higher in Hispanic neighborhoods than in most neighborhoods. For each 10% increase in proportion of residents in poverty status (for comparison, the IQR is 19%), PM_{2.5} levels increase 0.2 $\mu\text{g}/\text{m}^3$ (0.1, 0.4). For summer, no disparity was identified among different groups. The disparity for disadvantaged neighborhoods remains in both summer and winter. In highly polluted days, predominantly Hispanic, Non-Hispanic Asian, and Non-Hispanic Black neighborhoods were all exposed to lower PM_{2.5} levels than most neighborhoods; no obvious difference was found between disadvantaged and non-disadvantaged neighborhoods.

CONCLUSIONS: PM_{2.5} exposure disparities among racial-ethnic groups and disadvantaged neighborhoods is higher for annual PM_{2.5} concentrations and winter season than for other seasons. Disparity may be much lower for highly polluted versus other days.

Keywords: Particulate matter, Environmental disparities, Exposure assessment-air pollution, Environmental justice



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Emergency visits and mortality caused by ischemic heart disease attributable to fine particulate matter during COVID-19 pandemic in Chile

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BACKGROUND AND AIM: A reduction in PM_{2.5} was reported worldwide during the COVID-19 pandemic confinement. Santiago, a Chilean city, characterized by high concentrations of PM_{2.5} caused by vehicular traffic, improved its air quality as a collateral effect of the quarantine implemented in the second quarter of 2020. We aim at revealing an ensuing decrease of emergency visits by acute myocardial infarction (AMI) and deaths due to ischemic heart disease (IHD) attributable to PM_{2.5}, comparing equivalent periods of 2019 and 2020.

METHODS: In Santiago, the air quality monitoring is accomplished through nine monitors located in nine communes of Santiago: Cerrillos, Cerro Navia, El Bosque, Independencia, La Florida, Las Condes, Pudahuel, Quilicura, and Santiago. These communes differ widely; Las Condes, located at East Santiago's foothills and plenty of green space, is one of the most affluent territories in the country. The other six counties range from the middle class (i.e., La Florida, Cerrillos, and Quilicura) to mostly deprived areas (i.e., Pudahuel and Cerro Navia), which are set into the flatlands in the northwestern area, with scarce green space and poor ventilation.

We described daily average PM_{2.5} concentration with time-series graphs of means and standard deviations, and the AMI-emergency visits and IHD-deaths were reported for each quarter each year. To estimate the impact of the PM_{2.5} excess, we estimated the population attributable fractions (PAF) for IAM-emergency visits and IHD-deaths.

RESULTS: We corroborated the daily average of PM_{2.5} decreased in 8 out of 9 communes in Santiago; however, the reduction was significant only in 3 communes. AMI-emergency visits and IHD-deaths attributable to PM_{2.5} decreased slightly but significantly in these three communes. The PAF in other communes remained similar to 2019 despite the quarantine.

CONCLUSIONS: We concluded that reductions in PM_{2.5} had an impact in attributable AMI emergency visits and IHD deaths in those communes with significant reduction

Keywords: particulate matter, ischemic heart disease, myocardial infarction, COVID-19, pandemic, Chile



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Short-term and Intermediate-term Fine Particulate Air Pollution are Synergistically Associated with Habitual Sleep Variability in Adolescents

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BACKGROUND AND AIM: While both fine particulate (PM_{2.5}) exposure and high sleep variability are potential risk factors for cardiovascular diseases (CVD), the association between PM_{2.5} and sleep variability remains unclear. Our study aimed at investigating the association between PM_{2.5} exposure and habitual sleep variability (HSV) in a population-based sample of U.S. adolescents.

METHODS: Data obtained from 421 adolescents, who participated in the Penn State Child Cohort follow-up examination, were analyzed. For each participant, we collected 24-hour (i.e. short-term) individual-level PM_{2.5} exposure by using a personal nephelometer. We further estimated their residential-level PM_{2.5}, during the 60-day period prior to the examination (i.e. intermediate-term), by utilizing a GIS-based kriging approach. Actigraphy was used to collect participants' total sleep time (TST) for 7 consecutive nights. HSV was calculated as the standard deviation (SD) of the 7-night TST. Multivariable-adjusted linear regression was used to assess the association between PM_{2.5} exposures and HSV. An interaction between the short- and intermediate-term PM_{2.5} was created to test their potential synergistic impact on HSV.

RESULTS: Both short-term and intermediate-term PM_{2.5} exposure were significantly (both $p < 0.01$) associated with HSV. There was a marginally significant ($p = 0.08$) synergistic interaction between short-term and intermediate-term PM_{2.5}. Specifically, the association between intermediate-term PM_{2.5} and HSV became stronger as short-term PM_{2.5} increased, and vice versa. For example, the regression coefficients (SE) between 1 SD (2.2 $\mu\text{g}/\text{m}^3$) increase in intermediate-term PM_{2.5} and HSV were 3.5 (2.7, $p = 0.21$), 5.1 (2.3, $p = 0.03$), and 10.5 (3.4, $p < 0.01$) minutes, when short-term PM_{2.5} were at its 10th percentile (1.7 $\mu\text{g}/\text{m}^3$), median (9.7 $\mu\text{g}/\text{m}^3$), and 90th percentile (35.3 $\mu\text{g}/\text{m}^3$), respectively.

CONCLUSIONS: Both short-term and intermediate-term PM_{2.5} exposure were associated with higher sleep variability among adolescents. More importantly, short-term and intermediate-term PM_{2.5} exposure may impact sleep variability in a synergistic manner, which highlighted the importance of PM_{2.5} reduction in the early prevention of CVD.

Keywords: Particulate Matter, Sleep Variability, Adolescents



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Sex-Specific Influence of Gestational PM_{2.5} Exposure on Placental Metabolic Gene Expression within the Rhode Island Child Health Study (RICHS)

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BACKGROUND AND AIM: Gestational exposure to ambient PM_{2.5} contributes to adverse metabolic health outcomes. Given the importance of the placenta in determining fetal growth and its potential to influence metabolic health outcomes in later life, we explored the influence of estimated ambient PM_{2.5} on placental metabolism in an infant sex-specific manner within the Rhode Island Child Health Study (RICHS).

METHODS: Using Gene Ontology annotations, we identified 657 genes related to lipid and/or glucose metabolism. We first used existing RNA-Seq data on gene expression from the placentas of 148 term births to identify those genes whose expression was associated with PM_{2.5}. We then validated the findings from this first stage using RT-PCR in placental samples from an additional 267 term births. Associations between pregnancy average PM_{2.5} levels and gene expression were quantified using linear regressions, overall and stratified by infant sex.

RESULTS: PM_{2.5} was associated with expression of 32 genes (FDR <0.1) related to lipid or glucose metabolism, 24 of which exhibited sex-specific associations. We selected 5 genes (*ABHD3*, *ATP11A*, *PSCA*, *CLTCL1* and *ST6GALNAC4*) for validation via RT-PCR in a separate sample. PM_{2.5} was associated with expression of four of these genes (*ABHD3*, *ATP11A*, *PSCA* and *ST6GALNAC4*). In sex-stratified analyses, we found that PM_{2.5} was associated with *ABHD3*, *ATP11A* and *PSCA* in male infants only, while *ST6GALNAC4* showed no sex dependency.

CONCLUSIONS: Placental metabolic gene expression was associated with PM_{2.5} levels during pregnancy, were over-represented for genes involved in lipid metabolism and demonstrated stronger associations in male infants. [NIH-NIEHS Funding: P30ES023515, P30ES109776; R24ES028507, 2T32ES007324-16].

Keywords: PM_{2.5}, placenta, metabolism, sex, pregnancy



ABSTRACT E-BOOK

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Other » Other (to be specified with keywords in the keywords section)

Influences of Windblown Particulate Matter on Children's Respiratory Health Residing Near the Salton Sea, California

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BACKGROUND AND AIM: The production of wind-blown dust and dust storms is expected to accelerate as climate change drives land use changes and diminishes water resources. For instance, in the rural U.S./Mexico border region of the Imperial Valley, sources of wind-blown particulate matter (PM) are growing due to anthropogenic activities and the shrinking of the Salton Sea, a land-locked saline "sea" situated in the Southern California region. Residents of this environmental justice community have expressed growing concern about these environmental changes, including the health implications of worsening air quality.

METHODS: To assess the impacts of PM on children's respiratory health in a structurally marginalized community, we administered a survey to parents of elementary school children (n=456). We estimated children's exposure to PM_{2.5} and PM₁₀ using air monitoring data from governmental regional monitors based on residence at time of survey.

RESULTS: 22% of children reported wheeze in the past 12 months. Individual annual exposure estimates for children were on average 7.55µg/m³ (SD: 1.9) and 42.44µg/m³ (SD: 6.75) for PM_{2.5} and PM₁₀, respectively. In models adjusted for age, sex, parental education, and survey language, a 1SD increase in PM₁₀ was associated with an increased risk of wheezing in the last 12 months (OR: 1.35, 95% CI: 0.9-1.8, P=0.06). Among asthmatics, a 1SD increase in PM_{2.5} or PM₁₀ was associated with an increased risk of wheezing (PM_{2.5} OR: 2.2, 95% CI: 1.4-3.4, P=0.0006; PM₁₀ OR: 1.9, 95% CI: 0.9-4.0, P=0.07), and any asthma medication usage (PM_{2.5} OR: 1.9, 95% CI: 1.2-2.9, P=0.005; PM₁₀ OR: 2.4, 95% CI: 1.1-4.9, P=0.01).

CONCLUSIONS: These results suggest that PM_{2.5} and PM₁₀ air pollution may influence children's risk of wheezing in this rural border region. Future work aims to identify additional environmental and modifiable risk factors to facilitate implementation of targeted intervention programs to improve health.

Keywords: Environmental Justice, rural health, border health, respiratory health



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Air pollution » Particulate matter

Associations of Pre- and Postnatal Air Pollution Exposures with Child Cognitive Performance and Behavior: A Multi-cohort Study

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BACKGROUND AND AIM: Research supports the adverse effect of air pollution exposures on child cognitive performance and behavior, but few studies have utilized spatiotemporally resolved pollution predictions.

METHODS: We investigated these associations in 1,894 mother-child dyads from three U.S. pregnancy cohorts (CANDLE, TIDES, GAPPs) in the ECHO-PATHWAYS Consortium. Child cognition was assessed using cohort-specific intelligence scales and quantified as the Full-Scale Intelligence Quotient (IQ). Child behavior was reported using the Child Behavior Checklist and quantified as the total problems raw score. Pre- and postnatal nitrogen dioxide (NO₂) and particulate matter $\leq 2.5\mu\text{m}$ in aerodynamic diameter (PM_{2.5}) were derived from an advanced spatiotemporal model. We fit multivariate linear regressions, adjusted for sociodemographic, behavioral, and psychological factors, to measure associations per 2-unit increase in pollutant in each window, and examined modification by child sex using interaction models.

RESULTS: Mean PM_{2.5} and NO₂ ranged from 8.4-9.1 $\mu\text{g}/\text{m}^3$ and 8.4-9.0 ppb, respectively, across pre- and postnatal windows. Average child IQ and total problems raw score at 4-6 years were 102.7 (SD:15.3) and 22.6 (SD:18.3). Children with a higher 3rd trimester NO₂ exposure had a lower IQ ($\beta=-0.44$, 95%CI: -0.81, -0.07). Each 2-ppb increase of NO₂ in the 2nd trimester and averaged over pregnancy was associated with a 0.68 (95%CI: 0.09, 1.27) and a 0.85 (95%CI: 0.09, 1.61) higher total problems raw score, respectively. Prenatal PM_{2.5} was only associated with a higher total problems score ($\beta=1.94$, 95%CI: 0.11, 3.76), while PM_{2.5} at 2-4 years was associated with both outcomes (IQ:



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$\beta=-2.30$, 95%CI: -4.53, 0.08; Total problems: $\beta=3.00$, 95%CI: 0.21, 5.78). Other associations were null. No modification by child sex was suggested.

CONCLUSIONS: The findings build on the current literature on air pollution and child neurodevelopment by using more refined exposure assessments across several pre- and postnatal windows in settings with modest air pollution levels.

Keywords: nitrogen dioxide, particulate matter, cognitive function, child behavior



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Air pollution » Particulate matter

Environmental health, racial/ethnic health-disparity, and climate impacts of freight transport in the United States

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BACKGROUND AND AIM: Atmospheric emissions from freight transportation contribute to human health and climate damage. In this research, we quantify and compare three environmental impact types from inter-regional (inter-state) freight transportation in the contiguous United States (U.S.): mortality from fine particulate matter (PM_{2.5}), racial-ethnic disparities in mortality, and climate impacts (CO₂ emissions).

METHODS: We compare all major modes (truck, rail, barge, aircraft), all major routes (~30,000 routes; ~90% of 2017 annual freight tonne-km). Our analyses use freight movement and geospatial data from the U.S. Department of Transportation, modal routing to identify shortest routes from origin to destination, and air quality and health impact modeling using a high spatial resolution air quality model, the Intervention Model for Air Pollution (InMAP).

RESULTS: Impacts (health, health-disparity, climate) per tonne are largest for aircraft. Among non-aircraft modes, per tonne, rail has the largest health and health-disparity impacts, and the lowest climate impacts; truck has the lowest health impacts and greatest climate impacts – an important reminder that health and climate impacts are not always aligned. These results represent 84%, 99%, 97%, and 98% of total annual truck, rail, barge, and air tonne-km, respectively. For aircraft, average monetized damages per tonne are larger for climate impacts than for PM_{2.5} air pollution impacts; for the other modes, the reverse holds. We find that average exposures from inter-state truck and rail are the highest for white non-Hispanics, from barge is highest for blacks, and from aircraft is highest for mixed/other race groups. Level of exposure and disparity among racial-ethnic groups vary in urban and rural areas.

CONCLUSIONS: Our study is the first to compare each route separately, and the first to explore racial-ethnic exposure disparities by route and mode. This research can be used to inform, for many origins and destinations, which freight mode offers the lowest environmental health, health-disparity, and climate impacts.

Keywords: Air Pollution, Particulate Matter, Exposure assessment, Climate, Environmental justice



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Air pollution » Particulate matter

Impact of Spatiotemporal Factors on Exposure to PM_{2.5} as Residents move between Residential, Commercial and Recreational areas

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BACKGROUND AND AIM: Reduction of annual average PM_{2.5} concentrations by 2.5µg/m³ is associated with a 3.5% reduction in all-cause mortality. However, population exposure is typically assessed assuming that a person spends their full day at their residential address but numerous studies have demonstrated that PM_{2.5} can have small-scale spatial variations. Consequentially, the impact of spatial movement in a person's day is often not represented in epidemiology studies.

METHODS: A network of 50 low-cost sensors were deployed in Allegheny county (PA) and used for prediction modelling of PM_{2.5} using spatial and temporal variables. The county was gridded and categorized into 4 land cover areas (residential, commercial, recreational and other) at 50m resolution. Daily concentrations were predicted at each grid location for 2017 using land-use random forest (LURF) models. Weight-based probability was assigned to each residential area, with medium- and high-density areas two and three times as probable as low-density areas, respectively. Using probability-based sampling with 100,000 iterations, the predicted concentrations were computed for various population groups (children, working adults, non-working adults and seniors) to account for variations in movement patterns, with different behavior patterns assigned for weekdays and weekends. Weekday and weekend combinations were then proportionately summed to compare estimated annual exposure of the residents using static (residential) vs movement-based models.

RESULTS: Daily concentrations were predicted to be higher in all non-residential areas when compared to residential areas (*baseline scenario*). The average exposure to PM_{2.5} for all population groups were higher than the baseline scenario, with exposure of a working adults being the highest (~0.2µg/m³ higher than baseline).

CONCLUSIONS: Findings of this study can be used to get a more accurate representation of exposure. Additionally, combined with epidemiology studies on impact of PM_{2.5} concentrations, it can help us determine the reduction in exposure and mortality rate due to behavioural changes.

Keywords: PM_{2.5}, population exposure, air pollution, low cost sensors



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Plasma biochemical signals associated with exposure to PM_{2.5} in an ethnically diverse aging population with and without dementia

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BACKGROUND AND AIM: Advances in public health have increased the average human lifespan across the globe. As a result, we are observing a greater burden of age-related disorders. The elderly population is particularly vulnerable to the adverse effects of air pollution. Using data from participants of the Washington Heights and Inwood Community Aging Project (WHICAP) in New York City, we assessed the relationship between plasma biochemical signals and exposure to particulate matter less than 2.5 μm in diameter (PM_{2.5}).

METHODS: As a pilot study, for 107 participants, we generated plasma metabolomic profiles using an untargeted liquid chromatography coupled high-resolution mass spectrometry platform, operated in two modes, using a HILIC column under positive ESI (HILICpos) and a C18 column under negative ESI (C18neg). The annual average level of PM_{2.5} exposure was predicted based on residential address at the time of enrollment. We modeled the relationship between each plasma biochemical feature, that was present in at least 70% of the samples, and PM_{2.5} exposure in the year prior to plasma collection using a metabolome wide association framework. The model was adjusted to account for confounding by age, sex, race/ethnicity, the year of plasma collection, and whether or not they were diagnosed with dementia.

RESULTS: From the HILICpos mode, 60 metabolic features were significantly associated (FDR < 0.05) with PM_{2.5}, including metabolites of cystine. Seventeen features from the C18neg mode, including metabolites of glutamic acid, were significantly associated with PM_{2.5}. Pathway analysis performed using features associated with PM_{2.5} from both modes revealed changes in metabolism of amino acids, energy production, and oxidative stress response.

CONCLUSIONS: Using an untargeted metabolomics approach, we found several plasma biochemical signals associated with annual PM_{2.5} levels in an ethnically diverse aging cohort. These signals could help understand the mechanisms through which PM_{2.5} exposure can lead to altered metabolic outcomes.



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Keywords: Air pollution, Particulate matter, Metabolomics, Aging

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Air pollution » Particulate matter

Chronic Exposure to Fine Particles (PM_{2.5}) and Mortality: Evidence from Chile

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BACKGROUND AND AIM: Cities in the center-south of Chile have a high atmospheric pollution derived from sources coming from industries, mobile and residential wood burning. Several studies, outside of Chile, have linked PM_{2.5} air pollution exposure to higher mortality risk due to cardiovascular, pulmonary and lung cancer diseases. On recent years Chile has develop an extensive network of air pollution monitoring, along with multiple public access databases for characteristics of the population, such as death certificates and socioeconomic conditions, which allows this relationship to be studied.

METHODS: An ecological cross-sectional study with national data at commune level from Chile to address the impact of long term PM_{2.5} exposures on age-adjusted mortality rates, controlling by multiple explanatory variables. We study different endpoints associated with all causes, cardiopulmonary, cardiovascular, pulmonary, cancer and lung cancer.

RESULTS: We found statistical evidence of a higher age-adjusted mortality risk associated with chronic exposure to PM_{2.5} air pollution (per 10 µg/m³ increase) cardiopulmonary (6%) and respiratory (11%) causes. For all causes, cardiovascular, cancer and lung cancer a positive effect was found, but without statistical significance. The positive associations remain even by controlling with multiple cofounding factors and by considering multiple cases.

CONCLUSIONS: PM_{2.5} air pollution exposure, among other demographic and socioeconomic factors, have a major influence on the mortality risk in Chile for cardiovascular and pulmonary diseases. Further air pollution reduction measures should be directed at the center-south of Chile, where PM_{2.5} air pollution is highest. Future research is needed to better understand the mortality and morbidity effects in Chile related to air pollution conditions.

Keywords: PM_{2.5} air pollution, LAC, Cardiopulmonary disease, Age-adjusted mortality rates, Ecological study



ABSTRACT E-BOOK

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Chemical exposures » Other (to be specified with keywords in the keywords section)

Associations of neonicotinoids with insulin and glucose homeostasis parameters in US adults: NHANES 2015-2016

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BACKGROUND AND AIM: Neonicotinoids are replacement insecticides increasingly used for organophosphates, methylcarbamates, and pyrethroids. Experimental evidence suggests neonicotinoid may affect glucose metabolism and insulin secretion as a result of pancreatic β cell dysfunction, oxidative stress, and inflammation. However, no epidemiologic study has investigated neonicotinoids as potential diabetogens. We examined associations between neonicotinoids with insulin and glucose homeostasis parameters among 1381 non-diabetic, US adults in the National Health and Nutrition Examination Survey (2015-2016).

METHODS: Urinary concentrations of acetamiprid, clothianidin, imidacloprid, N-desmethyl-acetamiprid, and 5-hydroxy-imidacloprid were quantified. Fasting plasma glucose, insulin, and hemoglobin A1c (HbA1c) were assessed. Insulin resistance was defined as a homeostatic model assessment of insulin resistance (HOMA-IR) ≥ 2.5 . We used weighted linear and logistic regression models to estimate associations between detectable neonicotinoids with insulin and glucose homeostasis parameters.

RESULTS: Weighted detection frequencies for imidacloprid, 5-hydroxy-imidacloprid, and N-desmethyl-acetamiprid were 4.4%, 21.5%, and 32.8%, respectively. Detectable imidacloprid ($\beta = -4.7$ $\mu\text{IU/mL}$, 95% CI -8.5, -0.8) and 5-hydroxy-imidacloprid ($\beta = -2.4$ $\mu\text{IU/mL}$, 95% CI -4.6, -0.2) were associated with lower fasting plasma insulin levels. Individuals with detectable 5-hydroxy-imidacloprid had lower odds of insulin resistance (OR=0.3, 95% CI 0.2, 0.7). We observed evidence of sexually dimorphic associations between N-desmethyl-acetamiprid with glucose (pint=0.079) and 5-hydroxy-imidacloprid with HbA1c (pint=0.038), with patterns suggesting positive associations in males and negative associations in females. Associations between 5-hydroxy-imidacloprid and insulin were modified by BMI (pint=0.013), with significant inverse associations among those overweight/obese and null associations for those under/normal weight. We additionally observed age modified associations between 5-hydroxy-imidacloprid and glucose (pint=0.048). Detectability of 5-hydroxy-imidacloprid among individuals aged 20-45 years were associated with higher glucose levels, while lower levels were noted among those 46+ years.

CONCLUSIONS: Results suggest neonicotinoids may be associated with insulin and glucose homeostasis indices and call for prospective studies to examine the metabolic impact of these replacement insecticides in humans.

Keywords: Neonicotinoids, glucose, insulin, HbA1c, HOMA-IR, insulin resistance



ABSTRACT E-BOOK

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Respiratory and Allergic Outcomes » Asthma

Proximity to petrochemical industry and risk of childhood asthma occurrence

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BACKGROUND AND AIM: Petrochemical industrial complexes would emission s several pollutants that were associated with adverse effect in respiratory system. Aim of present study is using different surrogate indices of petrochemical exposure to evaluate the effect on childhood asthma.

METHODS: We conducted a singleton birth cohort by using the 2000-2014 Taiwan Birth Certificate Database (TBCD), linked with Nation Health Insurance Research Database (NHIRD) for follow-up. The distance to the nearest petrochemical industrial parks (PIPs) and benzene exposure level were uses as surrogating petrochemical exposure indices. Exposure windows were divided into prenatal and postnatal periods. The Cox proportional hazard models were applied to evaluate the effects.

RESULTS: In total, 227601 asthma cases were newly diagnosed until to 2016/12/31. Younger maternal age and greater proportions of male, preterm birth, low birth weight, delivery by Caesarean section, maternal gestational hypertension were observed for asthma children than non-asthma children. The results showed that compared with those living in the farthest, living close to PIPs (HR = 1.67, 95% CI: 1.65–1.70, for <10 km vs. ≥ 40 km) were observed to have an increased risk of asthma occurrence. Higher benzene exposure levels during prenatal or postnatal period having higher risks of asthma were also found.

CONCLUSIONS: In present study, we found living near PIPs and exposure to higher level of benzene during prenatal or postnatal period would increase the risk of childhood asthma occurrence.

Keywords: Children's environmental health, Asthma, Chemical exposures



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-500

Chemical exposures » Heavy metals

Relationship between blood cadmium and iron status among Korean population

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BACKGROUND AND AIM: In recent studies for the association between blood Cd and iron deficiency (ID), it was found that ID elevates blood cadmium levels in children, adolescents or adults. But, the previous studies almost only used either serum ferritin or Hemoglobin (Hb) for evaluating ID or iron deficiency anemia (IDA). Blood Cd level according to actual iron status have not been studied. The objective of this study was to investigate the association between Cd and Iron status(normal, negative iron balance, iron deficiency erythropoiesis, IDA) and the risk for high cadmium level depending each iron status using a large-scale nationwide representative sample of the Korean.

METHODS: A nationwide cross-sectional study was conducted to examine the relationship between iron status and blood Cd level in 3,366 men and 3,443 women over 10 years of age, using data from the 2010–2012 Korean National Health and Nutrition Examination Survey (KNHANES). We used analysis of variance (ANOVA) or chi-square test to estimate differences in the demographic and biochemical characteristics of participants. Multiple logistic regression models were also used to examine the associations between iron status and high blood Cd level (>75th percentile of Cd level in the current sample; 1.37µg/L)

RESULTS: Mean values of blood Cd gradually increased in accordance with poor iron status (P-trend<0.001). We found that increased risk for high Cd level was associated with poor iron status after adjusting for age, sex, BMI, education, income, cigarette smoking and alcohol consumption. In a sex and menopause stratified analysis, a significant association was stronger only in premenopause women, not in men, menopause women

CONCLUSIONS: We found a relationship between poor iron status and blood Cd in a representative population sample of Korean adult. Our results suggested considering the reproductive toxicity of Cd, management for blood Cd level would be necessary in women of childbearing age with poor iron status

Keywords: Heavy metals, Environmental epidemiology



ABSTRACT E-BOOK

P-501

Chemical exposures » Mixtures

Mixture effects of prenatal exposure to per- and polyfluoroalkyl substances and polybrominated diphenyl ethers on maternal and newborn telomere length

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BACKGROUND AND AIM: Per- and polyfluoroalkyl substances (PFAS) and polybrominated diphenyl ethers (PBDEs) are endocrine disrupting chemicals associated with reproductive toxicity and adverse health outcomes, including certain cancers. PFAS and PBDEs may affect health through alternations in telomere length. We examined joint associations between prenatal exposure to PFAS, PBDEs, and maternal and newborn telomere length using mixture analyses, to characterize effects of cumulative environmental chemical exposures.

METHODS: Study participants were enrolled in the Chemicals in Our Bodies study, a demographically diverse cohort of pregnant women and children in San Francisco, CA. Seven PFAS (ng/mL) and four PBDEs (ng/g lipid) were measured in second trimester maternal serum. Telomere length (T/S ratio) was measured in delivery cord blood of 292 newborns and 110 second trimester maternal whole blood samples. Quantile g-computation was used to assess the joint associations between groups of PFAS and PBDEs and newborn and maternal telomere length. Groups considered were: (1) all PFAS and PBDEs combined, (2) PFAS, and (3) PBDEs. Maternal and newborn telomere length were modeled as separate outcomes.

RESULTS: T/S ratios in newborn cord and maternal whole blood were moderately correlated (Spearman $\rho = 0.31$). In mixtures analyses, a simultaneous one quartile increase in all PFAS and PBDEs was associated with a small increase in newborn (mean change per quartile increase = 0.03, 95% confidence interval [CI] = -0.03, 0.08) and maternal telomere length (mean change per quartile increase = 0.03 (95% CI = -0.03, 0.09)). When restricted to maternal-fetal paired samples (N=76), increasing all PFAS and PBDEs combined was associated with a strong, positive increase in newborn telomere length (mean change per quartile increase = 0.16, 95% CI = 0.03, 0.28). These associations were primarily driven by PFAS (mean change per quartile increase = 0.11 [95% CI = 0.01, 0.22]).

CONCLUSIONS: Our findings show that PFAS and PBDEs may be positively associated with newborn telomere length.

Keywords: Per- and poly-fluoroalkyl substances, Polybrominated diphenyl ethers, telomere, exposure mixture



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-502

Chemical exposures » Heavy metals

Influence of Serum Ferritin Combined with Blood Cadmium on Blood Pressure, and Hypertension: from the KNHNES

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BACKGROUND AND AIM: Previous studies have suggested that cadmium (Cd) exposure and serum ferritin levels may influence the development of hypertension. We evaluated whether the association between blood Cd levels and the development of hypertension could be modified by serum ferritin levels in a representative sample of the adult population of South Korea.

METHODS: We used data from the Korean National Health and Nutrition Examination Survey (2008–2012), a nationally representative, cross-sectional, population-based study. We included 6,816 adults aged 19 years and older who had records of blood Cd and ferritin levels and blood pressure measurements. Multiple logistic regression was used to examine the association between Cd exposure and the development of hypertension, as well as the modifying effects of serum ferritin.

RESULTS: Men had higher levels of serum ferritin, and women had higher levels of Cd. Smoking in men was significantly associated with high blood pressure and risk of hypertension. Significantly less women were smokers, and the combination of abnormal serum ferritin levels and high Cd levels was significantly associated with high systolic blood pressure (OR = 3.05; 95% CI = 1.45–6.39) in women who never smoked.

CONCLUSIONS: Our results provide further evidence that individuals with abnormal serum ferritin levels should limit their exposure to Cd to prevent hypertension.

Keywords: Heavy metals, Obesity and metabolic disorders



ABSTRACT E-BOOK

P-503

Chemical exposures » Heavy metals

Associations between arsenic, cadmium, and selenium exposure and oxidative stress in rural residents of northern Laos

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BACKGROUND AND AIM: Oxidative stress is an important consequence of exposure to arsenic and cadmium, but it is unclear to what extent low-level exposures contribute to oxidative stress. Additionally, previous studies suggested that selenium suppresses the toxicity of arsenic and cadmium. This study aimed to examine associations between arsenic and cadmium exposure and oxidative damage to DNA and lipid in rural residents of northern Laos, considering selenium interactions with the two toxic elements.

METHODS: We collected data on general characteristics (village, sex, age, smoking, drinking, height, and weight) and a single spot urine sample from the participants (n = 341). Urinary concentrations of arsenic, cadmium, and selenium were measured by inductively coupled plasma mass spectrometry to estimate their exposure/intake levels. Urinary 8-hydroxy-2'-deoxyguanosine (8-OHdG) and 8-isoprostane concentrations were measured by liquid chromatography-tandem mass spectrometry (oxidative stress biomarkers of DNA and lipid, respectively). Multiple linear regression analyses examined associations of urinary concentrations of arsenic and cadmium with those of oxidative stress markers, adjusted for covariates. We performed additional analyses to include interaction terms between urinary concentrations of arsenic/cadmium and selenium.

RESULTS: Geometric means of specific gravity-adjusted urinary concentrations of arsenic, cadmium, selenium, 8-OHdG, and 8-isoprostane were 40.0, 1.38, 11.7, 3.89, and 0.934 µg/L, respectively. Urinary concentration of arsenic and cadmium showed positive associations with that of 8-isoprostane. We also observed that there were significant interactions between arsenic and selenium in the association with 8-OHdG (Coefficient (95% CI) = -0.21 (-0.37, -0.05)) and between cadmium and selenium in the association with 8-isoprostane (Coefficient (95% CI) = -0.14 (-0.25, -0.03)).

CONCLUSIONS: Our findings suggested that arsenic and cadmium exposure were positively associated with oxidative stress in rural residents of northern Laos. Additionally, selenium might have protective effects on arsenic-/cadmium-induced oxidative stress.

Keywords: Heavy metals, Chemical exposures, Environmental epidemiology



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-504

Outcomes » Microbiome

Inorganic Arsenic Exposure and Gut Microbiota in a Birth Cohort from Central Taiwan

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BACKGROUND AND AIM: Increasing evidence supports the association between composition and abundance of gut bacteria and human diseases (such as obesity and type 2 diabetes). Certain environmental toxicants, such as inorganic arsenic (iAs), may alter the equilibrium and diversity of human gut microbiota. Reversely, gut microbiota might affect the toxicokinetics of toxicants such as absorption and distribution. As folate-mediated one-carbon metabolism is crucial in fetus and children's health and development, this study aimed to investigate the associations between iAs exposure, gut microbiota, and folate-related functional pathways in children.

METHODS: Eighty children previously recruited in central Taiwan (2012–2014) were followed in 2015–2017. The structured questionnaire was interviewed with urinary sample collected at baseline and follow-up for pregnant women and children, and feces specimens were collected in children aged 3–4 years. Urinary concentration of iAs species was quantified, and DNA was extracted from feces specimen. The composition and abundance of gut microbiota, and microbial functional profiles were sequenced by whole metagenome shotgun sequencing. We utilize the sum of urinary concentrations of arsenate, arsenite, monomethyl- and dimethyl arsenic acids (Σ iAs) as the index of total iAs exposure.

RESULTS: High level of total iAs exposure (upper tertile, Σ iAs \geq 21.06 μ g/L) had a significantly lower abundance of Parabacteroides distasonis but the higher abundance of Roseburia intestinalis and Eubacterium rectale as compared to mid and lower tertile. Total iAs exposure was significantly associated with a decreased abundance of Parabacteroides distasonis ($\beta = -0.021$) after adjustment for sex and environmental tobacco smoke. Importantly we also found a significantly decreased function of N10-formyl-tetrahydrofolate biosynthesis ($\beta = -0.040$) and folate transformations II ($\beta = -0.040$) in relation to total iAs exposure.

CONCLUSIONS: Exposure to iAs may alter the abundance of gut microbiota associated with human health, and it also had a negative association with folate-related functions.

Keywords: Heavy metals, Microbiome, Epidemiology



ABSTRACT E-BOOK

P-505

Chemical exposures » Pesticides

Prenatal exposure to DDT and cardiometabolic events among boys from Mexico

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BACKGROUND AND AIM: The role of *in utero* exposure to the pesticide DDT and its main breakdown product DDE, on the development of chronic disorders is not well established. Although experimental evidence suggests that DDT exposure result in adverse outcomes, such as cardiometabolic diseases, data from human studies remain inconclusive. We evaluated the association between prenatal exposure to DDT and cardiometabolic alterations in a cohort of boys from a highly exposed area of Mexico.

METHODS: We followed 253 boys from birth to ~13.5 years of age; DDT and DDE was determined in maternal serum samples drawn at delivery (2002-2003). The outcomes of interest were central obesity, elevated blood pressure (BP), and high percentage of glycated hemoglobin (HbA1c: $\geq 6.5\%$); all outcomes were measured at the last follow-up visit (2015-2017). The association between the exposures and outcomes was assessed individually with logistic regression models adjusted for maternal age at delivery, education, residence, parity, and smoking.

RESULTS: Overall, 19% of the boys had central obesity, 22% high BP and 26% high HbA1c. Compared to boys least exposed to DDE ($\leq 3.00\mu\text{g/g}$ lipids), those with the highest exposure ($>9.00\mu\text{g/g}$) had slightly higher odds of having central obesity (OR=1.20; 95%CI: 0.48, 3.00); no association with high HbA1c (OR=1.05; 95%CI: 0.45, 2.45) emerged. Compared to boys least exposed to DDT ($\leq 0.25\mu\text{g/g}$), those with the highest exposure ($\geq 2.00\mu\text{g/g}$) had slightly higher odds of having central obesity (OR=1.16; 95%CI: 0.39, 3.38) and high HbA1c (OR=1.31; 95%CI: 0.48, 3.59). High blood pressure was unrelated to DDE (OR=0.85; 95%CI: 0.34, 2.10) and DDT (OR=1.04; 95%CI: 0.34, 3.14).

CONCLUSIONS: Our data suggests that DDE might increase their risk of developing central obesity and DDT might impair glucose metabolism of teenage boys whom experienced high levels of exposure prenatally. Nonetheless, our data do not support an association between DDT exposure and high blood pressure.

Keywords: Chemical exposures, children's environmental health, male, pesticides.



ABSTRACT E-BOOK

P-506

Chemical exposures » Mixtures

Prenatal and postnatal exposures to heavy metal mixtures and IQ in 6-year-old children: a prospective cohort study in South Korea

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BACKGROUND AND AIM: Humans are exposed to a mixture of heavy metals during their lifetime; however, evidence of neurotoxicity of such mixtures against critical time windows is still insufficient. We aimed to elucidate the associations of heavy metal mixtures across multiple time points with children's intelligence quotient (IQ) in a prospective cohort study.

METHODS: Prenatal exposure and exposure at age 4 and 6 to four types of heavy metals were quantified in pregnant women and their children who participated in the Environment and Development Cohort study. Children's IQ scores were assessed using the Wechsler Intelligence Scale at age 6. Linear regression models, Bayesian kernel machine regression (BKMR), weighted quantile sum (WQS) regression models, and elastic net (ENET) models were used to assess the associations of each heavy metal and their mixtures with IQ scores.

RESULTS: Linear regression models indicated that postnatal blood lead level at the age of 6 years and manganese levels at the ages of 4 and 6 were significantly negatively associated with total IQ at 6 years of age. In the multi-chemical BKMR and WQS models, statistically significant inverse associations were found between the mixture of prenatal and postnatal heavy metal exposures and total IQ scores. Higher quantiles of metal mixtures were associated with lower children's IQ. Interestingly, we found that manganese level at the age of 6 years was the most contributing factor to children's IQ at 6 years of age in the mixture models of BKMR, WQS, and ENET.

CONCLUSIONS: Multi-pollutant mixtures of prenatal and postnatal exposures to heavy metals affected child IQ at 6 years of age. We found a strong relationship between postnatal lead exposure and children's IQ at the age of 6 years. Additional studies are warranted to confirm these associations and to control the exposure to different metals during pregnancy and preschool childhood.

Keywords: Bayesian kernel machine regression, elastic net, heavy metals, intelligence quotient, weighted quantile sum



ABSTRACT E-BOOK

P-507

Other » Other (to be specified with keywords in the keywords section)

Blood lead concentrations in traditional Mexican potters through four decades

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BACKGROUND AND AIM: Traditional pottery in Mexico is produced using lead-based glazes, resulting in high occupational and environmental exposure to lead. There are over 10,000 traditional potters and their families that continue to use this technology. We aimed to systematize and characterize traditional Mexican potters' historic lead exposure through their blood lead levels (BLL). **METHODS:** Using PRIMSA guidelines, we conducted a systematic review of published studies that included BLL in Mexican potters through January 2021. BLL data reported and main study population characteristics were extracted. Studies that included a non-potter comparison group were used to analyze BLL differences.

RESULTS: A total of 15 studies were published with BLL sampled between 1980 and 2013. Except for one study, non-potters (n= 838) lived in the same communities as potters (n= 998). Across the study period, the mean BLL in potters was twice as high as non-potters (41.8 ± 13.1 vs. 19.5 ± 12.4 $\mu\text{g/dL}$, $p < 0.001$). Among potters, adult men had higher BLL than women (40.6 ± 13.9 vs 23.3 ± 17.5 $\mu\text{g/dL}$), and adults had higher BLL than children and adolescents (38.3 ± 15.8 vs 32.8 ± 13.6 $\mu\text{g/dL}$). Among non-potters, children and adolescents had higher BLL than adults (23.4 ± 2.6 vs 18.5 ± 16.4 $\mu\text{g/dL}$). Average BLL for potters decreased from 55.6 ± 7.7 $\mu\text{g/dL}$ in 1980 to 19.3 ± 6.4 $\mu\text{g/dL}$ in 2013. Potters whose main activity was firing the kiln (50.7 ± 12.9 $\mu\text{g/dL}$), applying glaze (45.8 ± 4.4 $\mu\text{g/dL}$), and sieving (43.9 $\mu\text{g/dL}$) had the highest BLLs.

CONCLUSIONS: Traditional potters' BLLs and health effects have been scarcely studied throughout the years. The use of lead-based glazes persists with no surveillance of potters' BLL or health. There is an urgent need for a sound policy for the use of lead-free glazes in traditional Mexican pottery.

Keywords: Occupational lead exposure, Traditional Pottery, Surveillance, Lead



ABSTRACT E-BOOK

P-508

Chemical exposures » Pesticides

Time of day effect on biomarkers of exposure to pesticides during an isopesticide time-restricted diet: a pilot randomized trial

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BACKGROUND AND AIM: The role of the circadian liver clock in shaping the metabolism of dietary pesticides and their downstream biological effects remains poorly understood in real-life human settings. This trial aimed to investigate whether the consumption of fruits and vegetables within a specific time-restricted window of the day would affect the magnitude and variance of biomarkers of exposure to pesticides.

METHODS: CIRCA CHEM is a randomized 2x2 cross-over chronotoxicity pilot trial. All participants (n=45) were randomly allocated to two groups and asked to daily adhere to an isopesticide dietary pattern consuming four fruits portions and two vegetable portions at specific time-restricted windows. The first group was asked to adhere to a week-long morning time-restricted window (9am-12pm) and after a week's washout to cross over to the evening time-restricted period for another week (7pm-10pm) and vice-versa for the other group. Anthropometrics measurements were obtained and urinary biomarkers of exposure to neonicotinoids (6-chloronicotinic acid, 6-CN) and pyrethroids (3-phenoxybenzoic acid, 3-PBA) pesticides were measured using mass spectrometry. Linear mixed effect models will be used to model the time of day effects on the biomarkers of exposure to pesticides.

RESULTS: A total of 41 healthy adults with mean age of 36 years old were included in the analysis. Overall fruit and vegetable daily intake adherence to the pre-specified time-restricted periods by the participants was high (>80%) in both groups. No difference in anthropometric measurements (weight, BMI, waist circumference) was observed for both groups by the end of the study. The diurnal variation in the 3-PBA and 6-CN biomarkers will be presented, including the effect of time of the day of fruits/vegetables consumption on the magnitude of these biomarkers.

CONCLUSIONS: This pilot trial will shed light on possible chronotoxicity trends associated with fruits/vegetables-based exposures to pesticides.

Keywords: biomarkers of exposure, pesticides, food/nutrition, chemical exposures, exposure assessment, exposome



ABSTRACT E-BOOK

P-509

Exposures » Other (to be specified with keywords in the keywords section)

Water arsenic exposure and endothelial dysfunction in Bangladeshi adolescents

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BACKGROUND AND AIM: Cardiovascular disease (CVD) is the leading cause of morbidity and mortality worldwide, with ~80% of CVD-related deaths occurring in low- and middle-income countries. Growing evidence suggests that chronic arsenic (As) exposure may contribute to CVD through its effect on endothelial dysfunction in adults. However, few studies have examined the influence of As exposure on cardiovascular health in children and adolescents.

METHODS: To examine As's relation to preclinical markers of endothelial dysfunction, we enrolled 200 adolescent children (ages 15-19 years; median: 17) of adult participants in the Health Effects of Arsenic Longitudinal Study (HEALS), in Araihasar, Bangladesh. Participant's water As exposure was determined by recall of lifetime well usage. Wells are color coded to indicate As level (<10 µg/L, 10-50 µg/L, >50 µg/L As). Endothelial function was measured by recording fingertip arterial pulsatile volume change using Endo-PAT2000 (Itamar Medical) and reactive hyperemia index (RHI) score, an independent CVD risk factor, was calculated from these measurements.

RESULTS: In linear regression models adjusted for sex, age, education and weight at the time of RHI measurement, individuals who reported always using wells with ≥50 µg/L As had a lower level of RHI by 11.62% (95% CI: -20.94, -1.16, p=0.03), as compared to participants who drank exclusively from wells with <50 µg/L As. Sex-stratified analyses suggest that these associations were stronger in female participants. The use of wells with ≥50 µg/L As was associated with 14.87% lower RHI (95% CI: -25.59, -2.60, p=0.02) in females, as compared to 5.05% lower RHI (95% CI: -21.81, 15.29, p=0.60) in males for the same comparison.

CONCLUSIONS: Our results suggest that chronic As exposure may be related to endothelial dysfunction and vascular reactivity in adolescents, with potential differences by sex. Further work is needed to confirm these findings and examine whether these changes may increase risk of later adverse cardiovascular health effects.

Keywords: Arsenic, adolescents, cardiovascular health, endothelial function, Bangladesh



ABSTRACT E-BOOK

P-510

Chemical exposures » Pesticides

Towards epigenomic and metabolomic profiles of chronic organophosphate exposure in residents of California' Central Valley

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BACKGROUND AND AIM: Organophosphates (OP) are widely used in the agricultural Central Valley region of California. This study aimed to elucidate metabolomic and epigenetic changes induced by chronic ambient OP exposure, as well as possible interactions between different molecular layers.

METHODS: We conducted high-resolution metabolomic profiling (liquid chromatography with high-resolution mass spectrometry) and genome-wide DNA methylation profiling (Illumina 450 k) of blood samples from 176 older adults living in the California Central Valley. Cumulative OP exposure from ambient sources at homes and workplaces over a ten-year period was estimated using a geographic information system (GIS)-based model. Biweighted midcorrelation (bicor) and partial least squares regression were used to identify metabolomic features and CpGs associated with OPs. Potential confounders, including age, sex, race/ethnicity, education, and cell compositions, were adjusted a priori. Functional annotation and pathway enrichment analyses were conducted for biological interpretation. We also integrated the methylome and metabolome by investigating the correlation structures existing between OP-related CpGs and metabolites and all other features via bicor.

RESULTS: The single-omic analyses showed both epigenomic and metabolomic signatures of OP as being enriched in the glycosphingolipid (GSL) biosynthesis pathway. Besides this common pathway, the metabolome and epigenome also exhibited distinct responses to OPs, with differently methylated CpGs being involved in intracellular membrane transport, cell adhesion, and carcinogenesis; and OP-related metabolites being involved in aromatic amino acids metabolism, neurotransmitter precursors, oxidative stress, and mitochondria function. Moreover, we illustrate possible interactions between these two molecular layers through metabolic processes and nutrient-sensing pathways when integrating the epigenomic and metabolomic signals.

CONCLUSIONS: In summary, we linked GIS-modeled chronic low-level OP pesticide data with blood metabolomic and epigenomic data in an older adult population. Our findings suggest that it seems feasible to use multi-omics integration in studies of chronic environmental exposures in humans to better understand the pathophysiology involved in pesticide-related chronic health outcomes.



ABSTRACT E-BOOK

Keywords: Organophosphates, multi-omics, metabolomics, epigenomics, glycosphingolipid

P-511

Chemical exposures » Heavy metals

Use of Lead-glazed Ceramics and Bone Health in Adult Women

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BACKGROUND AND AIM: One of the main sources of lead (Pb) exposure in Mexico is the use of lead-glazed ceramics (PbC). Exposure to Pb is associated with a decrease in bone mineral density (BMD) and bone mass in adults. Our aim was to evaluate the association between use of PbC and bone health in adult women.

METHODS: Our cross-sectional study comprised 101 women from the Early Life Exposure in Mexico to Environmental Toxicants (ELEMENT) cohort. Women reported the use of PbC (yes/no) in the past 3 months. BMD was measured by dual-energy X-ray absorptiometry and bone matrix by ultrasound (speed of sound; SOS). We used z-scores from BMD and SOS to create quantity (normal bone: both z-scores between -1 and 1; less abundant (LA): both <-1; and more abundant (MA): both >1) and quality (normal bone: absolute difference between z-scores ≤.5 standard deviations (SD); rigid bone (RB): BMD >.5 SD of SOS; softer bone (SB): SOS z-score >.5 SD of BMD) indexes for cortical and trabecular bone. Multinomial logistic regressions (normal bone as reference outcome category) were performed to estimate the association between use of PbC and the quantity and quality of cortical and trabecular bone, adjusting for age, menopause, socioeconomic status, physical activity, body mass index and gynoid adiposity.

RESULTS: Use of PbC was associated with lower odds of MA cortical bone (OR: 0.28, p=0.05) and marginally significant odds of cortical SB (OR: 0.31 p=0.1). Null associations were found for the rest of the bone indexes, however the direction of the estimates were opposite with trabecular bone being >1 whereas cortical bone estimates were <1.

CONCLUSIONS: Findings from this pilot study suggest that use of PbC, as a proxy of lead exposure, may influence bone health in midlife and should be examined using a lead biomarker and in a larger sample.

Keywords: lead-glazed ceramics, bone health, women



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-512

Chemical exposures » Heavy metals

Association of plasma manganese and MnSOD rs4880 polymorphism with nonalcoholic fatty liver disease

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BACKGROUND AND AIM: Manganese is both an essential micronutrient and a known toxicant, and plays crucial roles in normal metabolism. However, few researchers have focused on the association between manganese and nonalcoholic fatty liver disease (NAFLD), and it is unclear whether this association differs according to manganese superoxide dismutase (MnSOD) genetic variations. We aimed to explore the association between plasma manganese and NAFLD as well as whether the association could be modified by MnSOD polymorphisms.

METHODS: We performed a 1:1 matched case-control study in 1838 Chinese Han subjects, who were determined according to the NAFLD diagnosis and treatment guidelines of the Chinese Medical Association. Plasma manganese levels were detected by inductively coupled plasma mass spectrometry, and MassArray system was applied for MnSOD rs4880 polymorphism genotyping.

RESULTS: The medians of plasma manganese concentrations were 3.80 and 3.38 $\mu\text{g/L}$ for controls and NAFLD, respectively. After multivariable adjustment, the correlation between plasma manganese levels and NAFLD still existed and showed a negatively correlated dose-effect relationship. The ORs (95% CIs) of NAFLD across quartiles of plasma manganese were 1.00 (reference), 0.78 (0.58–1.07), 0.58 (0.41–0.81), 0.55 (0.39–0.77) (P-trend <0.001). For each SD increment in plasma manganese, the risk of NAFLD decreased by 20% (adjusted OR = 0.80, 95% CI: 0.71–0.91). In the restricted cubic spline analysis, we observed the odds of NAFLD were decreased with the increment of manganese concentration and reached a plateau at around 4.50 $\mu\text{g/L}$. Compared with the rs4880 TT genotype, the associations between CT, CC, CT + CC genotypes and NAFLD were not significant, and we did not observe interaction effects of plasma manganese and MnSOD rs4880 polymorphisms on NAFLD.

CONCLUSIONS: Our results suggested a significantly negative association between plasma manganese levels and NAFLD, and the association was not modified by the MnSOD rs4880 polymorphism.

Keywords: Heavy metals, Epidemiology, Obesity and metabolic disorders



ABSTRACT E-BOOK

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Outcomes » Obesity and metabolic disorders

Associations of Prenatal First-Trimester Metal Mixtures with Adiposity during Childhood in the Project Viva Cohort

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BACKGROUND AND AIM: Prenatal metal exposure influences child health. We evaluated associations between prenatal metals and childhood adiposity.

METHODS: Six nonessential (As, Ba, Cd, Cs, Hg, Pb) and four essential metals (Mg, Mn, Se, Zn) were measured in first trimester red blood cells from Project Viva participants. Sum of skinfold thicknesses (SST) (mm) (N=859), waist circumference (cm) (N=882), and body mass index (BMI) z-score (N=875) were measured at early childhood. In mid-childhood and late teen, SST (N=747-715), WC (N=748-717), BMI (N = 745-716), and dual-energy x-ray absorptiometry total- and trunk-fat-mass-index (kg/m²) (N=599-511) were measured. Linear regression and quantile g-computation models estimated associations between individual and mixtures of metals and adiposity, adjusting for confounders.

RESULTS: Higher levels of prenatal cadmium were associated with increased SST at early childhood ($\beta=0.30$, 95% CI: 0.02, 0.58), and higher total ($\beta=0.25$, CI: 0.02, 0.48) and trunk fat ($\beta=0.12$, CI: 0.01, 0.23) at early teen. Cesium was associated with higher BMI at mid-childhood ($\beta=0.18$, CI: 0.02, 0.35) and trunk fat at early teen ($\beta=0.24$, CI: 0.003, 0.48). In mixture analyses, with concurrent adjustment for nonessential and essential metals, higher levels of prenatal nonessential metals were associated with higher total ($\beta=0.07$ per quartile, 95% CI: 0.01, 0.12), trunk fat ($\beta=0.12$, CI: 0.02, 0.22), WC ($\beta=0.01$, CI: 0.002, 0.01), and BMI ($\beta=0.24$, CI: 0.08, 0.41) at mid-childhood and higher total fat ($\beta=0.06$, CI: 0.002, 0.11) and BMI ($\beta=0.19$, CI: 0.02, 0.37) at early teen, while higher prenatal essential metals were associated with lower total ($\beta=-0.07$, CI: -0.12, -0.02), trunk fat ($\beta=-0.13$, CI: -0.21, -0.05), SST ($\beta=-0.08$, CI: -0.14, -0.01), WC ($\beta=-0.03$, CI: -0.05, -0.003), and BMI ($\beta=-0.16$, CI: -0.28, -0.04) at early teen.

CONCLUSIONS: Prenatal nonessential metals were associated with increased adiposity, while essential metals were associated with decreased adiposity during childhood.

Keywords: Heavy metals, Obesity and metabolic disorders, Mixtures analysis, Children's environmental health



ABSTRACT E-BOOK

P-514

Chemical exposures » Other (to be specified with keywords in the keywords section)

Association Between PAHs and Chronic Kidney Disease in the US Adult Population

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BACKGROUND AND AIM: Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals produced from the incomplete combustion of carbon-containing products. Exposure to PAHs is linked to respiratory disease, heart disease, liver disease, and cancer. Chronic kidney disease (CKD) is irreversible, progressive, and linked with higher cardiovascular risk. Very few studies have investigated the association between exposure to PAHs and CKD in humans. The rationale of this study was to assess seven types of urinary PAHs (1-hydroxynaphthalene, 2-hydroxynaphthalene, 3-hydroxyfluorene, 2-hydroxyfluorene, 1-hydroxyphenanthrene, 1-hydroxypyrene, and 2 & 3-hydroxyphenanthrene) concentrations and the correlation with CKD in adult US population.

METHODS: A cross-sectional analyses using the 2015-2016 National Health and Nutrition Examination Survey (NHANES) dataset was conducted. A specialized complex survey design analysis package was used in analyzing the NHANES data. Chronic kidney disease was defined as estimated glomerular filtration rate (eGFR) < 60 ml/min/1.73m² or albumin to creatinine ratio (ACR) > 30 mg/gm. Prior to analysis, the urinary PAH concentrations were normalized by the urinary creatinine concentration to account for dilution effects. Multivariate Logistic Regression Analysis of Complex Survey models were used to study the correlation between urinary PAH concentrations (seven types) and kidney disease associated with abnormal eGFR or ACR. Models were adjusted for demographic and lifestyle factors.

RESULTS: The total study population analyzed included 4,117 adults aged 20 years and older, of whom 49.6% were males and 50.4% females. The analysis showed urinary 2-Hydroxynaphthalene [Odds Ratio (OR): 1.60, 95% Confidence Interval (CI): 1.41, 2.24] was significantly associated with increased odds of chronic kidney diseases. The other six types of urinary PAHs were not associated with CKD.

CONCLUSIONS: The study concluded that urinary 2-Hydroxynaphthalene form of PAHs is significantly associated with CKD.

Keywords: polycyclic aromatic hydrocarbons, chronic kidney disease, urinary 2-Hydroxynaphthalene, NHANES, environmental pollution



ABSTRACT E-BOOK

P-515

Chemical exposures » Heavy metals

Lead Exposure, Stunting and Language Development in Mexico: a first national study

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BACKGROUND AND AIM: Lead exposure affects language development. Poor nutrition increases lead absorption and its toxic effects. According to the 2018 National Health and Nutrition Survey (ENSANUT), there are more than 1.4 million children under 5 years of age (21.8%) with elevated blood lead levels (BLL) ($> 5 \mu\text{g}/\text{dL}$), and 14.9% presented nutritional deficiencies. Our aims were: 1) to analyze the association between lead exposure and language development in a representative sample of children aged 12–59-months and 2) to assess the potential modifying effect of this association by chronic undernutrition (stunting).

METHODS: We analyzed data from the 2018 ENSANUT, a representative survey of localities with $< 100,000$ inhabitants in Mexico. An Early Childhood Development (ECD) module with language assessment was applied to 1413 children aged 12-59 months. One child per household was randomly selected for a capillary BLL (Lead Care II, detection limit = $3.3 \mu\text{g}/\text{dL}$) and anthropometric measurements. A multiple linear regression (MLR) model estimated the association between BLLs (categorized as below detection limit, $3.3 - 5.0 \mu\text{g}/\text{dL}$, and above $5.0 \mu\text{g}/\text{dL}$) and language score (continuous z-score). Furthermore, we stratified by stunting condition and all analyses were estimated according to the survey sampling design.

RESULTS: 26% of children had BLL $3.3 - 5.0 \mu\text{g}/\text{dL}$ and 16% above $5.0 \mu\text{g}/\text{dL}$; 18% had stunting and mean language z-score was -0.10 ± 1.00 . Compared to children with BLL below the detection limit, children with BLLs $> 3.3 \mu\text{g}/\text{dL}$ showed -non statistically significant- lower language Z-score ($\beta = -0.16$, $p < 0.163$). Children with stunting and BLL between $3.3 - 5 \mu\text{g}/\text{dL}$ had a significant reduction in language Z-score ($\beta = -0.63$, $p < 0.001$).

CONCLUSIONS: The co-exposure of lead and stunting was associated with a decrease in language score. These results add to previous research on a call for action to reduce lead exposure, particularly in children with chronic undernutrition.

Keywords: Lead exposure, language development, stunting



ABSTRACT E-BOOK

P-516

Air pollution » Particulate matter

Long-term exposure to fine particle components and mortality in the Southeastern US

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BACKGROUND AND AIM: Long-term exposure to fine particulate matter (PM_{2.5}) has been associated with adverse health effects. However, health effects of PM_{2.5} components have been less studied.

METHODS: We performed a population-based cohort study, comprising all Medicare enrollees (aged ≥65, N=13,590,387) in the southeastern US from 2000-2016. Based on well-validated prediction models at 1-km resolution, we estimated ZIP Code-level annual mean concentrations for five major PM_{2.5} components, including black carbon (BC), nitrate (NIT), organic matter (OM), sulfate (SO₄), and soil particles. Cox proportional hazards models were fit to examine the association between each PM_{2.5} major component and all-cause mortality, adjusting for potential confounders.

RESULTS: In single pollutant models, all five major PM_{2.5} components were statistically significantly associated with all-cause mortality. In multi-pollutant models that included all five major components simultaneously, we observed statistically significant associations with long-term exposure to BC, OM, NIT, and soil particle, and the hazard ratios (HR) per interquartile range (IQR) increases in exposure were 1.023 (95% CI:1.019-1.027), 1.004 (95%CI:1.001-1.007), 1.013 (95%CI: 1.012-1.015), and 1.003 (95% CI: 1.001-1.004). However, with adjustment of other PM_{2.5} components, SO₄ was not associated with increased mortality, with a HR of 0.995 (95%CI: 0.992-0.998).

CONCLUSIONS: Our study provides epidemiological evidence that long-term exposure to major PM_{2.5} components, including BC, OM, NIT, and soil particle, was significantly associated with elevated mortality.

Keywords: Air pollution, PM_{2.5} components, all-cause mortality, survival analysis



ABSTRACT E-BOOK

P-518

Air pollution » Particulate matter

Association of ambient air pollutant PM_{2.5} with skin redness features: An urban-rural comparison in Taiwan

Fu Yu Chan

FU-YU CHAN

BACKGROUND AND AIM: Air pollutants have been linked to adverse skin health outcomes in the urban setting, although evidence in the rural context is limited. In Taiwan, the PM_{2.5} concentration often reaches a dangerous level because of industrial and traffic pollutants, especially in the central and southern areas. Thus, this study aims to examine the associations between PM_{2.5} and skin redness features in Taiwan's urban and rural communities.

METHODS: In May 2018, we recruited the study participants in Taipei's communities (as the urban area) and Taisi Village in Changhua County (as the rural area, where nearby the Sixth Naphtha Cracker Complex Industrial Zone). The inclusion criteria were living in the local community for more than one year, 20 years of age or older, and free of skin and infectious diseases. The skin redness features were measured by the VISIA 7 Imaging System device (Canfield, NJ, USA) and facial image analysis software. We used the Land Use Regression Model to estimate the level of outdoor PM_{2.5} exposure based on participants' residential addresses. We also collect information on covariates by self-administered questionnaires. We conducted linear regression models to examine the association between air pollution exposure and skin redness features.

RESULTS: The study participants included 93 residents of Taipei City and 42 residents of Taisi Village. After controlling for sex, age, ultraviolet exposure risk, sebum secretion level, and skincare behaviors (using a facial cleanser, using sunscreen, and wearing mask habits), the regression model showed that the PM_{2.5} concentration was significantly associated with skin redness features ($b=10.16$, 95% CI=1.83 to 19.49) in Taisi village. In contrast, in Taipei's communities, PM_{2.5} concentration was not associated with skin redness features.

CONCLUSIONS: Higher PM_{2.5} concentration is associated with a higher risk of skin redness features in the rural context in Taiwan but not in the urban area.

Keywords: PM_{2.5}, Skin redness features, Rural area, Taiwan



ABSTRACT E-BOOK

P-521

Air pollution » Particulate matter

Assessment of Respiratory morbidity burden from exposure to vegetation fire-PM_{2.5} in Upper Northern Thailand for the year 2018

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BACKGROUND AND AIM: The seasonal occurrence of vegetation fire in the Mainland Southeast Asia (MSEA) has deteriorated air quality, which can increase respiratory diseases. Nevertheless, no study has assessed the health burden from exposure to vegetation-fire smoke in the MSEA. We aimed to estimate the number of hospital visits from respiratory diseases attributable to vegetation-fire PM_{2.5} in the Upper northern Thailand (UNT).

METHODS: The modelled vegetation fire-PM_{2.5} were obtained from System for Integrated modelling of Atmospheric composition (SILAM) model, which is a global-to-meso-scale air pollution dispersion model. Vegetation fire-PM_{2.5} were simulated based on fire radiative power data of Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data. We averaged the extracted grid-cell of fire-PM_{2.5} within district boundaries. The number of respiratory disease-related hospital visits attributable to fire-PM_{2.5} was estimated for the whole year and burning period (January to April) of the year 2018 by using the modelled daily fire-PM_{2.5}, population data, and concentration-response function derived from the previous epidemiological study.

RESULTS: In 2018, we estimated 17,817 hospital visits for respiratory diseases attributable to vegetation fire-PM_{2.5} in the UNT. Our estimation was accounted approximately 1% of the total hospital visits for respiratory diseases throughout the year and 3 % during the burning season.

CONCLUSIONS: This study suggests that PM_{2.5} emitted from vegetation fire events poses a health burden across the UNT.

Keywords: Health burden estimation, Vegetation fires, Hospital visits, Respiratory diseases



ABSTRACT E-BOOK

P-522

Air pollution » Particulate matter

Association between long-term exposure to particulate matter and childhood cancer: Retrospective cohort study

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BACKGROUND AND AIM: Particulate matter is known carcinogen, but its association with childhood cancer is inconsistent. The aim of the present study was to examine the association between air pollution and childhood cancer.

METHODS: A retrospective cohort was constructed from claims database of the Korea National Health Insurance Service. Children who had been born in 7 metropolitan cities in Korea (Seoul, Incheon, Daejeon, Gwangju, Daegu, Busan, and Ulsan) from 2002 to 2012 were recruited and half of them were randomly selected. Children who were diagnosed with cancer within 5 years of birth were excluded. Monthly mean concentrations of particulate matter with aerodynamic diameter < 10 μm (PM10) and other air pollutants (NO₂, SO₂, CO and O₃) was calculated from AirKorea. Monthly mean concentrations of particulate matter with aerodynamic diameter < 2.5 μm (PM2.5) was estimated with a concentration prediction model. The cumulative exposure was calculated by averaging monthly concentrations according to the subject's residential information. We constructed Cox proportional hazard model adjusting for potential confounders and O₃ concentration.

RESULTS: A total of 1,261,855 children (boys 641,704, girls 610,151) were included in the analysis. During the study period, 1,725 were newly diagnosed with cancer. Exposures to higher mean ambient PM2.5 and PM10 concentration increased the risk of childhood cancer. The hazard ratio of all cancers was 3.02 (95% confidence interval [CI]: 1.63, 5.59) and 1.04 (95% CI: 0.71, 1.45) for an increment of 10 $\mu\text{g}/\text{m}^3$ of annual mean concentrations of PM2.5 and PM10, respectively.

CONCLUSIONS: We observed significant positive association between particulate matter exposure and childhood cancer in a retrospective cohort of 1.2 million children.

Keywords: Particulate matter, Cancer, Children, Retrospective cohort



ABSTRACT E-BOOK

P-523

Air pollution » Particulate matter

Identifying spatio-temporal patterns in the association between PM10 and mortality

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BACKGROUND AND AIM: It is well known that the short-term effects of PM10 on mortality are not homogeneous across regions. In recent years, a few studies have revealed that the mortality effects of PM10 could also vary over time with specific patterns. Since the effects of PM10 could be heterogeneous over regions, its temporal pattern might also be different according to geographical locations. In this study, we tried to investigate whether there are specific spatio-temporal patterns in the association between PM10 and mortality in Seoul, Korea. By scrutinizing the spatio-temporal variations, we expect to gain more insight than just investigating spatial or temporal variations.

METHODS: The study area is Seoul, Korea, for 2004-2018. For the 25 districts in Seoul, we estimated district and time-window specific effect of PM10 on the non-accidental mortality using the time series analysis. We used 5-year moving time window that shifts every month for the study period (window 1: Jan 2004 - Dec 2008, ..., window 120: Jan 2014, - Dec 2018). The estimated 120 coefficients in each district are then smoothed using B-spline. After that, we clustered the coefficients of the B-spline using the K-means.

RESULTS: We discovered that the mortality effects of PM10 have been changed with specific temporal patterns and that patterns are different over districts. By using K-means clustering, we could identify four different patterns. In one cluster, the effects of PM decreased in the early years but increased in recent years. Another cluster showed the opposite patterns. There was also a linearly decreasing pattern.

CONCLUSIONS: Identifying the spatio-temporal pattern is important since it could improve our understanding of the PM. Further studies would be needed to explain the observed spatio-temporal variations.

Keywords: Air pollution, Particulate matter, Short-term exposure, Mortality



ABSTRACT E-BOOK

P-524

Air pollution » Particulate matter

Short-term effect of fine particulate matter on daily mortality: Effect modification by prolonged continuous exposure to high concentration

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BACKGROUND AND AIM: Although the evidence for short-term mortality effect is very high, the epidemiological study for the effect of prolonged continuous exposure to high concentration is rare. The aim of this study is to investigate how the size of the mortality effect of PM_{2.5} would be modified when high concentration period persist.

METHODS: We used daily mortality counts (non-traumatic all-cause, respiratory, and cardiovascular), simulated daily PM_{2.5} concentrations, measured daily mean temperature and relative humidity data in seven metropolitan cities (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan) during 2006 to 2019. Generalized additive models (GAMs) with quasi-Poisson distribution in the seven cities and Random effect meta-analyses for pooling the city-specific effects were used to examine the short-term effects of PM_{2.5} on mortality. To investigate effect modification by prolonged continuous exposure to high concentration (referent level: 35 µg/m³), we applied categorical consecutive day variables to the GAMs as effect modification terms with PM_{2.5} concentration variables.

RESULTS: The daily percent changes per 10 µg/m³ of daily PM_{2.5} concentration for all-cause, respiratory, and cardiovascular mortality were 0.31% (95%CI: 0.16 – 0.46, lag 0 model), 0.61% (95%CI: -0.02 – 1.24, lag 0-2 model), 0.37% (95%CI: 0.08 – 0.66, lag 0 model), respectively. In the effect modification model for all-cause mortality applied lag 0-1 PM_{2.5} exposure, the daily percent changes per 10 µg/m³ for first, second and third, and fourth day or more of consecutive days were 1.30% (95%CI: 0.05 – 2.57), 0.18% (95%CI: -0.70 – 1.06), and 1.19% (95%CI: 0.31 – 2.08). This pattern was similar in the models for cardiovascular than respiratory mortality.

CONCLUSIONS: We found a greater effect on daily mortality of daily PM_{2.5} exposure when the high concentration day began and the days lasted for more than fourth days with high concentration.

Keywords: Air pollution, Short-term exposure, Environmental epidemiology, Mortality



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Glucose metabolism disorder enhanced the changes in cardiovascular function associated with exposure to ambient air particulate matter: a panel study

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BACKGROUND AND AIM: Exposure to ambient air particulate matter (PM) is associated with increasing risk to cardiovascular diseases, but the underlying mechanisms remain unclear. This study aims to assess the effects of exposure to PM on indicators of cardiovascular function in a group of Beijing residents with and without pre-diabetes.

METHODS: In a panel study (SCOPE) conducted in Beijing, China, 112 nonsmoking participants completed two to seven clinical visits. Indicators of cardiovascular function, including peripheral blood pressure, central arterial pressure, augmentation pressure normalized to a heart rate of 75 bpm (AP75), augmentation index normalized to a heart rate of 75 bpm (AIx75), ejection duration (ED), subendocardial viability ratio (SEVR), and reactive hyperemia index (RHI) were measured. Fine particles (PM_{2.5}), ultrafine particles (UFP), accumulation-mode particles (AMP), and black carbon (BC) were monitored continuously at a fixed monitoring site. The associations between changes in cardiovascular function and moving average concentrations of PM during 1-7 day prior to clinical visits, and the modification of glucose metabolism status on such associations were examined with linear mixed-effects models.

RESULTS: The changes in cardiovascular function associated with PM exposure differed significantly between participants with and without pre-diabetes. Among pre-diabetic participants, higher peripheral blood pressure and central arterial pressure were in significant association with UFP, AMP, or BC exposure, for example, an interquartile range increment in 7-day moving average BC exposure (4.8 µg/m³) was associated with 3.2% (95% confidence interval: 0.6%, 5.9%) increase in peripheral systolic blood pressure (p-SBP), while the associations among those without pre-diabetes were close to null or inverse. Additionally, positive associations in AP75 with BC exposure, and negative associations in SEVR with PM_{2.5} exposure were only shown among pre-diabetic participants.

CONCLUSIONS: Glucose metabolism disorder may enhance the adverse impacts of exposure to PM on cardiovascular function.

Keywords: Particulate matter, cardiovascular function, pre-diabetes



ABSTRACT E-BOOK

P-526

Air pollution » Particulate matter

To predict PM_{2.5} by a deep learning method of long-short term memory network - A case study of Kaohsiung City

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BACKGROUND AND AIM: In recent years, particulate matter (PM) has become a serious air pollutant in urban areas of Taiwan and has drawn more and more attention. This study selected possible factors affecting the concentration of PM_{2.5} (PM with aerodynamic particle size of less than 2.5 μm) and aimed at establishing a model using machine learning for predicting air pollution.

METHODS: Long-short term memory (LSTM) is a special recurrent neural network (RNN) model proposed to solve the problem of gradient dispersion of RNN model. In this study, we applied the LSTM network to identifying air pollutants (SO₂, NO₂) and meteorological factor (wind speed) that affect the concentration of PM. We used the information provided by the Air Quality Monitoring Network of the Environmental Protection Administration and obtained data on three air pollutants (PM_{2.5}, SO₂, NO₂) from the eight monitoring stations in Kaohsiung City from 2017 to 2018. The LSTM network was used to classify, process, and train time series. The prediction model of PM_{2.5} was based on supervised learning that used the air pollution on the previous 3 hours to predict the level of PM_{2.5} every other hour.

RESULTS: The average concentration of PM_{2.5} in Kaohsiung City from January 1, 2017 to December 31, 2018 was 25.329 $\mu\text{g}/\text{m}^3$. PM_{2.5} had a correlation coefficient of 0.261 with SO₂, and that with NO₂ was 0.648 and -0.085 respectively. By integrating the above four air pollutants, an LSTM network analysis was used to establish a prediction model of PM_{2.5}. By comparing the trained values with the test values, we obtained a root mean square error value of the model as 2.759.

CONCLUSIONS: This study showed that the LSTM network approach could be applied to predict daily pollution levels. This may improve the accuracy of air quality forecasting and the warning of specific pollution elements.

Keywords: Long-short term memory (LSTM), deep learning, particulate matter (PM)



ABSTRACT E-BOOK

P-528

Air pollution » Particulate matter

Associations between difference in anemia-related blood cell parameters and short-term exposure to ambient fine particles in Beijing elderly residents

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BACKGROUND AND AIM: Anemia is a highly prevalent disease among elderly population with multiple adverse health outcomes. Particle exposure was a potentially risk factor of anemia. However, few studies have investigated the associations of particle exposure with anemia-related outcomes in the elderly, and the underlying mechanism is unclear.

METHODS: Based on a panel study conducted between July 2016 and September 2017, anemia-related blood cell parameters, including red blood cell count (RBC), hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and tumor necrosis factor α (TNF α), a marker of systemic inflammation, in serum samples were measured from 135 elderly participants at up to four clinical visits. Particulate pollutants—including particulate matter with an aerodynamic diameter of $\leq 2.5\mu\text{m}$ (PM_{2.5}), black carbon (BC), ultrafine particles (UFPs), and accumulated-mode particles (Acc)—were continuously monitored at a fixed-site monitoring station. Linear mixed-effects models were used to examine the associations between particle exposure and anemia-related blood cell parameters, and mediation models were used to evaluate the mediation effect of TNF α on the associations.

RESULTS: In the elderly participants, exposure to all measured pollutants were significantly associated with differences in anemia-related blood cell parameters, such as the association between HGB difference and per interquartile range (IQR) increase in average Acc concentration 14 d before clinical visits was -2.2% (95% CI: -3.8%, -0.6%). The significant associations of UFPs and Acc exposure with difference in anemia-related blood cells kept robust after adjustment for other pollutants. In advanced analysis, 25.2 % (95% CI: 7.4 %, 64.8 %) of difference in MCHC associated with average UFPs concentration 14 d before clinical visits were mediated by the level of TNF α .

CONCLUSIONS: Short-term exposure to fine particles, especially UFPs and Acc, contributed to damage of anemia-related blood cell in the elderly, and systemic inflammation is a potential internal mediator.

Keywords: anemia-related blood cell parameters, ambient fine particles, mean corpuscular hemoglobin concentration (MCHC), tumor necrosis factor α (TNF α), ultrafine particles (UFPs),



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accumulated-mode particles (Acc)

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Air pollution » Long-term exposure

Low-concentration air pollution and mortality in American older adults: A national cohort analysis (2001-2017)

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BACKGROUND AND AIM: Mounting epidemiological evidence has documented the associations between air pollution and mortality. There is a pressing need to determine whether risks persist at low concentrations including below current national standards. Better understanding of the health effects of low-level air pollution is essential for the amendment of National Ambient Air Quality Standards.

METHODS: A nationwide, population-based, open cohort study was conducted to estimate the association between long-term exposure to low-level PM_{2.5}, NO₂, O₃ and mortality. The study population included all Medicare enrollees in the contiguous United States from 2001-2017. We further defined three low-exposure sub-cohorts comprised of Medicare enrollees who were always exposed to low-level PM_{2.5} (annual mean ≤ 12 $\mu\text{g}/\text{m}^3$), NO₂ (annual mean ≤ 53 ppb), and O₃ (warm-season mean ≤ 50 ppb), respectively, over the study period. We applied multiple statistical methods and compared causal modeling methods to standard methods, to provide strong epidemiologic evidence.

RESULTS: Of the 68.7-million Medicare enrollees, 33.1%, 93.8%, 65.0% were always exposed to low-level annual PM_{2.5}, annual NO₂, and warm-season O₃ over the study period, respectively. Among the low-exposure cohorts, a 10- $\mu\text{g}/\text{m}^3$ increase in PM_{2.5}, 10-ppb increase in NO₂, and 10-ppb increase in warm-season O₃, was respectively associated with an increase in mortality rate ranging between 10-13%, 2-4%, and 12-14% in single-pollutant models, and between 6-8%, 1-3%, and 9-11% in tri-pollutant models, using three statistical approaches. There was strong evidence of linearity in concentration-response relationships for PM_{2.5} and NO₂ at levels below the current NAAQS, suggesting that no safe threshold exists for health-harmful pollution levels. For O₃, the concentration-response relationship shows an increasingly positive association at levels above 30-ppb.

CONCLUSIONS: Long-term exposures to PM_{2.5}, NO₂, and O₃ were significantly associated with an increased risk of all-cause mortality, particularly at levels below the current NAAQS standards, suggesting that implementing more stringent regulations in air quality may yield substantial health benefits.

Keywords: low concentration, air pollution, NAAQS, survival analysis, causal modeling



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Air pollution » Long-term exposure

Emulating causal dose-response relations between air pollutants and mortality in elders

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BACKGROUND AND AIM: What has been mostly missing in air pollution epidemiology is causal dose-response (D-R) relations between exposures and mortality. Such causal D-R relations can provide profound implications in predicting health impact at a target level of air pollution concentration.

METHODS: Using Medicare cohort ≥ 65 years of age in the US during 2000–2016, we simultaneously emulated causal D-R relations between chronic exposures to fine particulate matter (PM_{2.5}), ozone (O₃), and nitrogen dioxide (NO₂) and all-cause mortality. To relax the contentious assumptions of inverse probability weighting for continuous exposures, we proposed a decile binning approach which divided each exposure into ten equal-sized groups by deciles, treated the lowest decile group as reference, and estimated the effects for the other groups.

RESULTS: Assuming the causal framework was valid, we found that higher levels of PM_{2.5}, O₃, and NO₂ were causally associated with greater risk of mortality and that PM_{2.5} posed the greatest risk. For PM_{2.5}, the relative risk (RR) of mortality monotonically increased from the 2nd (RR, 1.022; 95% confidence interval [CI], 1.018-1.025) to the 10th decile group (RR, 1.207; 95% CI, 1.203-1.210); for O₃, the RR increased from the 2nd (RR, 1.050; 95% CI, 1.047-1.053) to the 9th decile group (RR, 1.107; 95% CI, 1.104-1.110); for NO₂, the DR curve wiggled at low levels and started rising from the 6th (RR, 1.005; 95% CI, 1.002-1.018) till the highest decile group (RR, 1.024; 95% CI, 1.021-1.027).

CONCLUSIONS: This study provided more robust evidence of the causal relations between air pollution exposures and mortality. The emulated causal D-R relations provided significant implications for reviewing the national air quality standards, as they inferred the number of potential early deaths prevented if air pollutants were reduced to specific levels; for example, lowering each air pollutant concentration from the 70th to 60th percentiles would prevent 65,935 early deaths per year.

Keywords: Mixtures, Long-term exposure, Mortality, Causal inference, Big data



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Air pollution » Long-term exposure

Long-term Exposure to Air Pollution and Temperature and Hospital Admissions with Cardiovascular Disease in the United States

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BACKGROUND AND AIM: Both air pollution and temperature have been associated with cardiovascular disease. In this study, we look at these exposures simultaneously and assess their relationship with cardiovascular disease using causal methodology.

METHODS: We looked at the relationship between long-term exposure to air pollution and temperature and hospital admissions with cardiovascular disease (CVD) among Medicare participants in the United States from 2000 to 2016. We assigned air pollution exposure, specifically PM_{2.5}, NO₂, and O₃, based on residential zip code using aggregations from fine-scaled spatiotemporal prediction models. We assigned temperature based on the predictions of the gridMET dataset which estimates levels on a 4 km x 4 km scale. Daily exposures were averaged by calendar year to obtain annual, long-term estimates. Hospital admissions with CVD were identified using ICD-9 and ICD-10 codes. We adjusted for demographic and socioeconomic confounders. A difference-in-difference approach was used to calculate the estimate for each exposure of interest. We did this conditioning on zip code and looking at change in rate of hospitalizations within each zip code. We further used multi-pollutant models to adjust for confounding by other concurrent exposures.

RESULTS: Higher warm-season temperature, NO₂, and PM_{2.5} were associated with an increase in the rate of CVD hospital admissions in the US with rate ratios of 1.021 (95% CI: 1.021-1.022), 1.002 (95% CI: 1.002-1.002), and 1.012 (95% CI: 1.012-1.013), respectively for each unit increase in exposure. Higher cold-season temperatures decreased the rate of CVD admissions by 0.991% (95% CI: 0.977-1.006) for each Celsius degree increase. Ozone was also associated with a decrease in the rate of CVD admissions.

CONCLUSIONS: Fine particulate matter, nitrogen dioxide, and warm-season temperature were associated with an increase in the rate of cardiovascular hospital admissions among the elderly in the US.



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Keywords: Air Pollution, Temperature, Epidemiology, Cardiovascular Disease

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Air pollution » Long-term exposure

Interaction between long-term coarse particulate matter exposure and physical activity in relation to overall and respiratory mortality in U.S. women

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BACKGROUND AND AIM: Coarse particulate matter (PM_{2.5-10}) air pollution exposure has been linked to respiratory health and increased mortality rates, while higher physical activity has been linked to decreased mortality rates. Increased respiration during physical activity may increase PM exposure, attenuating the benefits of physical activity. We examined the interaction between long-term residential exposure to PM_{2.5-10} and physical activity on overall and respiratory mortality rates.

METHODS: Exposure to PM_{2.5-10} was assigned to each residential address using a spatio-temporal model and physical activity was reported on biennial questionnaires in the Nurses' Health Study, a U.S. nationwide prospective cohort. We determined nonaccidental death and cause of death through searching the National Death Index. We followed 106,267 women between 1988 and 2008. We used Cox proportional hazards models to assess associations with each exposure separately and jointly, adjusted for demographics, diet, and individual- and area-level socioeconomic status.

RESULTS: We observed 10,928 nonaccidental deaths, of which 918 were attributed to respiratory disease. In adjusted models, 24-month average ambient PM_{2.5-10} exposure per 10 µg/m³ increase was associated with modest increased risk of overall mortality (HR: 1.06, 95% CI: 1.01-1.11) and respiratory mortality (HR: 1.22, 95% CI: 1.05-1.42). Increasing overall physical activity per 9 metabolic equivalent of task-hours/week increase (based on meeting weekly physical activity recommendations) was associated with decreased risk of overall mortality (HR: 0.94, 95% CI: 0.94-0.95) and decreased risk of respiratory mortality (HR: 0.90, 95% CI: 0.88-0.91). We observed no interactions between PM_{2.5-10} exposure and physical activity.

CONCLUSIONS: Exposure to PM_{2.5-10} was associated with increased risk of overall and respiratory mortality. Higher physical activity was associated with decreased overall and respiratory mortality; this association remained at all levels of PM_{2.5-10} experienced in this study, suggesting that the benefits of physical activity outweigh the negative impacts of air pollution exposures.

Keywords: air pollution, particulate matter, long-term exposure, respiratory outcomes, mortality



ABSTRACT E-BOOK

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Air pollution » General

Racial-ethnic disparities in exposure to NO₂ and PM_{2.5} in the United States: Insights from spatial decomposition of ambient concentrations

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BACKGROUND AND AIM: In the US, average exposure to ambient NO₂ and PM_{2.5} is higher for racial-ethnic minorities (Hispanic, Black, and Asian people) than for the majority (White people). We investigate spatially decomposed concentrations, and how differences among racial-ethnic groups shed light on patterns underlying existing disparities.

METHODS: We use Census data for demographic information and national empirical models for ambient concentrations. We employ two approaches for spatially decomposed concentrations, subdividing concentration prediction by (1) length scale of variability (<1 km, 1-10 km, 10-100 km, and >100 km), and (2) political boundaries: (a) across-state; then, the remaining (i.e., within-state) component is divided into (b) urban versus rural, (c) within-rural, (d) across-urban (i.e., differences across urban areas within one state), and (e) within urban (i.e., differences within that urban area). We calculate national racial-ethnic exposure disparities using those decomposed concentrate surfaces.

RESULTS: The largest contributors to absolute disparities are the between-state and within-urban components: racial-ethnic minority populations live in the more-polluted cities within their state and in the more-polluted part of their city (exception: PM_{2.5} for Asian people). The 1-100 km component contributes the most to disparities (exception: for NO₂ for Black people, <1 km contributes the most). For PM_{2.5}, the >100 km and between-state components lead to higher-than-average concentrations for Black people and lower-than-average for Hispanic, Asian people; this finding reflects, in part, in which regions of the US people live.

CONCLUSIONS: Within-urban disparities, which are the focus of substantial research on environmental justice, are important but are only one contributor to national disparities. Overall, disparities for NO₂ come mostly from local variability (within-state; 1-100 km range) while for PM_{2.5} they relate more with regional sources (across-state; >100 km).

Keywords: Environmental Justice, Air Pollution, Spatial Decomposition



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Air pollution » Long-term exposure

Association between chronic obstructive pulmonary disease and long-term ozone and PM2.5 exposure among Medicare participants: a national cohort study

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BACKGROUND AND AIM: Chronic obstructive pulmonary disease (COPD) is the third leading cause of death globally and both ozone and PM2.5 exposures are main risk factors. However, few studies have investigated the association of long-term ambient ozone exposure with respiratory morbidity and its simultaneous effect with PM2.5.

METHODS: A nationwide population-based open cohort study was used to estimate the association between long-term exposure to ambient ozone, PM2.5 and COPD incidence. The study population included all Medicare enrollees (aged ≥ 65 years) who were always enrolled in Medicare free-for-service program and in both Medicare Part A (hospital insurance) and Part B (medical insurance) in the contiguous United States from 2000-2016. We estimated the hazard ratios (HRs) for the first diagnosis with COPD using single- and co-pollutant Cox proportional hazards models that controlled for demographic characteristics, Medicaid eligibility, and area-level covariates. We further looked at this relationship at lower pollutant concentrations, restricting Medicare enrollees who were always exposed to pollutant levels below the US EPA National Ambient Air Quality Standards [NAAQS] (annual PM2.5 $\leq 12 \mu\text{g}/\text{m}^3$ and warm-season ozone ≤ 50 ppb), and among potentially susceptible subgroups.

RESULTS: Among the full cohort of 18.9 million enrollees, increases of 10 ppb in annual warm-season ozone and $10 \mu\text{g}/\text{m}^3$ in annual PM2.5 were associated with increased risk of first diagnosis with COPD, with HRs of 1.048 (1.039-1.057) and 1.054 (95% CI, 1.036-1.072) in the co-pollutant model, respectively. When restricting analyses to the below EPA low-exposure sub-cohort (9.6-million enrollees), the corresponding HRs were 1.160 (1.142-1.178) for exposure to ozone and 1.109 (95% CI, 1.068-1.151) for exposure to PM2.5.

CONCLUSIONS: Both long-term ozone and PM2.5 exposures were associated with increased risk of COPD incidence among the US elderly population, even at concentrations below the current NAAQS standards.

Keywords: Air pollution, Multi-pollution, Chronic obstructive pulmonary disease



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Air pollution » General

Associations between ambient air pollutants and clonal hematopoiesis of indeterminate potential (CHIP)

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BACKGROUND AND AIM: Biological mechanisms underlying the relationship between exposure to ambient air pollution and development of cardiovascular disease (CVD) have not been adequately described. One pathway could involve acquisition of somatic mutations associated with incidence of hematologic cancers and CVD termed “clonal hematopoiesis of indeterminate potential” (CHIP), most commonly mutated in DNMT3A. We assessed cross-sectional associations between long-term air pollutant concentrations and CHIP mutation prevalence.

METHODS: CHIP mutations were identified in the Trans-omics for Precision Medicine program using blood DNA-derived whole genome sequencing for participants of the Multi-Ethnic Study of Atherosclerosis. A spatio-temporal modeling framework predicted individual-level average air pollution concentrations (particulate matter <2.5 µm, PM2.5; nitrogen dioxide, NO₂; oxides of nitrogen, NO_x) at residential locations one year before blood draw (Exams 1-3, 2000-2005). Primary exclusions were history of hematologic malignancy or myelosuppressive chemotherapeutics. Logistic regression estimated odds ratios (OR) of CHIP mutation per IQR increase in air pollutant concentration, adjusting for age, gender, smoking status, race/ethnicity, income, and calendar year.

RESULTS: 4,445 individuals were included and 196 (4.41%) had CHIP mutations. 67.9% of CHIP mutations were in DNMT3A. Adjusted ORs for CHIP per increase in air pollution were increased, however did not reach statistical significance. ORs for CHIP mutation were 1.05 (95% CI 0.90, 1.23) per 4 µg/m³ for PM2.5, 1.18 (95% CI 0.87, 1.59) per 16 ppb for NO₂, and 1.21 (95% CI 0.93, 1.56) per 38 ppb for NO_x. Adjusted ORs for DNMT3A-specific CHIP were 1.13 (95% CI 0.94, 1.36) for PM2.5, 1.26 (95% CI 0.87, 1.81) for NO₂, and 1.28 (95% CI 0.93, 1.75) for NO_x.

CONCLUSIONS: Our results are suggestive of associations between long term concentrations in air pollution and prevalence of CHIP mutations, but not statistically significant. A larger sample size may be required to provide insight into the relationship between air pollution and CHIP.

Keywords: air pollution, pm2.5, no2, CHIP



ABSTRACT E-BOOK

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Air pollution » Long-term exposure

The impact of air pollution on mortality risk in the older adults with Alzheimer's disease and related dementias (ADRD)

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BACKGROUND AND AIM: Increasing evidence links fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂) and ozone (O₃) to mortality risk. We aimed to investigate the long-term effects of PM_{2.5}, NO₂, O₃ and oxidant (Ox) exposures on mortality in an elderly population with a hospitalization in which Alzheimer's disease or related dementias (ADRD) were coded.

METHODS: Using nationwide fee-for-service Medicare Part A data, we constructed a population-based open cohort including beneficiaries (age ≥ 65 years) in the contiguous United States (2000-2016) who had an ADRD code during a hospital stay, and we followed them from the year after the first such hospitalization to the end of the study period or their death. We assigned annual averages of PM_{2.5}, NO₂ and O₃ from hybrid high-resolution models, and oxidant level as $Ox = [(1.07 \times NO_2) + (2.075 \times O_3)] / 3.14$ to each individual based on calendar year and ZIP code. We applied multiple-pollutant (PM_{2.5}+NO₂+O₃; PM_{2.5}+Ox) Cox proportional hazard models with time-varying exposures to estimate hazard ratios (HRs) for mortality, stratifying on individual risk factors and adjusting for zip-code level socioeconomic status, seasonal temperature and humidity.

RESULTS: Our cohort consisted of 5,076,794 individuals hospitalized with an ADRD code, of whom 81.5% died during the study period. We found that annual exposure to both PM_{2.5} (1.003 (95% CI 1.001, 1.006) for an IQR increase (3.7 µg/m³)) and NO₂ (1.010 (95% CI 1.008, 1.013) for an IQR increase (13.9 ppb)) were associated with increased mortality but we didn't detect an association with ozone. We also found a HR of 1.004 (95% CI 1.002, 1.006) for an IQR increase (4.8 ppb) in Ox.

CONCLUSIONS: In a large nationwide cohort, we provide new evidence on the association between long-term exposure to pollutants and mortality among elderly with an ADRD diagnosis during hospitalization. The associations were smaller than mortality risks previously reported in the general Medicare population.



ABSTRACT E-BOOK

Keywords: Air pollution, Particulate matter, Long-term exposure, Environmental epidemiology, Mortality, Multi-pollutant

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Air pollution » Long-term exposure

Exposure to ultrafine particles and the incidence of asthma in children: A population-based open cohort study in Montreal, Canada

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BACKGROUND AND AIM: Asthma is the most prevalent chronic respiratory disease in children and represents an important burden on health care systems. The association between air pollution and asthma is well established, however the role of ultrafine particles (UFPs) remains unclear. We evaluated the association between long-term exposure to UFPs and childhood-onset asthma in a population-based birth cohort in Montreal, Canada.

METHODS: The cohort was constructed from the Quebec Integrated Chronic Disease Surveillance System and included all children born in Quebec between 2000 and 2015 who were resident of Montreal. Case definitions consisted of at least two physician claims with a diagnosis of asthma within a two-year period or one hospital discharge with a primary or secondary diagnosis of asthma. Annual concentrations of UFPs and of nitrogen dioxide (NO₂) were estimated from land use regression models developed for Montreal and assigned at participants' residence over the follow-up using their residential postal codes. The association between UFPs and childhood asthma onset was estimated with a Cox proportional hazards model stratified for sex and adjusted for age, neighbourhood material and social deprivation, calendar year and co-exposure to NO₂.

RESULTS: The cohort included 352,966 children, with 30,825 incident asthma cases. The annual average concentrations were 24,427 particles/cm³ for UFPs and 18.55 ppb for NO₂. In the single pollutant model, the adjusted hazard ratio (HR) per interquartile range (IQR) increase in UFPs was 0.990 (95% CI: 0.983, 0.997). The two-pollutant model showed no association for UFPs (HR per IQR = 0.986; 95% CI: 0.979, 0.997) but a positive association for NO₂ (HR per IQR = 1.038; 95% CI: 1.013, 1.051).

CONCLUSIONS: In this population-based birth cohort, childhood asthma onset was not associated with UFPs but positively associated with NO₂ estimated at participants' residential location.



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ABSTRACT E-BOOK

Keywords: Air pollution, Particulate matter, Asthma, Respiratory outcomes, Children's environmental health



ABSTRACT E-BOOK

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Air pollution » Long-term exposure

Long-term Ambient Air Pollution Associated with Weekly COVID-19 Mortality Counts in California Census Tracts

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BACKGROUND AND AIM: A growing number of studies have reported associations between ambient air pollution and COVID-19 mortality. Most of these studies are ecological, relying on county or regional level aggregate data which disregard important local variability. Using COVID-19 deaths identified from death certificates in California, we evaluated whether ambient air pollution related to weekly COVID-19 mortality at the census tract-level.

METHODS: Weekly COVID-19 mortality for each California census tract was calculated based on geocoded death certificate data obtained from the Department of Public Health Vital Records. Annual average concentrations of ambient nitrogen dioxide (NO₂), ozone (O₃), particulate matter <2.5µm (PM_{2.5}) and <10µm (PM₁₀) over 2014-2019 were assessed for all census tracts using inverse distance-squared weighting based on data from the ambient air quality monitoring system. Negative binomial mixed models related weekly COVID-19 census tract mortality counts to a natural cubic spline for calendar time (df=7), with adjustment for potential confounders (census tract demographic and socioeconomic factors, state region), random effects for census tract and county, and an offset for census tract population. Each air pollutant was evaluated separately.

RESULTS: From March 16 through October 25, 2020, there were 16,397 COVID-19-related deaths in California. Mean (standard deviation [SD]) 6-year annual average pollution concentrations for NO₂, O₃, PM_{2.5}, and PM₁₀ were 12.2 ppb (4.5), 42.8 ppb (7.0), 10.4 µg/m³ (2.2), and 25.5 µg/m³ (7.1), respectively. Preliminary results indicate positive associations between long-term air pollution concentrations and weekly COVID-19 census tract mortality rates. COVID-19 mortality rate ratios were 1.11 (95%CI: 1.07-1.15) and 1.15 (95%CI: 1.10-1.21) per SD increase in long-term PM_{2.5} and PM₁₀, respectively.

CONCLUSIONS: Study findings support a relation between chronic ambient air pollution exposure and weekly COVID-19 mortality. We are exploring how pollution effects may have varied over the course of the pandemic, as well as by individual-level characteristics (age, sex).

Keywords: air pollution, COVID-19, mortality, particulate matter, ozone, nitrogen dioxide



ABSTRACT E-BOOK

P-539

Air pollution » Long-term exposure

Associations of Long-term Air Pollution Exposure and Incident Late-Life Disability in Older U.S. Adults: The Health Retirement Study

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BACKGROUND AND AIM: Late-life disability is of critical concern to older adults and can reflect the cumulative burden of chronic disease over the lifespan. Although air pollution has been associated with many common chronic conditions, associations with disability are understudied. We aimed to quantify associations between long-term exposures to air pollution and late-life disability.

METHODS: We used biennial data between 2000 and 2016 on self-reported Activities of Daily Living (ADL) from participants >65 years from the nationally representative Health and Retirement Study. Using a spatiotemporal prediction model, we estimated 10-year PM_{2.5}, PM_{10-2.5}, NO₂, and O₃ concentrations at participant residences. We then estimated the risk of incident ADL disability as a function of time-varying air pollution, adjusting for individual and area-level confounders and sampling weights in a Cox model. We fitted single- and two-pollutant models.

RESULTS: Our study population of 16,927 adults (70+6.4 years) was predominantly non-Hispanic White (76%), Non-Hispanic Black (14%), and Hispanic White (8%) and 32% reported a new disability during follow-up. Overall, we found some evidence that air pollution was associated with an increased risk of ADL disability. After adjustment for place and PM_{2.5}, we found that interquartile increases in PM_{10-2.5} and NO₂ were associated with 8% (HR: 1.08 per 5 µg/m³, 95% CI: 1.01, 1.17) and 9% (HR: 1.09 per 6 ppb, 95% CI: 1.00, 1.19) greater hazards of ADL, respectively, with similar findings in the single pollutant models. PM_{2.5} and O₃ were not associated with higher hazards of ADL in single or multipollutant models after detailed adjustment for place.

CONCLUSIONS: This prospective study in a nationally representative sample of older adults found some evidence that higher levels of some but not all long-term air pollutants assessed are associated with increased risk of late-life disability.

Keywords: Air Pollution, Long-Term Exposure, Activities of Daily Living



ABSTRACT E-BOOK

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Air pollution » Long-term exposure

The Impact of Long-Term Air Pollution Exposure on Type 1 Diabetes Mellitus-Related Mortality among U.S. Medicare Beneficiaries

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BACKGROUND AND AIM: The impact of chronic exposure to air pollution [including fine particulate matter (PM_{2.5}) and nitrogen dioxide (NO₂)] on type 2 diabetes mellitus has been extensively studied. However, little previous literature has investigated associations between air pollution exposures and type 1 diabetes mellitus (T1DM)-related mortality, despite a well-established link between air pollution exposures and other autoimmune diseases. In a cohort of 53 million Medicare beneficiaries (with 32,596 T1DM related deaths) living across the conterminous United States between 2000 to 2008, we examined the association of chronic PM_{2.5} and NO₂ exposure and T1DM-related mortality.

METHODS: We used Cox proportional hazard models to assess the association of long-term PM_{2.5} and NO₂ exposures on T1DM-related mortality from 2000-2008. We estimated 12-month moving average PM_{2.5} concentrations using well validated Geographical Information System-Based spatio-temporal models that estimated daily PM_{2.5} exposures on a 6 km grid covering the conterminous US and 12-month moving average NO₂ concentrations using land use regression models that estimated monthly NO₂ exposure for census blocks. Models included strata for age, sex, race, and ZIP code and controlled for neighborhood socio-economic status (SES) in our main analyses; we additionally investigated for effect modification by participant demographics.

RESULTS: A 10 µg/m³ increase in 12-month average PM_{2.5} (HR: 1.183; 95% CI: 1.037-1.349) and a 10 ppb increase in NO₂ (RR: 1.248; 95% CI: 1.089-1.431) was associated with increased risk of T1DM-related mortality in age, sex, race, ZIP code, and SES-adjusted models. Associations for both pollutants were consistently stronger among Black (PM_{2.5}: HR:1.877, 95% CI: 1.386-2.543; NO₂: HR: 1.586, 95% CI: 1.258-2.001) and female (PM_{2.5}: HR:1.297, 95% CI: 1.101-1.529; NO₂: HR: 1.390, 95% CI: 1.187-1.627) beneficiaries.

CONCLUSIONS: Long-term PM_{2.5} and NO₂ exposure is associated with elevated risks of T1DM related mortality.

Keywords: Air pollution, Type 1 Diabetes Mellitus, Mortality,



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ABSTRACT E-BOOK



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Air pollution » Long-term exposure

Estimation of long-term exposure to PM_{2.5} based on short-term personal measurements in mother-child pairs in rural Ghana

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BACKGROUND AND AIM: Air pollution epidemiological studies usually rely on estimates of long-term exposure to air pollutants, which are difficult to ascertain. This problem is accentuated in low- and middle-income countries where sources of personal exposure often differ from those of ambient concentrations.

METHODS: We used a well-characterized cohort of mother and child pairs in 29 communities in rural Ghana and evaluated modeled long-term predictions of PM_{2.5} exposure. The models relied on three types of short-term measurements: personal exposure to PM_{2.5} in mother-child pairs, ambient PM_{2.5} concentration at the community level, and ambient PM_{2.5} concentration at a central site. Intra-class correlation coefficients (ICC) were computed to assess sources of variability in community ambient and personal exposure. Empty models were linear mixed models with a random intercept for the community or for the participant. Additional predictors included time-varying factors for the community and time-invariant characteristics for the household and participant. Personal exposure in mother and children were modeled separately. Models were evaluated using leave-one-out cross validation and the lowest root-mean-square-error (RMSE) was used to select the best performing model.

RESULTS: We analyzed 240 community-days and 251 participant-days of PM_{2.5}. Means (sd) of daily PM_{2.5} were 30.2 (24.9) µg/m³ for the central site, 43.5 (36.2) µg/m³ for the communities, 83.0 (53.2) µg/m³ for mothers, and 82.3 (43.6) µg/m³ for children. The ICCs (95% CI) for community ambient and personal exposure were 0.30 (0.17, 0.47) and 0.74 (0.65, 0.81) respectively. The sources of variability differed during the Harmattan season. Children's daily exposure was best predicted by models that used community ambient compared to mother's exposure as a predictor (log-scale RMSE: 0.165 vs 0.325).

CONCLUSIONS: Our results support the feasibility of predicting long-term personal exposure to PM_{2.5} using short-term measurements in settings similar to rural Ghana and suggest that mother's exposure may not be the best proxy for child's exposure.

Keywords: Particulate matter, long-term exposure, children's environmental health



ABSTRACT E-BOOK

P-543

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Living near petrochemical industries and risks of attention-deficit/hyperactivity disorder

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BACKGROUND AND AIM: Growing evidence has revealed that air pollution would increase the risk of attention-deficit/hyperactivity disorder (ADHD); however, little is known about the effect of petrochemicals on neurodevelopment in children. We aim to evaluate the association between petrochemical exposure during pregnancy and early life and risks of ADHD in children.

METHODS: We conducted a population-based birth cohort study using the 2004–2016 Taiwanese Birth Certificate Database, and verified the diagnosis of ADHD using the National Health Insurance Research Database. The petrochemical exposure in each subject's residential township was evaluated using three approaches: distance to the nearest petrochemical industrial plants (PIPs), petrochemical exposure probability which accounts for monthly prevailing wind direction, and monthly benzene concentrations estimated by using Kriging-based land use regression models. We applied Cox proportional hazard models to evaluate the associations.

RESULTS: During the study period, 49771 out of 1863963 children have been diagnosed as having ADHD. For prenatal exposure, we found that living in townships near PIPs (hazard ratio [HR] = 1.14–1.19, reference: ≥ 40 km) or with high benzene concentrations (HR = 1.04–1.19, reference: < 0.5 ppb) during pregnancy would increase the risks of ADHD. Similar detrimental effects were also observed for petrochemical exposure during postnatal period. Furthermore, those children with high postnatal petrochemical exposure probability were also found to have increased risks for developing ADHD (HR = 1.06–1.10, reference: < 10 %).

CONCLUSIONS: The present work revealed that living near petrochemical industries would increase the risks of ADHD, and further studies are warranted to confirm our findings.

Keywords: Air pollution, Neurodevelopmental outcomes, Children's environmental health, Big data



ABSTRACT E-BOOK

P-545

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

The effect of epigenome-wide DNA methylation on the association between prenatal exposure to air pollution and childhood attention-deficit hyperactivity disorder

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BACKGROUND AND AIM: Prenatal exposure to air pollution including particulate matter (PM), NO₂, and SO₂, has been linked with attention deficit hyperactivity disorder (ADHD) in children. Epigenetic influence has been suggested to have a role in the association between exposure to air pollution and ADHD. We aimed to investigate the epigenetic effects on the association between prenatal air pollution exposure and ADHD symptoms in children.

METHODS: Whole blood samples of 60 children were obtained at age 2 and 6 years repeatedly and genome-wide DNA methylation was analyzed using the Illumina Infinium Human Methylation BeadChip 450K. After quality control, a total of 256,864 CpG sites were analyzed for their association with prenatal PM₁₀, PM_{2.5}, NO₂, and SO₂ exposure in the first, second, and third trimesters of pregnancy, respectively. CpG sites associated with prenatal air pollution exposure were studied in relation to ADHD rating scale (ARS) scores at ages 6 and 8. We aimed to investigate the epigenetic effects on the association between prenatal air pollution exposure and ADHD symptoms in children.

RESULTS: DNA methylation levels at the 6 CpG sites at age 2 were associated with prenatal SO₂ exposure levels at the third trimester: CpG sites located in GP1BB, ATP2C2, GNB4, GRIA1, RPE, INPP5D. Among these, 1 IQR increase in the methylation of cg14130977 (GP1BB) and cg16698748 (ATP2C2) at age 2 was associated with a 0.11 (95% confidence interval (CI) 0.41, 0.83) and 0.12 (95% CI 0.3, 0.76) increase in ARS at age 6, respectively. cg21656520 (RPE) and cg22331159 (INPP5D) showed similar results.

CONCLUSIONS: Changes in DNA methylation levels at the CpG sites associated with prenatal SO₂ exposure led to increases in ARS scores, suggesting that epigenetic mechanisms underly the effects of prenatal exposure to air pollution on ADHD symptoms in children.



ABSTRACT E-BOOK

Keywords: prenatal, sulfur dioxide, SO₂, DNA methylation, ADHD, epigenome-wide association study, epigenetics

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Neurologic and Mental Health Outcomes » Neurodegenerative outcomes

Long-term Ozone Exposure and Cognitive Impairment among Chinese Older Adults: Analysis of the Chinese Longitudinal Healthy Longevity Survey

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BACKGROUND AND AIM: Increasing evidence points to an association between PM_{2.5} exposure and late-life cognitive health, but little is known about whether ambient ozone exposure affects cognitive functioning. This study aimed to examine the association of long-term ozone exposure with risk of cognitive impairment among older adults in China.

METHODS: We used longitudinal data from five waves (2005, 2008-2009, 2011-2012, 2014, and 2017-2018) of the Chinese Longitudinal Healthy Longevity Survey. In total, 9,544 participants (aged 81.4 ± 10.8 years at baseline, 48.3% male) with normal cognitive function at the baseline surveys from March 2005 to November 2014 were included in this analysis. The ozone exposure of each participant was estimated by the cumulative annual average ozone concentration for the county of residence. Cognitive function was assessed by the Chinese version of the Mini-Mental State Examination (MMSE). We used a cutoff MMSE score below 18 points with an additional restriction of MMSE decline ≥ 4 points from baseline to define cognitive impairment. A Cox proportional hazard model was utilized to explore the association of ozone exposure with cognitive decline.

RESULTS: During an average observation time of 6.5 years (62,133 person-years), 2,601 participants developed cognitive impairment. Preliminary results show that each 10-µg/m³ increase in ozone was associated with a 13.1% increased risk of cognitive impairment [95% confidence interval (CI): 6.8%, 19.8%]. No evidence was found for a threshold down to 70 µg/m³. The association between ozone exposure and risk of cognitive impairment was stronger for men than women (p-value for interaction: 0.03).

CONCLUSIONS: Long-term exposure to ozone was associated with an increased risk of cognitive



ABSTRACT E-BOOK

impairment among Chinese older adults. Reducing ambient ozone pollution may delay cognitive decline among older adults in China.

Keywords: Ozone, Long-term exposure, Neurodegenerative outcomes

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Mediation effect of air pollution and temperature on the association between greenness and infant's neurodevelopment: to identify critical windows

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BACKGROUND AND AIM: Green spaces can have a beneficial effect on health, but little is known about how they affect the neurodevelopment of infants. We investigated to identify mediation effect of TRAPs and temperature mixtures between greenness and infant's neurodevelopment during windows of susceptibility.

METHODS: 418 mother-infant pairs from the mothers and children environmental health (MOCEH) study were analyzed. Daily TRAPs concentrations including PM10 and NO₂ were estimated by land-use regression and daily temperature levels obtained from the Korea Meteorological Administration were averaged over each period from pregnancy to 24 months of age. Infant's neurodevelopment was evaluated based on mental development index (MDI) and physical development index (PDI) at 6 months, 12 months, and 24 months of age assessed by the Korean Bayley Scale of Infant Development II. Bayesian kernel machine regression was used to estimate the mixture index of TRAPs and temperature on infant's MDI and PDI. Then, causal mediation approach was used to estimate the mediation effect of the mixture index on the association between greenness and infant's MDI and PDI after adjusting for potential confounders.

RESULTS: The total effect of greenness during the entire pregnancy and 6 months from birth on MDI at 6-month-old infants was 1.25 [95% confidence interval: 0.39, 2.39] and 1.09 (0.12, 2.09), respectively. And the indirect effect of the mixture index of TRAPs and temperature during the entire pregnancy and 6 months from birth was each 0.59 (0.19, 1.00) and 0.53(0.04, 1.09). Further, the total effect and the indirect effect of greenness during the entire pregnancy on PDI at 6-month-old infants was 1.45 (0.40, 2.72) and 0.47 (0.12, 0.99). No significant association was observed in other periods.

CONCLUSIONS: Our finding suggested that the residential green space has a beneficial effect on infant's neurodevelopment by reducing overall effect of TRAPs and temperature during pregnancy and early childhood.



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ABSTRACT E-BOOK

Keywords: Neurodevelopmental outcomes, Green space, Multi-pollutant, Causal inference



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Effects of Prenatal Exposure to Perfluorononanoic Acid on Neurobehavioral Development in Rat Offspring

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BACKGROUND AND AIM: Perfluorononanoic Acid (PFNA), a kind of fluorinated aliphatic molecules, had been extensively used in industrial applications as a surface protectant and known to accumulate in humans and wildlife. Although PFNA had been adversely associated with the growth and development of wild-type mice, much less is known about the impact of short-term exposure to PFNA during gestation on neurobehavioral development in rat offspring. The purpose of this study was to investigate the effects of PFNA on the physical and neurobehavioral development in sprague-dawley rat offspring.

METHODS: Dams were dosed daily via oral gavage during gestation days 1-19 with control, 0.02, 0.2, 1.0, and 5.0 mg/kg of PFNA. During postnatal day (PND) 1-21, a series of developmental test battery were conducted, including body weight, maturational milestones (pinnae unfolding, incisor eruption, hair growth and eye opening) and neurobehavioral reflex (surface righting reflex, negative geotaxis, and cliff avoidance tests). Morris water maze tests were performed to study the learning and memory ability of the rat offspring on PND 28.

RESULTS: PFNA exposure during gestation resulted in lower weight (≥ 1.0 mg/kg), later eye opening and worse performance in negative geotaxis (5.0 mg/kg), but no associations were observed between PFNA exposure and other maturational milestones or neurobehavioral reflex. Further, morris water maze tests indicated damaged spatial learning and memory ability of offspring (≥ 0.2 mg/kg).

CONCLUSIONS: Our study reveals that PFNA exposure during gestation produce multiple adverse effects on neuro-development in rat, research is needed to examine the potential mechanisms linked to the adverse effects of PFNA.

Keywords: perfluorononanoic acid, neurobehavioral development, rat offspring, prenatal exposure



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Association between prenatal air pollutant exposure and child development in a follow-up birth cohort study

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BACKGROUND AND AIM: Air pollutant exposure adversely associates with infant development. This study aimed to investigate the effect of prenatal air pollutant exposure on children development.

METHODS: Mother–infant pairs in two birth-cohort studies were recruited from five hospitals from 2001 to 2005. Children’s mental and psychomotor development was measured by the Bayley Scales of Infant Development in children aged 2 years. Hourly concentrations of five air pollutants (i.e. NO₂, CO, O₃, SO₂, and PM₁₀) within 1 year before childbirth were obtained from 76 air quality monitoring stations cross Taiwan. We used weighted K-nearest neighbor method (k=3) to estimate the personalized air pollution exposure and transformed the concentration of the five air pollutants into Individual Air Quality Index (IAQI) values. Multiple variable regression was used to assess the association between prenatal air pollutant exposure and Bayley score in 2-year-old children.

RESULTS: Overall, 286 mother-infant pairs completed all measurements. The geometrical mean of mental development index (MDI) score and psychomotor development index (PDI) score were 95.2 and 99.3, respectively. After adjusted for recruited cohort, parental education, gestational week, and child's sex, monthly average of prenatal air pollutants' IAQI different of CO, NO₂, and PM₁₀ were negatively associated with PDI score. Per unit increasing of the monthly average different of CO, NO₂, and PM₁₀ IAQI were associated with 10.30 (95% confidence interval, CI = 4.40-16.56), 2.58 (95% CI = 0.96-4.21), and 0.63 (95% CI = 0.06-1.19) decrease of PDI score in children, respectively.

CONCLUSIONS: Prenatal exposure to CO, NO₂, and PM₁₀ and their concatenation changes with time may affect children’s development at age 2 years.

Keywords: air pollution, neurodevelopmental outcomes, children's environmental health, birth cohort



ABSTRACT E-BOOK

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Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Residential Proximity to Roadways and Children's Behaviour and Psychomotor Development: findings from the Mothers and their Children's Health study

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BACKGROUND AND AIM: Evidence is growing on the adverse neurodevelopment effects of traffic-related air pollution in children. This study explored the role of multiple exposure periods based on residential proximity to roadways on behaviour and early development in children < 13 years.

METHODS: Data were from 2016/17 Mothers and their Children's Health study, a sub-study from a prospective longitudinal study called Australian Longitudinal Study on Women's Health (ALSWH). We geocoded mother's residential addresses at each ALSWH survey wave since 1996, and calculated distance to major roadways including roadway density in 100, 200 and 500 metre buffers as measures of traffic-related air pollution. Child outcomes were maternal-rated behaviour problems (Strengths and Difficulties Questionnaire; SDQ, aged 2-12 years, n=5,471 children) and developmental delays in communication and gross motor (Ages and Stages Questionnaire; ASQ, aged 1-66 months, n=1,265 children). Defined exposure periods calculated were roadway proximity before birth, children's lifetime, and mothers' long-term exposure. We performed logistic regression to estimate odds ratio (OR) for each child outcome, adjusting for potential confounders.

RESULTS: Although not statistically significant, children who lived ≤ 200m compared to >200m away from major roads had ORs>1 for poor behaviour and gross motor delay across all periods of exposure. Similar findings were observed in fully-adjusted models for road density of all road types in 100 and 200m buffers. However, this was only present for two exposure periods, children's lifetime and mothers' long-term exposure to road proximity. Residing closer to roadways prior to birth was associated with behaviour problems (e.g. [OR 1.16; 95% CI 0.83- 1.62] and [1.39; 0.82- 2.34] for all road types and major roads only in 200m buffer, respectively). Findings were mixed for communication delays in younger children due to small sample size (n=57).

CONCLUSIONS: No evidence of a significant association was present between road proximity and children's behaviour and early development.

Keywords: Neurodevelopmental outcomes, Traffic-related, Epidemiology



ABSTRACT E-BOOK

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Air pollution » Long-term exposure

PM2.5-associated burden of disease and its cost in 429 Iranian counties from 2016 to 2018

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BACKGROUND AND AIM: Ambient fine particulate matter (PM2.5: particles with an aerodynamic diameter of $\leq 2.5 \mu\text{m}$) causes a globally considerable disease burden. Little is known about the impacts of PM2.5 in all counties of Iran. We estimated the PM2.5-health burden, years of life lost (YLL) and economic impacts (based on the value of statistical life (VSL) and value of life year (VOLY)) of 429 Iranian counties during the period 2016-2018.

METHODS: All-natural cause and cause-specific mortalities were assessed using the Environmental Benefits Mapping and Analysis Program (BenMAP-CE v1.5) based on the Global Exposure Mortality Model (GEMM) and integrated exposure-response (IER) functions.

RESULTS: The annual mean population-weighted PM2.5 exposure concentrations across Iranian counties varied from 17.5 to 44.9, 16.8 to 58.2 and 19.4 to 66.1 $\mu\text{g m}^{-3}$ in 2016, 2017 and 2018, respectively. The premature all-natural cause mortality attributed to long-term exposure to ambient PM2.5 in Iran was approximately 49300 (95% Confidence Interval (95% CI): 45400, 52000), 51000 (95% CI: 47000, 53500) and 49300 (95% CI: 45600, 51800) in 2016, 2017 and 2018, respectively. Furthermore, approximately 16% of all-natural cause mortality in adults (aged above 25 years) was attributed to PM2.5. The YLL attributable to PM2.5 exposures in Iran was approximately 817000 (95% CI: 679000, 950000), 848000 (95% CI: 705500, 985000) and 827000 (95% CI: 687000, 961000) in 2016, 2017 and 2018. These YLL related to premature deaths were equivalent to the death of approximately 11 thousand children at birth. The economic loss in Iran due to the total estimated premature mortality attributable to ambient PM2.5 exposures was 20600 (95% CI: 19000, 21700), 21600 (95% CI: 20000, 23000) and 20300 (95% CI: 19000, 21300) million US\$ from 2016 to 2018.

CONCLUSIONS: Our findings provide a quantitative assessment of PM2.5 burden, assisting national evidence-based public health programs in Iran.

Keywords: Particulate matter, Long-term exposure, Outcomes, Mortality.



ABSTRACT E-BOOK

P-553

Air pollution » Long-term exposure

The Relationship between Long-Term Air Pollution Exposure and Cognition in Older Adults

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BACKGROUND AND AIM: Accumulation of evidence has raised concern regarding the harmful effect of air pollution on cognitive function, but results are diverging. We aimed to investigate whether long-term exposure to air pollutants may have an adverse effect on cognitive function in older adults residing in an urban area.

METHODS: Data were obtained from the Swedish National Study on Aging and Care in Kungsholmen (SNAC-K). Cognitive impairment, no dementia (CIND) was assessed by a comprehensive neuropsychological battery (scoring ≥ 1.5 standard deviations below age-specific means on ≥ 1 cognitive domain). We assessed long-term residential exposure to particulate matters (PM_{2.5} and PM₁₀) and nitrogen oxides (NO_x) with dispersion modeling. The association with CIND was estimated using Cox proportional hazards models with time-varying air pollution exposure. We further estimated the effect of long-term air pollution exposure on the progression of CIND to dementia.

RESULTS: Among 2499 cognitively intact participants, 351 individuals developed CIND during the 12-year follow-up. A 1- $\mu\text{g}/\text{m}^3$ increment in PM_{2.5} exposure was associated with a 63% increased risk of CIND incidence (HR=1.63, 95%CI: 1.44-1.86). Weaker associations were found for PM₁₀ (HR=1.06, 95%CI: 1.01-1.11) and NO_x (HR=1.01, 95%CI: 1.00-1.02). Among those with CIND at baseline (n=607), 118 participants developed dementia during follow-up. Moreover, PM_{2.5} exposure might increase the risk of progression from CIND to dementia in individuals with prevalent CIND at baseline (HR=1.24, 95%CI: 0.88-1.74).

CONCLUSIONS: We found suggestive evidence of an association between long-term exposure to ambient air pollutants and incidence of CIND and its progression to dementia in older adults. Further research should focus more on the underlying mechanisms.

Keywords: Long-term exposure, Neurodegenerative outcomes, Traffic-related



ABSTRACT E-BOOK

P-554

Air pollution » General

Ambient air pollution and cardiorespiratory outcomes amongst adults residing in four informal settlements in the Western Province of South Africa

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BACKGROUND AND AIM: Despite the majority of ambient air pollution-related deaths occurring in low-and middle-income countries, most of the studies that have investigated the relationship between ambient air pollution and cardiorespiratory outcomes were not conducted in Africa.

This study investigated the relationship between ambient air pollution exposure and self-reported cardiorespiratory outcomes amongst adults residing in four informal settlements of the Western Province of South Africa.

METHODS: A cross-sectional study comprising of 572 adults from four informal settlements (Khayelitsha, Marconi-Beam, Oudtshoorn and Masiphumelele) in Western Cape, South Africa was conducted. The study made use of modelled exposure estimates using Land-Use Regression for particulate matter of aerodynamic diameter of 2.5µm (PM2.5) and nitrogen dioxide (NO₂) at each participant's home address. An adapted European Community Respiratory Health Survey and National Health and Nutrition Examination Survey questionnaire was used to collect data on self-reported cardiorespiratory outcomes and covariates.

RESULTS: The median age of the participants was 40.7 years and 88.5% of the participants were female. The median NO₂ level was 19.7 µg/m³ with interquartile range (IQR): 9.64 – 23.7 and PM2.5 level, 9.7 µg/m³ (IQR: 7.3 – 12.4). An interquartile range increase of 5.12 µg/m³ in PM2.5 was associated with an increase prevalence of self-reported chest-pain [1.38 (95%CI: 1.06 - 1.80)] adjusting for NO₂, and other covariates.

CONCLUSIONS: The study found preliminary evidence of a possible association between annual ambient PM2.5 exposure and chest-pain (a crude proxy of angina-related pain), even at levels below both WHO Air Quality Guidelines and the South African National Ambient Air Quality Standards. However, the results should be interpreted cautiously due to the self-reported nature of the outcome measure, small sample size and the cross-sectional design of the study.

Keywords: Air Pollution, Cardiovascular Diseases, Respiratory Diseases, Chemical Exposures, Asthma



ABSTRACT E-BOOK

P-555

Air pollution » Long-term exposure

Effective Biosecurity measures during the Diagnosis of COVID-19 at the Pasteur Institute from the Perspective of Hazardous Hospital Waste Management

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BACKGROUND AND AIM: Waste is a daily health hazard that must be addressed through appropriate management. The Institut Pasteur of Côte d'Ivoire (IPCI) produces waste that is generally infectious waste and waste assimilated to household waste. The presence of this mostly infectious waste can create a risk for staff. Thus, since March 11, 2020, the date of the first case of COVID-19, a rigorous health management policy has been taken to protect health workers.

METHODS: Diagnosis of the COVID-19 pandemic in Côte d'Ivoire is mainly done at the Institut Pasteur of Côte d'Ivoire (IPCI). Thus, the waste produced in the various laboratories is disinfected, then sorted, packaged in 5 to 10 liter bags, transported in dedicated bins to final storage. The waste is weighed under biosafety conditions before being incinerated in an ATI Environment CP100 incinerator.

RESULTS: Waste management at IPCI in 2020 during COVID-19 resulted in biosafety training for staff, collection, packaging, transportation, storage and incineration of 26.4 tons of waste. It should be noted that no waste management personnel were infected during the entire period from March to December 2020.

CONCLUSIONS: During the year 2020 and mainly from March 11, 2020 to December 31, 2020, waste management increased significantly from 12.2 tons in 2019 during the same period to 26.4 tons in 2020 and was related to COVID-19. This shows that waste has more than doubled and requires rigorous management. It would therefore be imperative to properly manage waste in order to protect health care personnel. Also, this study showed one aspect of the environmental impact of COVID-19 that needs further research.

Keywords: COVID-19, Waste management, incineration



ABSTRACT E-BOOK

P-556

Air pollution » General

Proxy exposure indicators for indoor air pollution, health impact and deprivation in the Marche region, Italy

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BACKGROUND AND AIM: In 2016 indoor pollution caused 3.8 million deaths attributable to respiratory, cardiovascular diseases and cancers. The aim of this study is to evaluate in our Marche region, possible association between hospitalization for asthma, Extrinsic Allergic Alveolitis (EAA) and Carbon Monoxide Intoxication (COI) and two proxy indicators of the exposure to indoor air pollution, such as PM_{2.5} concentration and socioeconomic deprivation index (DI).

METHODS: We included subject's hospital admissions residing in the Marche region between 2006 and 2013. For PM_{2.5} air concentrations we used estimates provided by the atmospheric modelling system of Italian National Integrated Assessment Model (AMS-MINNI). Exposure was defined on the basis of the quintiles of PM_{2.5} municipalities distribution values. Socio-economic disadvantage was measured through the DI built considering five features of the resident population: low instruction, unemployment/first job-employment, rent living, being part of a single parent family and high population density. The DI provides following municipalities classification: very wealthy, wealthy, middle, deprived, very deprived.

RESULTS: Regarding asthma, results show a higher risk of hospitalization with the increasing of PM_{2.5} concentration quintiles. The risk increases by 35% (90% CI 1.09-1.65) for the third and fourth quintile compared to the first and 30% (90% CI 1.07-1.59) for the highest quintile. For EAA and CO intoxication there is an evident risk gradient of hospitalization as the DI increases despite the low number of events for these pathologies.

CONCLUSIONS: This work confirms that PM_{2.5} concentration has an impact in increasing hospital admissions due to asthma and suggests a possible correlation between lower socio-economic status and increased risk of hospitalization due to EAA and CO intoxication.

Keywords: Air pollution, Socio-economic factors, Allergies, Respiratory outcomes, Asthma



ABSTRACT E-BOOK

P-559

Air pollution » Long-term exposure

Vigilance index for outdoor air quality around schools and nurseries

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BACKGROUND AND AIM: Every day a lot of children breathe air that is so polluted it puts their health and development at serious risk. Children are particularly vulnerable to the effects of air pollution because they breathe more rapidly than adults and so absorb more pollutants. A vigilance index was therefore developed to alert authorities about the outdoor air quality around schools and nurseries in Wallonia, Belgium.

METHODS: A long-term air quality index (AQI) was built to reflect long-term health impact of traffic-related pollutants. Annual concentrations of NO₂, PM₁₀ and PM_{2,5} were estimated on each location of schools and nurseries (7130 address points) in Wallonia using ATMO-street model. This model represents the varying concentrations of air pollutants across a region, taking into account the regional and urban background but also capturing so called street canyon effects into one single air quality map. The AQI and its sub-indices are subdivided into 10 index classes. The concentration scales of NO₂, PM₁₀ and PM_{2,5} sub-indices were determined based on the relative risk of mortality associated with long-term exposure to these air pollutants. The highest sub-index value is attributed to the final long-term AQI.

RESULTS: The results showed that 868 structures (12%) are impacted by poor to execrable air quality (AQI ≥ 6), i.e. 14% of schools and 10% of nurseries. PM₁₀ was generally the highest sub-index at the locations and therefore the most critical pollutant for determining the long-term AQI. Results are presented into a secured web app, with an interactive interface via ArcGIS Dashboard. A pop-up window provides details for each structure: type, municipality, AQI value, sub-index values and annual concentrations of pollutants.

CONCLUSIONS: This study provides a vigilance index to accurately assess the impact that the air quality has on children's health. Using this information, policymakers can take action to check and reduce levels in pollution hotspots.

Keywords: Air pollution, Children's environmental health, Traffic-related, Long-term exposure, Spatial statistics



ABSTRACT E-BOOK

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Air pollution » Long-term exposure

Long-term exposure to air pollution and incidence of rhinitis in adults in the French population-based cohort Constances

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BACKGROUND AND AIM: The link between air pollution and incidence of rhinitis, especially in adults, is poorly understood. We aimed to study the associations between long-term exposure to nitrogen dioxide (NO₂), particulate matter $\leq 2.5 \mu\text{m}$ (PM_{2.5}) and black carbon (BC) and incident rhinitis, among adults from Constances, a large French population-based cohort.

METHODS: At inclusion (in 2012/2013) and at follow-up (in 2014), questionnaires included questions on the presence of rhinitis symptoms over lifetime. We defined incident rhinitis as: 1) "General incidence": when the participant reported never rhinitis at inclusion but reported rhinitis at follow-up; 2) "Strict incidence": when in addition the age of onset of rhinitis was higher than the age at inclusion. Annual concentrations of NO₂, PM_{2.5} and BC were estimated at the participants' residential address by European land-use regression models. Associations between each air pollutant and incident rhinitis were assessed using logistic models adjusted for age, sex, smoking, education level and French deprivation index.

RESULTS: Among the 19,829 participants with available data at inclusion and follow-up, 6,644 reported never rhinitis, 2,516 were categorized as "general incident" rhinitis, and 103 as "strict incident" rhinitis. Adjusted(a) ORs (95% Confidence Interval) for "general incidence" were 1.07 (0.99, 1.17) per 5 $\mu\text{g}/\text{m}^3$ PM_{2.5}, 1.13 (1.03, 1.24) per 10-5m-1 BC, and 1.07 (1.00, 1.15) per 15 $\mu\text{g}/\text{m}^3$ NO₂. aORs for "strict incidence" were 1.30 (0.91, 1.86) for PM_{2.5}, 1.40 (0.93, 2.10) for BC, and 1.27 (0.95, 1.70) for NO₂.

CONCLUSIONS: Air pollution may increase the risk of incident rhinitis in adults in the general population. Interestingly, although the associations were not statistically significant for "strict incidence", probably due to sample size, ORs were higher than for "general incidence", suggesting the importance of the outcome definition.

Keywords: Air pollution, Incidence, Long-term exposure, Respiratory outcomes, Environmental epidemiology



ABSTRACT E-BOOK

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Air pollution » Long-term exposure

Associations between exposure to outdoor air pollution and cognitive function in England: the ELSA cohort

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BACKGROUND AND AIM: The potential role of exposure to air pollution on cognitive health outcomes is yet to be fully understood, although there is an increase in evidence for a negative association between cognition and several pollutants. Here, long-term estimates of NO₂, PM₁₀, PM_{2.5} and O₃ were linked to respondents of the English Longitudinal Study of Ageing (n = 8,967 respondents aged 50 years and older) and the effects of each pollutant on cognitive test scores were investigated.

METHODS: Annual average CMAQ-urban (Community Multiscale Air Quality) dispersion model estimates were applied to the residential postcode of respondents. A composite memory scale (0-20) incorporated responses to both an immediate and delayed word recall test. The animal naming test was included as a measure of executive function (0-50). Mixed-effects models were implemented separately for each pollutant and for each test, adjusting for age, gender, number of follow-ups, physical activity and smoking status.

RESULTS: Respondent score on the composite memory scale decreased by 0.12 per interquartile range (IQR) increase for NO₂ (IQR: 12.4µg/m³), as well as decreases of 0.02 for PM₁₀ (IQR: 3.65µg/m³) and 0.08 for PM_{2.5} (IQR: 2.7µg/m³). An increase in score of 0.25 was reported for ozone per increase in IQR (15.05µg/m³). For executive function scores, negative associations were found for NO₂, PM₁₀ and PM_{2.5}, with decreases of 0.29, 0.06 and 0.15, respectively per IQR increase. An IQR increase in ozone increased executive function score by 0.46. All results were statistically significant (p < 0.05).

CONCLUSIONS: Cognitive function in ELSA respondents decreased as exposure to NO₂, PM₁₀ and PM_{2.5} increased. Both episodic memory and executive function may be affected by long-term exposure to air pollution and further investigation is required to fully determine the extent to which the cognitive health of the elderly population of England may be vulnerable to outdoor air pollution.

Keywords: Air pollution, Long-term exposure, Mental health outcomes



ABSTRACT E-BOOK

P-562

Air pollution » Long-term exposure

Risk of breast cancer associated with long-term exposure to Benzo[a]pyrene (BaP) air pollution: Evidence from the French E3N cohort study

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BACKGROUND AND AIM: Benzo[a]pyrene (BaP) is an endocrine-disrupting pollutant formed during incomplete combustion of organic materials. It has been recognized as a reproductive toxicant, however epidemiological evidence of its long-term effect on breast cancer (BC) is limited. Thus we evaluated associations between ambient air BaP exposure and risk of BC, overall and according to menopausal status and molecular subtypes (estrogen receptor negative/positive (ER-/ER+) and progesterone receptor negative/positive (PR-/PR+)), stage and grade of differentiation of BC in the French E3N cohort study.

METHODS: Within a nested case-control study of 5,222 incident BC cases and 5,222 matched controls, annual BaP exposure was estimated using a chemistry-transport model (CHIMERE) and was assigned to the geocoded residential addresses of participants for each year during the 1990-2011 follow-up period. Multivariable conditional logistic regression models were used to estimate odds ratios (ORs) and 95% confidence intervals (CIs).

RESULTS: Overall, cumulative airborne BaP exposure was significantly associated with the overall risk of BC, for each 1 interquartile range (IQR) increase in the concentration levels of BaP (1.42 ng/m³), the OR = 1.15 (95%CI: 1.04-1.27). However, by menopausal status, the significant positive association remained only in women who underwent menopausal transition (i.e. premenopausal women at inclusion who became postmenopausal at diagnosis), OR per 1 IQR = 1.20; 95%CI: 1.03-1.40. By hormone receptor status, positive associations were observed for ER+, PR+ and ER+PR+ BC, with ORs = 1.17 (95%CI: 1.04-1.32), 1.16 (95%CI: 1.01-1.33), and 1.17 (95%CI: 1.01-1.36) per 1 IQR, respectively. There was also a borderline positive association between BaP and grade 3 BC (OR per 1 IQR = 1.15(95%CI: 0.99-1.34).

CONCLUSIONS: We provide evidence of increased risk of BC associated with cumulative BaP exposure, which varied according to menopausal status, hormone receptor status, and grade of differentiation of BC. Our results add further epidemiological evidence to the previous experimental studies.

Keywords: airborne benzo[a]pyrene, breast cancer, residential history, menopausal transition,



ABSTRACT E-BOOK

hormone receptor status, differentiation grade

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Air pollution » Long-term exposure

National scale LUR model over France for PM₁₀, PM_{2.5}, NO₂ and O₃: development, validation and back-extrapolation from 2010 to 1990

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BACKGROUND AND AIM: In the context of a case-control study nested in a French cohort of about 10400 subjects, on air pollution exposures and breast cancer risk, we reconstructed subjects' exposures to four pollutants (PM₁₀, PM_{2.5}, NO₂ and O₃) between 1990 and 2010, using land use regression models.

METHODS: We used databases of ambient air measurements, a large number of geographical variables and background pollution data provided by a country-wide chemistry-transport model (CTM) with an 8x8km resolution. We first built baseline models for the most recent year of the study period (2010) and validated them via cross-validation (pooling of predictions from leave-20%-out). In a second step, we extrapolated the baseline models to 1990. For each pollutant, we tried multiple backextrapolation approach (trends established with concentrations measured from remote location or simulated by the CTM). We selected the best method, based on the performance compared to the measurement data available between 1990 and 2009 (and non-used for the backextrapolation).

RESULTS: The cross-validation of the baseline models showed robust results (CV-R²; CV-RMSE): NO₂ (0.67; 7.5), PM₁₀ (0.64; 3.3), PM_{2.5} (0.51; 2.6) and O₃ (0.60; 6.2). Based on the baseline models, we produced high spatial resolution maps of the French territory (50x50m). The extrapolation of the baseline models to 1990 seems to produce better results if based on trends established at the local scale (8x8km) with the CTM data. For NO₂ and O₃, the statistical indicators remain fairly stable over the period. For PM₁₀ and PM_{2.5}, we observe a drop in performance over the period 1990-1998. This can partly be explained by the very low number of PM₁₀ and PM_{2.5} measurement data available in France before 2000, which limits extensive comparisons.

CONCLUSIONS: This work shows that it is possible to accurately reconstruct exposures over very large territories and long periods thanks to the input of simulated background pollution data.

Keywords: air pollution, long term exposure, LUR, CTM, PM_{2.5}, NO₂



ABSTRACT E-BOOK

P-564

Air pollution » General

Separating personal exposure from indoor and outdoor sources in a large London cohort (a part of MELONS* project)

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BACKGROUND AND AIM: Traditional time-series studies use ambient measurements as a proxy for personal exposures. Yet this accounts for neither the different time activities of individuals nor the spatial heterogeneity of the pollutants. Hence it introduces exposure measurement error and produces bias in epidemiological studies. Instead, we propose the use of personal exposure to outdoor sources as a better proxy was proposed as it is not affected by indoor sources and is important for policy intervention. This study aims to separate personal exposure of outdoor sources from indoor sources in a large London cohort.

METHODS: The London cohort was formed by four large field campaigns within London. It comprises over 200 million linked and validated 1-minute mean measurements of gaseous (NO, NO₂, CO, O₃) and particulate (BC, PM_{2.5}, PM₁₀) pollutants, from 130 Chronic Obstructive Pulmonary Disease (COPD) patients continuously measured for six months, 40 healthy adults continuously measured for seven days, 250 primary age children and 140 professional drivers continuously measured for four days. We integrated the pollutant database, clustered GPS measurements, performed location tagging on one-minute data, then calculated monthly home infiltration efficiency. Using this information, we estimated participants' personal exposure from indoor and outdoor sources.

RESULTS: These COPD patients spent the majority of their time at home (on average 92%). The daily mean (\pm SD) personal exposure from indoor sources and from outdoor sources for these COPD participants were 4.9 ± 3.7 and 8.1 ± 6.1 $\mu\text{g}/\text{m}^3$.

CONCLUSIONS: Personal exposures were separated into indoor and outdoor sources for COPD patients in London and will be extended to other subgroups. Personal exposure from outdoor sources, regardless of the time they actually spent outdoors, was the main source of pollution exposure for these COPD patients. Separating sources of personal exposure allows separate examinations on the associations of health effects and more targeted pollution control interventions.

Keywords: personal exposure, outdoor sources, indoor sources, measurement error



ABSTRACT E-BOOK

P-565

Air pollution » General

Pro-inflammatory effects of air pollution using simple blood marker

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BACKGROUND AND AIM: Air pollution is a known risk factor for cardiovascular and respiratory morbidity and mortality. One mechanism explaining the observed associations is that exposure to air pollution induces inflammation processes. This link from an epidemiological perspective has been investigated for Particulate Matter (PM) and for nitrogen oxides (NO_x). This study aims to evaluate the association between air pollution and inflammation using immune blood markers.

METHODS: We evaluated the short-term association between PM₁₀, PM_{2.5}, NO₂, NO, and routine immune blood markers (white blood cells (WBC), lymphocytes, and neutrophils) on subjects whose had routine blood sample tests in Padova, Italy, from 2009 to 2019. We estimated the short-term association between each immune blood markers and pollutant using a linear regression model with generalized estimating equations combined with distributed lag non-linear models to assess both delayed effect in time (till 21 days) and the possible non-linear exposure-response relationship. Models were adjusted for age, gender, temperature, relative humidity, pressure, and seasonality.

RESULTS: More than 500,000 blood samples were collected among 169,508 subjects. We observed a non-linear positive association between NO_x and circulating immune cells. An increase of 190 (10⁶/L) WBC (CI: 141-238), 60 (10⁶/L) neutrophils (CI: 23-98) and 86 (10⁶/L) lymphocytes (CI: 69-104) was detected for an IQR increase in NO₂.

PM₁₀ and PM_{2.5} showed a non-linear relationship with WBC, neutrophils, and lymphocytes. The overall effect was detectable as positively associated with increased levels of circulating immune cells from 20 µg/m³ of PM₁₀ and 15 µg/m³ of PM_{2.5}.

CONCLUSIONS: Air pollution has an impact on the immune response measured with immune blood markers. NO_x shows a more evident pro-inflammatory effect from low concentrations without a threshold effect. PM has an overall impact on circulating immune cells detectable at higher exposures. These results reinforce the evidence of a link between air pollution and systemic inflammation and oxidation.

Keywords: Oxides of nitrogen, Particulate matter, Short-term exposure



ABSTRACT E-BOOK

P-566

Air pollution » General

Air pollution policies in European cities: single-focused and holistic solutions

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BACKGROUND AND AIM: Poor air quality is recognized as a major environmental health problem requiring immediate action. What may be still lacking attention, however, is how the path taken to reach improvements matters for health. Air pollution policies can be narrowly focused on reaching concentration targets with no further benefits to society, or can deliver health co-benefits, such as physical activity promotion or noise reduction when reducing car use or promoting active travel. Some cities may take the opportunity of tackling air pollution to deliver much more broadly on health improvements. This paper examines the balance of single vs holistic policy focus in current air pollution strategies adopted across a range of UK and German cities.

METHODS: A framework was developed to categorize air quality policies as holistic or single-focused. Local Clean Air Plans from 2015 onwards were analyzed for a selection of nine UK and nine German cities. The importance given to each type of approach was estimated by counting the number of distinct policies in each camp, weighted by considerations of funding allocation and level of concreteness (e.g. implementation schedule).

RESULTS: The focus on holistic approaches ranged from 30% (in Frankfurt am Main) to 87% (in Stuttgart) in the selected German cities, with an average across cities of 68% of the policy strategies taking on a holistic approach (vs 32% single-focused). In contrast, UK cities' focus on holistic policies ranged from 9% (in London) to 79% (in Cardiff), with an average of 46%.

CONCLUSIONS: While some UK cities, such as London, have been heralded as exemplary in their approach to tackling air pollution, they seem to often miss an opportunity to tackle health more holistically. German cities on the other hand generally seem to have espoused broader concepts of health promotion in their approach to air pollution mitigation.

Keywords: Air pollution, Health co-benefits, Particulate matter, Policy, Traffic-related, cities



ABSTRACT E-BOOK

P-567

Air pollution » Long-term exposure

Ambient air pollution and prostate cancer in a population-based Canadian case-control study

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BACKGROUND AND AIM: Age, ethnicity and family history are the only established risk factors for prostate cancer, but they are not modifiable. Other risk factors have been investigated, with inconsistent findings. A possible role of air pollution, which has been classified as a human carcinogen, has been suggested yet there have been few studies of prostate cancer.

METHODS: We conducted a case-control study in eight Canadian provinces to investigate the relationship between PM_{2.5} and NO₂ and incident prostate cancer. Participants provided data between 1994 and 1997 and the development of air pollution historical surfaces now permits risks to be estimated. 1416 cases of prostate cancer and 1426 controls who reported addresses between 1975 and 1994 were examined. Three methods were used to measure the mean exposure to PM_{2.5} and NO₂: (1) satellite-derived observations; (2) satellite-derived observations scaled with historical fixed-site measurements of PM_{2.5} and NO₂; and (3) a national land-use regression (LUR) model for NO₂. Odds ratios (OR) and 95% confidence intervals (CI) were estimated per interquartile range (IQR) increase in PM_{2.5} and NO₂ using logistic regression.

RESULTS: We found a positive association between prostate cancer and both measures of PM_{2.5} from 1975 to 1994; for an increase of 1 IQR of PM_{2.5}, the OR adjusted for personal and contextual factors was 1.27 (95% CI: 1.09-1.54) while for the satellite derived-observation the OR was 1.21 (95% CI: 1.04-1.41). We also observed positive associations for NO₂. The ORs for satellite-derived observations and scaled satellite-derived observations of NO₂, adjusted for personal and contextual factors, were 1.05 (95% CI: 0.93-1.19) and 1.15 (95% CI: 0.97-1.36) per IQR increase, respectively.

CONCLUSIONS: Our study highlights a potential role of air pollution in prostate cancer etiology. Given the paucity of studies on this topic, further research is needed exploring the role of screening and variations in risk by prostate cancer aggressiveness.

Keywords: prostate cancer, air pollution, PM_{2.5}, NO₂, case control study, Canada



ABSTRACT E-BOOK

P-568

Birth and Pregnancy Outcomes » Birth outcomes

Prenatal exposure to nitrate from household drinking water and the risk of preterm birth: A nationwide study from Denmark, 2011-2015

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BACKGROUND AND AIM: Only two studies of prenatal exposure to nitrate from drinking water and the risk of preterm birth have been conducted, both with ecologic exposures and from the US. We aimed to examine this relationship utilizing individual-level exposure estimates in Denmark.

METHODS: Nationwide register-based health data from singleton live births during 1991–2015 born to Danish-born parents were linked to national water monitoring and administrative data, including each maternal residence during pregnancy. The association between individual-level prenatal nitrate (NO_3^-) exposure from household drinking water and the odds of preterm birth (<37 weeks gestation) was evaluated using logistic regression with generalized estimating equations to account for sibling clusters. Models were adjusted for sex, birth year, birth order, urbanicity, and maternal age, smoking, education, income, and employment status at the individual level.

RESULTS: Using a complete case analysis, 1,009,189 births were included in main models, including 3.6% of households with nitrate levels >25 mg/L NO_3^- (half the European Union standard) and 5.1% of births being preterm. The median exposure in the cohort was 1.9 (IQR: 1.0–3.4) mg/L NO_3^- . An increased risk of preterm birth was seen across categories of exposure ($p < 0.001$) with an odds ratio in the uppermost category (>25 mg/L NO_3^-) of 1.05 (95% CI: 1.00, 1.10) compared to the referent (<2 mg/L NO_3^-). Continuous models also demonstrated an increased risk of preterm birth per 10 mg/L NO_3^- increase [OR: 1.01 (95% CI: 1.00, 1.03)].

CONCLUSIONS: We observed an increased risk of preterm birth as nitrate concentrations in maternal household drinking water increased. This estimated risk was of a similar magnitude as the two previous studies from the US. Our findings add to a body of evidence of the physical harm from nitrate in drinking water, even at concentrations below current regulatory levels. Policymakers may consider lowering maximum contaminant levels to protect public health.



ABSTRACT E-BOOK

Keywords: Big data, Birth outcomes, Children's environmental health, Environmental epidemiology, International collaboration, Water quality

P-569

Birth and Pregnancy Outcomes » Birth outcomes

Nitrate in Danish household tap water and the risk of small-for-gestational-age, 1991-2015

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BACKGROUND AND AIM: Findings from studies examining the effects of prenatal exposure to nitrate from drinking water on fetal growth have been inconsistent, small, and mostly ecologic in nature. The aim of this study was to assess maternal exposure to nitrate (NO_3^-) in drinking water and small-for-gestational-age in a large population-based cohort.

METHODS: Exposure estimates from each maternal address during pregnancy were obtained from a national public and private water monitoring database. We linked these individual household nitrate concentrations with individual-level birth registry data to create a cohort of 1,078,892 singleton live births in Denmark to Danish-born parents during 1991–2015. Exposures were modeled as log-transformed continuous estimates and categorically. Small-for-gestational-age was defined as the lightest 10% of infants at birth per sex and gestational week. Multivariable logistic regression with generalized estimating equations was used to assess associations and account for the non-independence of siblings. National register-based data were used to adjust for sex, birth year, birth order, and maternal age, smoking, education, income, and employment status at the individual level.

RESULTS: In this cohort, the median nitrate concentration was 1.9 mg/L NO_3^- . An increased risk of small-for-gestational-age was observed when comparing half the European Union standard (25 mg/L NO_3^-) to 1 mg/L NO_3^- [OR: 1.03 (95% CI: 1.01, 1.05)] and in categorical analyses, except for the highest category (>25 mg/L NO_3^-) compared to the referent (<2 mg/L NO_3^-), possibly due to small numbers.

CONCLUSIONS: In this nationwide study spanning 25 years, we found that nitrate in maternal household tap water during pregnancy was associated with an increased risk of her child being born small-for-gestational-age. While the increased risk may be small at an individual level, given the



ABSTRACT E-BOOK

widespread presence of nitrate in drinking water it is important on a global scale. When evaluating nitrate regulations, policymakers should focus on health impacts at levels below current standards.

Keywords: Big data, Birth outcomes, Children's environmental health, Environmental epidemiology, International collaboration, Water quality

P-570

Birth and Pregnancy Outcomes » Pregnancy outcomes

Maternal mortality among women following motor vehicle crashes: systematic review and meta-analysis

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BACKGROUND AND AIM: Several studies have reported that pregnant women involving in motor vehicle crashes (MVCs) are associated with increased risk of adverse health outcomes. Given that pregnant women are more likely than non-pregnant women to seek medical care after MVCs due to precaution, it is still unclear whether MVCs themselves may increase the risk of mortality in pregnant women. This study aimed to provide a systematic review and meta-analysis of mortality risk in association with pregnancy after MVCs.

METHODS: This study used relevant keywords and MESH terms to identify epidemiological studies of mortality risk in relation to MVCs from PubMed, Web of Science, Embase, and Cochrane database from 1968 to 2020. Two authors independently screened the titles, reviewed abstracts, and performed data extraction. We used the Newcastle-Ottawa scale for quality assessment. For comparison of mortality from MVCs between women with- and without pregnancy, we calculated the odds ratio (OR) with 95% confidence interval (CI) using a random effect model. The heterogeneity of included studies was estimated with I^2 statistic.

RESULTS: Six studies, 13,830 injured victims with pregnancy and 204,612 victims without pregnancy were included. Compared to non-pregnant women, pregnant women were shown to have moderate but insignificantly increased mortality risk (pooled OR = 1.27, 95% CI=0.92–1.74, $I^2=91.76\%$). However, the pooled OR was significantly increased at 1.64 (95% CI=1.16–2.33, $I^2=0.00\%$) for the two studies with similar mean of injured severity score (ISS) between pregnant and non-pregnant women was. In contrast, the pooled OR was significantly reduced at 0.38 (95% CI=0.18–0.80, $I^2=90.28\%$) in favour of pregnant women for the four studies in which the diversity of the mean of ISS in non-pregnant women and their pregnant counterparts.

CONCLUSIONS: After risk stratifications, the pregnant women tended to experience increased mortality after MVCs. Future studies should be performed to further explore factors associated with MVCs in pregnant women.

Keywords: Mortality, Female, Pregnancy outcomes, Traffic-related



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-571

Birth and Pregnancy Outcomes » Birth outcomes

Modeling complex effects of exposure to particulate matter and extreme heat during pregnancy on congenital heart defects

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BACKGROUND AND AIM: Previous research suggests gestational exposure to particulate matter ≤ 2.5 μm (PM_{2.5}) and extreme heat may independently increase risk of birth defects. We investigated whether duration of gestational extreme heat exposure modifies the associations between PM_{2.5} exposure and specific congenital heart defects (CHDs).

METHODS: We identified live-birth, stillborn, and induced termination CHD cases ($n = 2,824$) and non-malformed live-birth controls ($n = 4,033$) from pregnancies ending between October 1997 and December 2011 in the National Birth Defects Prevention Study (NBDPS). We assigned mothers 6-week averages for 24-hour PM_{2.5} exposure during the cardiac critical period (gestational weeks 3-8) using the closest monitor within 50 kilometers of maternal residence. We assigned a count of extreme heat days (EHDs, days above the 90th percentile from daily maximum temperature distribution for region, year, and season) during this period using the closest weather station. Using generalized additive models (GAMs), we explored logit-nonlinear exposure-outcome relationships, observing that linearity assumptions were reasonable. We estimated joint effects of PM_{2.5} and EHDs on six CHDs using logistic regression models adjusted for critical period regional mean dewpoint and maternal age, education, and race/ethnicity. In final models, we assessed multiplicative and additive effect modification.

RESULTS: In adjusted models, conditional on mothers experiencing the highest observed EHD count (17), each 5 $\mu\text{g}/\text{m}^3$ increase in average PM_{2.5} exposure was associated with increased odds of any septal defect (OR: 1.52 [95% CI: 1.04, 2.23]) and perimembranous ventricular septal defects (OR: 1.68 [95% CI: 1.02, 2.83]). Associations conditional on low/median maternal EHDs were null or inverse. Multiplicative and additive effect modification estimates were consistently positive when considering septal defects.



ABSTRACT E-BOOK

CONCLUSIONS: Results suggest cumulative extreme temperature exposure during early pregnancy may modify associations between PM_{2.5} and some CHDs. Specifically, maternal extreme heat and PM_{2.5} exposure may jointly increase risk of offspring septal defects. Abstract does not represent EPA/CDC policy.

Keywords: particulate matter, temperature extremes, birth outcomes, cardiovascular diseases

P-572

Birth and Pregnancy Outcomes » Birth outcomes

Birth Outcomes Associated with Paternal Polybrominated and Polychlorinated Biphenyl Exposure

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BACKGROUND AND AIM: In 1973, polybrominated biphenyl (PBB) flame retardant was shipped to Michigan feed mills in place of a nutritional supplement and contaminated the food supply. Following the accident, the Michigan PBB Registry was established to study the long-term health effects of halogenated compounds, and is now led by a community-academic partnership. PBB exposure is associated with decreased DNA methylation in sperm regulatory elements controlling imprinted genes, which may lead to adverse birth outcomes in children whose fathers have increased levels of serum PBB or polychlorinated biphenyl (PCB), an analogue of PBB. To further understand the impact of paternal exposures on children, we analyzed paternal PBB and PCB levels and premature birth and low birthweight.

METHODS: We investigated the outcomes of birthweight and gestational age of offspring whose fathers enrolled in the PBB Registry and provided serum to measure PBB and PCB concentrations. Birth outcomes were determined by linking paternal PBB records to the Michigan vital records. Birthweight and gestational age were dichotomized at the 25th percentile and 37 weeks respectively, and paternal PBB and PCB levels were divided into tertiles. Offspring birthweight and gestational age were modeled against paternal PBB and PCB serum concentrations using log-risk regression, adjusting for clustering, paternal health and lifestyle factors, and offspring sex.

RESULTS: Elevated PBB and PCB levels are associated with an increased risk of low offspring birthweight, but not preterm birth. Fathers in the middle and upper PBB and PCB tertiles illustrated increased risk ratios (RR) for low offspring birthweight, RR=1.42 (CI=0.93-2.17) and RR=1.47 (CI=1.03-2.10) for PBB, and RR=1.73 (CI=1.12-2.67) and RR=1.42 (CI=0.84-2.41) for PCB respectively. Elevated PBB and PCB levels illustrated no significant increased risk for preterm birth in the middle and upper tertiles.

CONCLUSIONS: These findings suggest increased paternal PBB and PCB levels may negatively impact offspring birthweight.

Keywords: Endocrine disrupting chemicals, Birth outcomes, Children's environmental health, Community outreach, Environmental epidemiology



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-573

Birth and Pregnancy Outcomes » Other (to be specified with keywords in the keywords section)

Association of prenatal exposures of parabens with children's obesity—A longitudinal cohort study

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BACKGROUND AND AIM: The association between prenatal exposure of parabens and children's obesity was inconclusive and we aimed to exam it.

METHODS: Mother-newborn pairs were enrolled at the 3rd trimester during pregnancy and followed as children aged 2-3, 5-6, 8-9, 11-12, 14-15, and 17-18 years in central Taiwan. Information were collected via questionnaires, physical examinations, and bio-samples. Urinary concentrations of methyl paraben (MP), ethyl paraben (EP), propyl paraben (PP), butyl paraben (BP) in pregnant women and 17-18 years-old children were determined using liquid chromatography/electrospray ionization-tandem mass spectrometry (LC/ESI-MS/MS) and corrected by urinary creatinine level. Molar concentrations of the four parabens were summed to Σ PB. Children's body mass index (BMI) were calculated at each follow-up. Ordinary linear regression model was performed.

RESULTS: Prenatal exposure levels of MP, EP, PP, BP, and Σ PB were similar in 92 male and 99 female children. MP was with the highest and EP was with the lowest concentration. After adjustment for child sex, annual family income, parental education level, maternal BMI, and weight gain, the associations of children's BMI with prenatal exposure of MP and Σ PB were positive though non-significant at ages of 2-3 years and null at ages of 5-6 years. The associations turned to be negative since ages of 8-9 years and borderline significant at ages of 14-15 years. In analyses at ages of 17-18 years, we additionally adjusted for children's paraben exposure levels and found that per log₁₀ μ g/g MP and Σ PB increase in-utero were significantly associated with 1.20 and 1.32 reductions of BMI ($p=0.022$ and 0.017).

CONCLUSIONS: MP was the most common paraben the pregnant women exposed in central Taiwan. The association between prenatal exposure of parabens and children's BMI may vary with age, it tended to be positive in toddlers and negative from puberty to post-puberty.

Keywords: Obesity and metabolic disorders, Children's environmental health, Endocrine disrupting chemicals, Environmental epidemiology, Food/nutrition, Birth outcomes



ABSTRACT E-BOOK

P-574

Birth and Pregnancy Outcomes » Birth outcomes

Associations between green space, air pollution and birthweight in Sydney Metropolitan Area, Australia

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BACKGROUND AND AIM: Low birthweight is one of the most common pregnancy complications. Previous studies have shown that while higher quantities of green space are associated with higher birthweights, exposure to ambient air pollution is associated with lower birthweights. These results might be related since green space is theorized to buffer air pollution harms; however, evidence of interactions between these exposures on birthweight remains inadequate. Therefore, aim of this study was to investigate how the association between air pollution (NO₂, PM_{2.5}, SO₂ and O₃) term birthweight is affected by quantity of green space.

METHODS: 79,430 births recorded in Sydney in 2016 and 2017 were included in the analysis. Multilevel linear regression with random intercepts for statistical area level 2 (SA2) were developed to assess association between air pollutants and birthweight. Furthermore, interaction terms between air pollutants and green space quantity were fitted in the model to examine potential effect modification.

RESULTS: Higher PM_{2.5}, NO₂ and SO₂ was associated with lower birthweight, while increase in O₃ exposure was associated with higher birthweight (all $p < 0.05$). Higher green space quantity was associated with lower birthweight ($p < 0.05$). Interactions between green space quantity and NO₂ and PM_{2.5} were identified ($p < 0.05$), indicating that increasing green space may help to mitigate harms of moderate levels of NO₂ and PM_{2.5} on birthweight.

CONCLUSIONS: Improving access to green spaces in cities may help support a healthy start in life by mitigating harms from certain air pollutants. Replication in different contexts and consideration of potentially contrasting results with different types of green space should be further investigated.

Keywords: Green space, Birth outcomes, air pollution



ABSTRACT E-BOOK

P-575

Birth and Pregnancy Outcomes » Birth outcomes

Urinary concentrations of bisphenol mixtures during pregnancy and birth outcomes: The MAKE study

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BACKGROUND AND AIM: Bisphenols are endocrine disruptors that may be associated with altered fetal growth in humans. To date, most studies between bisphenols and birth outcomes have focused on the effect of individual bisphenol. The aim of this study was to explore the associations of urinary bisphenol mixtures with birth outcomes.

METHODS: We conducted a prospective birth cohort study in South Korea. One hundred eighty mother-infant pairs were recruited from 2017 to 2019. Bisphenol A (BPA), bisphenol F (BPF), and bisphenol S (BPS) in one spot urine were analyzed using ultra-performance liquid chromatography–tandem mass spectrometry. We used two statistical approaches to examine potential associations of BPA, BPF, and BPS with birth weight and gestational age: 1) multivariable linear regression; 2) Bayesian kernel machine regression (BKMR).

RESULTS: The geometric means of BPA, BPF, and BPS were 2.1, 0.2, and 0.1 µg/L, respectively. In stratified linear analyses by each median value, a higher BPF was positively associated with birth weight (g) ($\beta = 125.5$; 95% CI: 45.0 to 205.9). Mixture analyses using BKMR suggested an inverse association between bisphenol mixtures and birth weight.

CONCLUSIONS: Our findings suggest that in utero bisphenol exposure may influence birth weight and that such relationships may differ considering non-linearity and the combined effect.

Keywords: Phenols, Birth outcomes, Mixtures analysis, Environmental epidemiology



ABSTRACT E-BOOK

P-576

Birth and Pregnancy Outcomes » Birth outcomes

The Impact of Sample Timing and Study Confidence on Mean Birth Weight Differences Detected in a Meta-analysis of PFHxS

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BACKGROUND AND AIM: Recent evidence suggests that timing differences in PFOA biomarker sampling may result in reverse causality or confounding due to pregnancy-related hemodynamic changes. In a meta-analysis of epidemiologic data from 16 studies of birth weight identified in a systematic review of the health effects of PFHxS exposure, we examined whether results differed by study quality and by timing of exposure measurement.

METHODS: Using a random effects model, we examined studies with maternal blood samples collected during first trimester (T1), second trimester (T2), third trimester (T3), post-partum (PP), or umbilical cord blood (UCB). Three grouping strategies were used: 1) early and mid-pregnancy (T1; T1/T2; T2, n=7) versus later sampling (T3; PP; UCB, n=9); 2) early pregnancy (T1; T1/T2, n=4) versus later sampling (T2; T3; PP; UCB, n=12); 3) early (T1; T1/T2, n=4), mid- and late-pregnancy (T2; T2/T3; T3, n=7), and post-pregnancy (UBC; PP, n=5).

RESULTS: The summary mean birthweight deficit was -12 grams (95%CI: -25, 0.1; I²=0%) per ln-unit PFHxS increase with no differences across study confidence level (High/Medium/Low). We saw minimal differences in pooled deficits with the first two dichotomized groups (-11 vs -15 g for early/mid-pregnancy versus late/post-pregnancy; -10 vs -13 g for early pregnancy versus other periods). The third analysis showed comparable pooled estimates for maternal samples collected during pregnancy (early: -10 g, mid-/late-pregnancy: -8 g); but a larger deficit for UCB or PP (-28 g; 95%CI: -69, 13).

CONCLUSIONS: Although we saw larger deficits for post-pregnancy samples based on few studies, we consistently saw birth weight deficits for pregnancy-based measures regardless of timing. Additionally, the few PFHxS studies adjusting for hemodynamics did not show evidence of confounding. Thus, more work to determine whether reverse causality is a plausible explanation of these differences and to determine the most relevant grouping strategies based on hemodynamic expectations will be informative.

Keywords: PFAS, PFC, PFHxS, Birthweight, Meta-analysis, Pregnancy



ABSTRACT E-BOOK

P-577

Other » Other (to be specified with keywords in the keywords section)

Atopic dermatitis in infants: The role of prenatal fish intake and mercury exposure

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BACKGROUND AND AIM: Incidence of atopic dermatitis (AD) are increasing in infants and children over the last decade. Diet plays an important role in connection with allergic diseases. Especially fish intake, lower the risk of AD and other allergic diseases. But, fish bio accumulates environmental contaminants, such as mercury. Thus, the objective of our study to evaluate the effect of maternal fish intake: type and frequency on AD in six-month-old infants concerning mercury exposure.

METHODS: Five hundred sixty-five eligible mother-infant pairs from the Mother and Children's environmental health study in South Korea were selected. Data was collected on prenatal fish intake, prenatal mercury concentration, and AD in infants at six months of age. A joint logistic regression analysis was conducted to evaluate the risk of prenatal fish intake and prenatal mercury concentration on AD in infants at six months of age. We explored multiplicative and additive interaction between fish intake and mercury concentration affecting AD in infants.

RESULTS: Total fish (odds ratio: 0.68,95% CI 0.46 to 0.99; P< 0.05) and white fish (odds ratio: 0.49,95% CI 0.27 to 0.89; P<0.05) intake frequency >1 time per week significantly decreased the risk of AD in infants at six months. Stratified analysis by prenatal mercury exposure showed that consuming fish >1 time per week reduced the risk of AD in six-month-old infants in the high-mercury (>25th percentile) exposure group significantly in comparison with low-mercury exposure group.

CONCLUSIONS: Our results show that prenatal white fish intake >1 time per week reduces the AD risk in infants with high prenatal mercury exposure.

Keywords: atopic dermatitis, fish, pregnancy, mercury



ABSTRACT E-BOOK

P-578

Birth and Pregnancy Outcomes » Birth outcomes

Association between Specific PM_{2.5} Chemical Constituents and Preterm Birth in China: A National Birth Cohort Study

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BACKGROUND AND AIM: Studies including ours have linked fine particulate matter (PM_{2.5}) exposure during pregnancy to high risk of preterm birth (PTB). However, the roles of specific PM_{2.5} chemical constituents remain unclear. This study aimed to examine the associations of exposure to PM_{2.5} and its main chemical components during pregnancy with the risk of PTB in China.

METHODS: We established a birth cohort with 1,280,524 singleton pregnancies who delivered from Dec 1st, 2013 to Nov 30th, 2014 and matched their home address to PM_{2.5} and its main component mass concentrations which were predicted with Weather Research & Forecasting model (WRF) and the Community Multi-scale Air Quality model (CMAQ). Cox proportional hazard regression models with time varying exposure were used to analyze the associations between PTB and exposure of PM_{2.5} and its main components, after controlling for individual level covariates.

RESULTS: In fully adjusted models, a PM_{2.5} concentration increase of 10 µg/m³ over the entire pregnancy was significantly associated with increased risk of PTB (hazard ratio [HR], 1.07; 95%CI, 1.06 to 1.07). We also find elemental carbon (EC), organic carbon (OC), Sulfate (SO₄²⁻), nitrate (NO₃⁻) and ammonium (NH₄⁺) exposure was associated with increased risk of PTB (HR = 1.21 to 1.76). PM_{2.5} with higher EC, NH₄⁺ or NO₃⁻ fraction, often linked to fossil combustion, exhibited a lower association with preterm birth (P<0.001), while PM_{2.5} with higher OC fraction, often linked to organic compounds, exhibited a higher association with preterm birth (P<0.001).

CONCLUSIONS: Our findings provide evidence that exposure to PM_{2.5} components mainly from organic compounds may have predominance in the contributions to increased PTB risk associated with PM_{2.5} exposure in China.

Keywords: Particle components, Birth outcomes, Environmental epidemiology



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-579

Birth and Pregnancy Outcomes » Pregnancy outcomes

Characteristics of pregnant women and their newborns of the Korean Children's ENvironmental health Study (Ko-CHENS)

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BACKGROUND AND AIM: The Korean Children's ENvironmental health Study (Ko-CHENS) is a nationwide birth cohort study investigating the effects on children's health and development. As core cohort recruitment was closed in 2020, we disclose the baseline profiles and the characteristics of the participating mothers and children using questionnaires administered during pregnancy and delivery outcomes.

METHODS: Thirteen Regional Centers located throughout Korea were responsible for recruiting women in early pregnancy residing in their respective recruitment areas. Self-administered questionnaires and medical records were collected to secure information on demographic factors, socioeconomic status, environmental exposure, lifestyle, and delivery information. In the period up to delivery, we measured indoor environmental exposure and collected bio-specimens, including blood, urine, and umbilical cord blood.

RESULTS: The total number of pregnancies was 5,799 and discounting pregnancies by the same woman, the study included 5,581 unique mothers and resulted in 5,452 live births. Response rate of the questionnaires of recruited women was 98.4% and the mean gestational ages (GA) was 14 weeks. The mean age of the subjects was 31.9 years old and the result showed 0.6% of maternal smoking and 1.8% of maternal alcohol drinking during pregnancy rate. Out of 5,581 mothers, we also obtained 5,221 labor and delivery record resulted in 5,213 live births and a sex ratio of births was 49 girls to 51 boys, with 38.6 weeks mean GA at delivery. Preterm delivery rate in singleton pregnancies was 7.8% and showed higher rate with older mothers. The mean weight at birth for total newborn was 3.2kg and the mean birth length at 50.2cm which was comparable to the latest version of Korean National Growth Charts for children and adolescents released in 2017.

CONCLUSIONS: Ko-CHENS results can assess various exposure burdens for the highly susceptible population and can strengthen the national pregnant woman and children environmental health management by providing policy guidance.

Keywords: National birth cohort, pregnancy outcome, delivery outcome



ABSTRACT E-BOOK

P-580

Birth and Pregnancy Outcomes » Birth outcomes

Identifying critical windows for ambient fine particulate matter exposure around pregnancy and risks of birth weight for gestational age

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BACKGROUND AND AIM: Investigations on the potential effects of ambient fine particulate matter (PM_{2.5}) on large for gestational age (LGA) are limited. Furthermore, no study has explored weekly-specific susceptible exposure windows for small for gestational age (SGA) and LGA. This study evaluated the associations of exposure to ambient PM_{2.5} over the preconception and entire pregnancy periods with risks of SGA and LGA, as well as explored critical weekly-specific windows.

METHODS: 10,916 singleton pregnant women with 24-42 completed gestational weeks from the Project ELEFANT between 2014 and 2016 were included in this study. Distributed lag models (DLMs) incorporated in Cox proportional hazard models were applied to explore the associations of maternal exposure to weekly ambient PM_{2.5} throughout 12 weeks before pregnancy and pregnancy periods with risks of SGA and LGA after controlling for potential confounders.

RESULTS: For a 10 µg/m³ increase in maternal exposure to PM_{2.5}, positive associations with SGA were observed during the 1st to 9th preconceptional weeks and the 1st to 2nd gestational weeks, with the strongest association in the 5th preconceptional week [Hazard ratio (HR), 1.06; 95% confidential interval (95% CI), 1.03-1.09]. For LGA, positive associations were observed during the 1st to 12th preconceptional weeks and the 1st to 5th gestational weeks, with the strongest association in the 7th preconceptional week (HR, 1.10; 95% CI, 1.08-1.12).

CONCLUSIONS: Exposure to high-level ambient PM_{2.5} is associated with increased risks of both SGA and LGA, and the most susceptible exposure windows are the preconception and early pregnancy periods.

Keywords: Fine particulate matter, Large for gestational age, Small for gestational age, Preconceptional period, Susceptible exposure windows



ABSTRACT E-BOOK

P-581

Birth and Pregnancy Outcomes » Birth outcomes

Global warming increases the risk of the stillbirth: a ten years follow-up study in Taiwan

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BACKGROUND AND AIM: Few studies have examined heat with respect to the risk of stillbirth. This study explored the association between ambient temperature and stillbirth in Taiwan.

METHODS: This study collected monthly stillbirths, air pollution, and meteorological variables in Taiwan from 2009 to 2018. We apply time-series analysis and use exponential smoothing to predict the risk of stillbirth in the next five years. The distributed hysteresis nonlinear model (DLNM) is used to study the associated hysteresis effect of temperature on stillbirth.

RESULTS: A total of 22,769 cases of stillbirth were reported, with a mean stillbirth rate of 1.13±0.14%. Risks were elevated during the warm season (May–July). There is an increasing trend of stillbirth together with ambient temperature. Chronic exposure to warm temperatures (27–30°C) (RR = 1.08, 95% CI 1.05, 1.12) and high temperature (>30°C) significantly increased the risk of stillbirth (RR = 1.15, 95% CI 1.04, 1.24). The effects of heat on stillbirth were observed in the first month of pregnancy at lag 10 and one month before delivery at lag 1.

CONCLUSIONS: Pregnant women in subtropical Asia countries are at increased risk of stillbirth during the hot season. The government should take the thermal effect on stillbirth seriously and formulate effective preventive strategies to mitigate the health burden of global warming.

Keywords: stillbirth, temperature, DLNM



ABSTRACT E-BOOK

P-582

Air pollution » Particulate matter

Prevalence of Respiratory Symptoms, Lung Function Abnormalities and Cardiac Conditions in "Jeepney" Drivers Exposed to Different Levels of Black Carbon

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BACKGROUND AND AIM: The "jeepney", a traditional mode of transportation in the Philippines since the end of World War II, has been shown by a recent study to be a major source of black carbon (BC) in the air of Metro-Manila. Chronic exposure to black carbon may constitute a significant health hazard for "jeepney" drivers. This study determined the effect of exposure to different levels of black carbon on the prevalence of symptoms, ECG and spirometric abnormalities in "jeepney" drivers in an area in Metro-Manila.

METHODS: Over a period of 3 months, 103 "jeepney" drivers plying two (2) routes with different levels of measured black carbon (BC) were interviewed using a modified BOLD questionnaire and underwent ECG and spirometry to evaluate their current health status. The effect of BC severity and respiratory risk factors such as smoking, environmental and other occupational exposures were determined by univariate and logistic regression analysis.

RESULTS: There were 103 "jeepney" drivers who participated in the study, with a mean age of 48.5 years, mean daily working period of 11.6 hours, and mean driving experience of 21.4 years. "Jeepney" drivers plying the route with higher BC severity reported 5 times more symptoms ($p=0.005$) and showed 3 times more ECG abnormalities ($p=0.014$) compared to those in the lower BC severity route. No difference in lung function parameters were seen in the comparative BC groups. No significant effect of other respiratory risk factors was found.

CONCLUSIONS: The study provides evidence that different levels of black carbon exposure affect local prevalence of symptoms and ECG abnormalities among "jeepney" drivers. There was no association between abnormalities in spirometric parameters and long-term BC exposure in this cohort. Further studies are required to determine the interaction between exposure to black carbon and other respiratory risk factors in the development of abnormalities in lung function.

Keywords: Air pollution, Particulate matter



ABSTRACT E-BOOK

P-583

Air pollution » Particulate matter

Long-term exposure to fine particulate matter and incident asthma among children

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BACKGROUND AND AIM: Although an association of fine particulate matter (PM_{2.5}) with asthma incidence has been assumed, there is insufficient evidence regarding the effect of long-term exposure to PM_{2.5} on incident asthma among children.

METHODS: Children ≤ 15 years of age who did not visit hospitals for asthma during a washout period (between 2008 and 2010) were followed up until 2016 using data from the National Health Insurance System in South Korea. Incident asthma was defined as the number of patients with a primary diagnostic code of asthma who visited hospitals more than ten times. We linked the health data with district-level PM_{2.5} concentrations and estimated hazard ratios (HRs) for incident asthma after adjusting for potential confounders in time-varying Cox proportional hazard models.

RESULTS: A total of 4,751,852 children was enrolled in the study including 240,543 cases (5.1%) of incident asthma. A 10 µg/m³ increase in the 12-month mean PM_{2.5} concentration was significantly associated with incident asthma (HR=1.28, p < 0.001). This association was found to be robust for different definitions of incident asthma.

CONCLUSIONS: Long-term exposure to PM_{2.5} was associated with the incidence of asthma in children. This finding provides evidence of an association between PM_{2.5} and asthma incidence.

Keywords: Asthma, Cohort studies, Children, Incidence, Particulate matter



ABSTRACT E-BOOK

P-584

Air pollution » Particulate matter

Association of Long-term Exposure to PM_{2.5} with Blood Lipids in the Chinese Population: Findings from a Longitudinal Quasi-experiment

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BACKGROUND AND AIM: Although epidemiological studies on the effect of chronic fine particulate matter (PM_{2.5}) exposure on lipid disorders have been conducted, it is unclear if improved air quality is associated with beneficial changes in the blood lipid profile. In China, clean air actions introduced in 2013 have rapidly reduced the concentration of ambient PM_{2.5}. We aim to explore the relationship between temporal variations in PM_{2.5} and changes in blood lipids.

METHODS: We conducted a change-by-change study, based on two waves (2011 and 2015) of a national survey of the same 5,111 Chinese adults before and after the clean air actions, respectively. Long-term PM_{2.5} exposure was assessed using a state-of-the-art estimator at the city level. Based on the within-individual differences between the two waves, we associated PM_{2.5} changes with the variations of four lipid biomarkers—triglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C)—using a mixed-effects regression model. The robustness and homogeneity of the association were tested via sensitivity analyses.

RESULTS: For each 10 µg/m³ reduction in PM_{2.5}, LDL-C, and TC decreased by 2.71 (95% confidence intervals [CI] 0.10–5.32) and 4.16 (95% CI 1.24–7.08) mg/dL, respectively. There was no significant association with HDL-C or TG. The results were robust among models adjusted for different covariates. PM_{2.5} was a significant risk factor for dyslipidemia with an adjusted relative risk of 1.21 (95% CI 1.09, 1.34). The association between PM_{2.5} and LDL-C was stronger with the older or the adults who did not take medications.

CONCLUSIONS: The results suggest that PM_{2.5} exert a cardiotoxic effect by increasing the risk of lipid disorders. Improvement of air quality could prevent dyslipidemia by reducing LDL-C and TC levels. Clean air policies should be implemented as public health measures in countries with aging societies, especially developing ones with a high air pollution burden.

Keywords: Cardiovascular diseases, Environmental epidemiology, Particulate matter, Long-term exposure, Policy and practice



ABSTRACT E-BOOK

P-586

Air pollution » Particulate matter

Pre- and postnatal exposure to multiple ambient air pollutants and child behavioral problems at five years of age

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BACKGROUND AND AIM: Ambient air pollution is emerging as a risk factor for adverse neurological problems and early childhood diseases. This study purposed to evaluate the association between pre- and postnatal exposure to multiple air pollutants and childhood behavioural problems using some statistical models.

METHODS: This study used the data from the MOCEH study, which is a prospective birth cohort study in Republic of Korea. Average exposure levels to PM_{2.5} during the pre- and postnatal periods were estimated using the Community Multiscale Air Quality (CMAQ) model. Other air pollutants were predicted using the kriging model. Mother-child pairs who completed the Korean version of the Child Behavior Checklist at five years of age were included. Primary outcomes were children's behavioural problems scores of total, internalizing, and externalizing. Multivariate linear regression (MLR) for each pollutant and weighted quantile sum (WQS) regression and Bayesian kernel machine regression (BKMR) for multiple exposure to six air pollutants and pre- and postnatal periods were applied.

RESULTS: In the MLR analysis, PM_{2.5}, PM₁₀, and NO₂ exposure during the first trimester were positively associated with the internalizing problem score. In the WQS regression analysis, the air pollutant index during the first trimester was positively associated with total problems score and PM₁₀ had the strongest individual weights in the air pollutant index. The postnatal air pollutant index at 0–6 months was also positively associated with the internalizing problem score and SO₂ and NO₂ had strong individual weights. In the BKMR model analysis, the overall effect of multiple air pollutants during the first trimester and at 0–6 months was significantly associated with behavioural problems.

CONCLUSIONS: When comparing the results from different models, PM_{2.5} and PM₁₀ exposures during the first trimester were identified as important factors associated with behavioral problems. Future studies investigating the effects of multiple air pollutants by applying diverse statistical methods are needed.



ABSTRACT E-BOOK

Keywords: Air pollution, Birth cohort study, Multiple exposure, Behavioral problem, children

P-587

Air pollution » Particulate matter

Mortality Risk of Specific Cancers and Long-term Exposure to Particulate Matter in the South Korean National Sample Cohort

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BACKGROUND AND AIM: Cancer is a major burden of disease worldwide. International Agency for Research on Cancer classified particulate matter (PM) as carcinogenic to human. Long-term exposure to PM has been associated with cancer mortality mainly from lung cancer. Although a few U.S studies demonstrated the association with mortality of various cancer types, evidence for non-lung cancer is limited. The aim of this study is to compare PM associations with cancer mortality across different types of cancer in the Seoul Metropolitan Areas, South Korea using a population-based nationwide cohort.

METHODS: Using the National Health Insurance Services-National Sample cohort, we selected the subjects who received national screening during 2005-2007, aged over 30, were non-severely disabled, and had full address information. We defined mortality of seventeen specific cancers based on the International Classification of Disease, 10th revision. Individual-level long-term PM concentrations were estimated for the previous 5 years of 2002-2015 from a previously developed prediction model. We performed time-dependent Cox proportional hazards model to estimate hazard ratios (HRs) and 95% confidence intervals per 10 μ g/m³ increase in PM_{2.5} and PM₁₀ adjusting for sociodemographic characteristics, family history of cancer, health behaviors, and area-level characteristics.

RESULTS: Of 206,717 included subjects, 4,122 subjects were died with cancer for 2007-2015 and lung cancer was accounted the most (24.81%). Although none of estimates were statistically significant possibly because of small sample size, HRs of PM_{2.5} were greater than 1 for lung, stomach, esophagus, non-Hodgkins, oral and pharynx, and brain cancer mortality (HR range: 1.44-7.14). These results were similar for PM₁₀ but with reduced effect estimates.

CONCLUSIONS: Although we found no evidence of the association, our findings of positive risk estimates for PM_{2.5} in lung, oral and pharynx, and brain cancer mortality were consistent with those in U.S. studies. Future studies should re-examine the association in expanded cohorts.

Keywords: Ambient air pollution, Particulate matter, Cancer mortality, National sample cohort



ABSTRACT E-BOOK

P-588

Air pollution » Particulate matter

Removal of Particulate Matter from Ambient Air by Four Evergreen Tree Species in Dhaka, Bangladesh

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BACKGROUND AND AIM: An investigation was conducted to assess the particulate matter (PM) removal capacity of four common roadside trees (*Ficus benghalensis*, *Ficus religiosa*, *Mangifera indica*, and *Polyalthia longifolia*) grown at four locations in Dhaka, Bangladesh.

METHODS: Gravimetric analyses were performed separately to quantify PM in three size fractions (0.2-2.5 μm , 2.5-10 μm , and 10-100 μm) deposited on surfaces and trapped in waxes. The particulate matter deposited on the leaves of the studied plants was also analyzed for cadmium (Cd), chromium (Cr), lead (Pb), and nickel (Ni) concentrations.

RESULTS: Among the species studied, the deposited mass of PM was highest on *Ficus benghalensis*. The mean PM load on plant foliage was significantly greater in the polluted sites compared with the control site ($p < 0.05$). Most of the PM accumulated on plant foliage belonged to the large fraction size (10-100 μm). Species-wise significant differences were also found among the sites with respect to total PM, surface PM, and wax-embedded PM ($p < 0.05$). The amount of wax deposited on the leaves of plants grown in these sites also differed ($p < 0.05$). A positive correlation was found between wax-embedded PM of diameter 0.2-2.5 μm and the amount of waxes. *Ficus benghalensis* was found to be the most effective with respect to total PM accumulation. On the other hand, *Mangifera indica* was found to be the most effective accumulator of wax-related PM and seems to be the best species for traffic-related sites, where organic substances from vehicle exhausts are present in high concentrations.

CONCLUSIONS: PM concentration was found to be significantly correlated to the concentrations of Cd and Pb meaning these two trace elements deposited simultaneously with the PM and originated from common anthropogenic sources. Total metal accumulation capacities of different plants were evaluated using the metal accumulation index (MAI) and *Ficus benghalensis* was found to have the highest MAI value (13.60).

Keywords: particulate matter, roadside species, trace element, metal accumulation index



ABSTRACT E-BOOK

P-589

Air pollution » Particulate matter

Interaction of Sirtuin 1 (SIRT1) longevity gene and particulate matter (PM_{2.5}) on all-cause mortality: a longitudinal cohort study

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BACKGROUND AND AIM: The SIRT1 gene was associated with the lifespan in several organisms through inflammatory and oxidative stress pathways. Long-term air particulate matter (PM) is detrimental to health through the same pathways.

METHODS: We used the Chinese Longitudinal Healthy Longevity Survey (CLHLS) to investigate whether there is a gene-environment (G × E) interaction of SIRT1 and air pollution on mortality in an older cohort in China. Among 7083 participants with a mean age of 81.1 years, we genotyped nine SIRT1 alleles for each participant and assessed PM_{2.5} concentration using 3-year average concentrations around each participant's residence. We used Cox-proportional hazards models to estimate the independent and joint effects of SIRT1 polymorphisms and PM_{2.5} exposure on all-cause mortality, adjusting for a set of confounders.

RESULTS: There were 2843 deaths over 42,852 person-years. The mortality hazard ratio (HR) and 95% confidence interval (CI) for each 10 µg/m³ increase in PM_{2.5} was 1.08 (1.05–1.11); for SIRT1_391 was 0.77 (0.61, 0.98) in the recessive model after adjustment. In stratified analyses, participants carrying two SIRT1_391 minor alleles had a significantly higher HR for each 10 µg/m³ increase in PM_{2.5} than those carrying zero minor alleles (1.323 (95% CI: 1.088, 1.610) vs. 1.062 (1.028, 1.096) p for interaction = 0.03). Moreover, the interaction of SIRT1 and air pollution on mortality is significant among women but not among men. We did not see significant relationships for SIRT1_366, SIRT1_773, and SIRT1_720.

CONCLUSIONS: We found a gene-environment interaction of SIRT1 and air pollution on mortality, future experimental studies are warranted to depict the mechanism observed in this study.

Keywords: longevity, air pollution, China, gene-environment interaction, SIRT1, sirtuin



ABSTRACT E-BOOK

P-590

Air pollution » Particulate matter

Asthma clinic visit and ambient air pollution exposure: relevance of diagnostic classifications on PM2.5-related health risks

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BACKGROUND AND AIM: The effect of particulate matter with a size of 2.5 micrometer (PM2.5) in diameter on asthma has been well-documented in previous studies. Ambient PM2.5 exposure exacerbates the risk of developing asthma. However, asthma has a wide spectrum of diagnostic classification. Several patients can be diagnosed with asthma but may not need medications, others, on the other hand, may require long-term treatment. To the best of our knowledge, there is inconclusive evidence whether diagnostic classifications confer differential PM2.5-related health effects.

METHODS: We utilized a health insurance claim database with the detailed medical information of 21 Japanese cities from 2013-2017 to elucidate these associations. Specifically, asthma clinic visits were classified into seven (7) diagnostic classifications, namely: 1) illness only, 2) medication only, 3) treatment only, 4) illness and medication, 5) medication and treatment, 6) medication and illness, and 7) illness, medication and treatment. Daily clinic visits (n = 4,983,521) were analyzed using a generalized additive mixed model after adjusting for several covariates (temperature, relative humidity, temporal variables, etc.) as well as city-random effects, sourced out from literature.

RESULTS: Exposure to PM2.5 resulted to a statistically significant increase in the risk, regardless of diagnostic classification. While the magnitude of effects did not vary substantially between diagnostic classification, we generally observe an increasing risk with more complex diagnostic classification. For example, (Classification 1) illness only had a percent change in the risk by 0.933% [95% Confidence Interval (CI): 0.856, 1.01%], it increased when accompanied with medication (Classification 4) (1.01%; 95% CI: 0.901, 1.119%), and was magnified when it further included treatment (Classification 7) (1.058%; 95%CI: 0.916, 1.201%).

CONCLUSIONS: In this study, though we did not find any compelling evidence on the differential effect of diagnostic classification on asthma visit-PM2.5 associations, it is worthy to further investigate the potential trend of increasing risk with increasingly complex diagnostic classification.

Keywords: asthma, diagnostic classification, particulate matter, clinic visit



ABSTRACT E-BOOK

P-592

Air pollution » Particulate matter

Exposure modelling for air pollution in India: Challenges and opportunities

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BACKGROUND AND AIM: Our consortium of exposure scientists and health researchers –CHAIR-India is developing a nation-wide exposure model for particulate matter. Our aim is to build a comprehensive database which will help develop/validate a hybrid exposure model. In this process, we attempt to discuss the gaps and indicate potential solutions to improve air pollution monitoring data quality.

METHODS: Data was collected from online monitors from Central Pollution Control Board (CPCB) Continuous Ambient Air Quality Monitoring Stations (CAAQMS) as well as offline monitors as part of the National Ambient Air Quality Monitoring Programme (NAMP) between the years of 2005-2020. Variables assessed were unique station name/ID, dates, pollutant variables – (PM_{2.5}, PM₁₀), geographical information (lat/long) and type of PM data generated (Gravimetric/BAMS). These data were collated, sorted and assessed for consistency and validity.

RESULTS: While data from online stations (BAMS) have a high level of completeness in recent years (2015 onwards), older data is sporadic and mostly available for Delhi and Maharashtra. The NAMP station data far outnumbers the CAAQMS data in size and spread, particularly for the years before 2015, but presented greater challenges with completeness and accuracy, especially with the geographical metadata.

CONCLUSIONS: The broad reach of CAAQMS and online stations in recent years make them an attractive option for air quality research post 2015 with important opportunities to expand the evidence base for India on health effects of air pollution. Comprehensive nationwide and smaller regional studies will need to rely on data from NAMP to supplement the gaps in data from the online stations. Building capacities of state /regional agencies to enhance the quality and accuracy of data will provide impetus to a growing body of air pollution researchers in India. The CHAIR consortium will complement these efforts by developing an online platform with accurate metadata for all stations and sources for public access.

Keywords: India, Air Pollution, Monitoring, Data Quality, Research



ABSTRACT E-BOOK

P-594

Air pollution » Particulate matter

The modifying effect of pollen on the association between particulate matter and respiratory mortality: a multi-city analysis in Kyushu, Japan

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BACKGROUND AND AIM: Pollen, a biogenic pollutant of growing concern due to climbing global temperatures, exacerbates the relationship between particulate matter and allergenicity-related adverse health outcomes. This study investigated the modifying effect that pollen may have on the short-term association between respiratory mortality (total and older adults aged ≥ 65) and suspended particulate matter (SPM), the volume of aerodynamic particles with a 100% cutoff at $10\mu\text{m}$ in terms of diameter, in eight Kyushu cities from 1989 to 2014 during spring months (February to April).

METHODS: A two-stage time-series regression analysis was conducted. First, we used a quasi-Poisson generalized linear model incorporating an interaction term between pollen and particulate matter and adjusted for long-term time trend, day-of-season, day-of-week, holidays, and mean temperature for each city. Pollen days were categorized into quartiles by distribution. City-specific estimates were combined with meta-regression analysis.

RESULTS: In total, 43,557 respiratory deaths were included in this study. A majority of total mortality was attributable to the older adults age group. Mortality risks increased by 2.9% (95% CI: 0.5%–5.3%) for total and 2.7% (95% CI: 0.2%–5.1%) for older adults per interquartile range increase in SPM on the previous day (lag1) at the highest pollen quartile. In contrast, risks were estimated toward the null at the lowest pollen quartile for both total (0.3%, 95% CI: -2.6%–3.3%) and older adults (0.1%, 95% CI: -2.7%–2.9%) mortality. Despite the potential differences between the lowest and highest pollen quartiles, no definitive evidence of an interaction was gleaned.

CONCLUSIONS: While no decisive evidence of a modifying effect of pollen on the relationship between air pollution and mortality exists, we observed some pattern of an exacerbating impact between SPM and pollen. Further research, preferably in heavily populated cities with high pollen and air pollutant concentrations, is required to confirm these conclusions.

Keywords: air pollution, particulate matter, pollen, mortality, elderly mortality, respiratory mortality



ABSTRACT E-BOOK

P-595

Climate » Natural disasters

The persistent effects of natural disaster exposure on child and adolescent psychological distress: evidence from a Hurricane Katrina displaced cohort

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BACKGROUND AND AIM: This study evaluates the association between exposure to cumulative natural disasters and psychological distress among Gulf Coast children and adolescents.

METHODS: We used data from the Gulf Coast Child and Family Health Study, a longitudinal cohort displaced by Hurricane Katrina. The exposure of interest was the number of additional natural disasters the respondent had experienced. Child psychological distress was based on their caregiver endorsing one of the following in the past month: feeling sad or depressed; having problems sleeping; feeling nervous or afraid; or having problems getting along with other children. We conducted bivariate analyses followed by logistic regression, evaluating moderation by race; annual household income; parental educational attainment; household financial constraints; stable housing; family functioning; parental coping; and parental mental component score.

RESULTS: Among 141 respondents with children, about 28% reported their children having psychological distress in the past month. Those respondents whose children had psychological distress experienced over twice the number of disasters, on average, than those without psychological distress (0.45 [SD 0.86] vs. 1.10 [SD 1.64]). None of the sociodemographic, vulnerability, or resilience variables significantly moderated the association between additional disaster exposure and child/adolescent psychological distress. Each additional disaster experienced by a respondent was associated with a 90% increase in the odds that his/her child exhibited symptoms of psychological distress (OR 1.90; 95% CI 1.01, 3.55). Those whose caregivers reported coping somewhat or not well at all with parenting responsibilities were over three times more likely to have psychological distress (OR 3.33; 0.11; 0.93) than those whose caregivers were coping very well. Children and adolescents in high functioning families were also significantly less likely than children in low functioning families to exhibit symptoms (OR 0.32; 95% CI 0.11, 0.93).

CONCLUSIONS: These results demonstrate the persistent effects of exposure to natural disasters on child/adolescent psychological distress.

Keywords: Natural disasters, Children's environmental health, Mental health outcomes



ABSTRACT E-BOOK

P-596

Climate » Temperature

Temperature-Mortality Relationship in North Carolina, USA: Regional and Urban-Rural Differences

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BACKGROUND AND AIM: Health disparities exist between urban and rural populations, yet research on rural-urban disparities in temperature-mortality relationships is limited. As inequality in the United States increases, understanding urban-rural and regional differences in temperature-mortality association is crucial. The study aim is to examine the regional and urban-rural difference of the temperature-mortality association in North Carolina (NC), USA, and investigated potential effect modifiers.

METHODS: We applied time-series models allowing nonlinear temperature-mortality associations for 17 years (2000-2016) to generate heat and cold county-specific estimates. We used second-stage analysis to quantify the overall effects. We also explored potential effect modifiers (e.g. social associations, greenness, population density, fine particulates (PM_{2.5})) using stratified analysis. Analysis considered relative effects (comparing risks at 99th to 90th temperature percentiles based on county-specific temperature distributions for heat, and 1st to 10th percentiles for cold) and absolute effects (comparing risks at specific temperatures).

RESULTS: We found null effects for heat-related mortality (relative effect: 1.001 (95% CI: 0.995-1.007)). Overall cold-mortality risk for relative effects was 1.019 (1.015-1.023). All regions had statistically significant cold-related mortality risks for relative and absolute effects (relative effect: 1.019 (1.010-1.027) for Coastal Plains, 1.021 (1.015-1.027) for Piedmont, 1.014 (1.006-1.023) for Mountains). While not statistically different, urban areas had higher heat- and cold-mortality risk than rural areas (relative effect for heat: 1.006 (0.997-1.016) for urban, 1.002 (0.998-1.017) for rural areas; relative effect for cold: 1.023 (1.017-1.030) for urban, 1.012 (1.001-1.023) for rural areas). Findings are suggestive of higher relative cold risks in counties with less social association, higher population density, less green space, higher PM_{2.5}, lower education level, higher residential segregation, and higher income inequality (e.g., Ratio of Relative Risks 1.72 (0.68, 4.35) comparing low to high education).

CONCLUSIONS: Results indicate heat- and cold-mortality risks in North Carolina, with potential differences by regional, urban-rural areas, and community characteristics.

Keywords: Temperature, Environmental disparities



ABSTRACT E-BOOK

P-597

Climate » Other (to be specified with keywords in the keywords section)

Long-term exposure to specific humidity and cardiovascular disease hospitalizations in the US Medicare population

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BACKGROUND AND AIM: Most studies that evaluate associations of weather on human health focus on temperature. Less is known about health effects of humidity. We evaluated associations of long-term exposure to specific humidity with cardiovascular disease (CVD), coronary heart disease (CHD) and cerebrovascular disease (CBV) hospitalization.

METHODS: We constructed an open cohort consisting of all fee-for-service Medicare beneficiaries, aged ≥ 65 , living in the contiguous US from 2000 through 2016 (~63 million individuals). We assessed zip code level annual (January-December), summer (June-August) and winter (December-February) average specific humidity and specific humidity variability (standard deviation) for each year, based on daily specific humidity estimates from the Gridded Surface Meteorological dataset (~4km spatial resolution). To estimate associations of specific humidity with first CVD, CHD and CBV hospitalization, we used Cox-equivalent Poisson models.

RESULTS: After adjustment for individual and area-level indicators and temperature, higher annual and summer average specific humidity and lower winter average specific humidity were associated with an increased risk of CVD, CHD and CBV hospitalization. For summer average specific humidity, we found HRs of 1.07 (95%CI: 1.07, 1.08) for CVD hospitalization, 1.08 (95%CI: 1.08, 1.09) for CHD hospitalization and 1.07 (95%CI: 1.07, 1.08) for CBV hospitalization per IQR increase (4.0 g of water vapor/kg of dry air). Higher annual, summer and winter specific humidity variability were also associated with increased risk of CVD, CHD and CBV hospitalization. Associations of annual and summer average specific humidity were strongest for beneficiaries eligible for Medicaid and for beneficiaries with an unknown or other race.

CONCLUSIONS: Among this cohort of US Medicare beneficiaries, higher annual and summer average specific humidity and higher annual, summer and winter specific humidity variability were positively associated with CVD, CHD, and CBV hospitalization. Associations were modified by race and Medicaid eligibility.



ABSTRACT E-BOOK

Keywords: humidity, cardiovascular diseases, climate

P-598

Climate » Health co-benefits

Differential Risk Factors of Climate Change, Health Vulnerabilities and Outreach Opportunities in the Eastern Caribbean

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BACKGROUND AND AIM: Differential risk factors of climate change (CC) pose not only a threat to health status, but also affect economic determinants of health and health-promoting factors within Eastern Caribbean small island developing states (ECSIDS).

METHODS: Our community-based participatory pilot research evaluated perceptions of vulnerabilities among St. Kitts & Nevis (SKN) residents, ages 18 to 75 in effort to identify outreach opportunities to educate and adapt with regard to CC effects.

RESULTS: Among 237 survey respondents and focus group members, 97% were at least partially concerned about CC effects, putting them at risk for eco-anxiety/eco-grief. Approximately 84.8% observed storm impacts in their residential areas, comparable to 85.2% of participants who experienced high heat. While most SKN residents (over 80%) engaged in adaptive behaviors such as taking cooler baths, using fans, wearing less clothing, spending more time indoors or seeking shade, employing natural ventilation and drinking more fluids in response to higher heat, only 1 in 4 persons routinely apply sunscreen. Men, relative to women, were especially less likely to use sunscreen when outdoors (OR: 0.50; 95%CI: 0.26, 0.94). Despite approximately 80% of participants reporting that lack of access to climate change education and resilience training created significant barriers to adaptation activities, only 26% sought information from non-governmental organizations. The SKN sectors perceived as being least resilient (i.e. "not ready for climate change") were healthcare (24.9%), energy (32.9%), transport (33.8%) and water works (34.2%). Tourism, a major industry in SKN and other ECSIDS, was viewed as especially "not ready" by persons 30 and over (OR: 3.87; 95%CI: 1.92, 8.52) relative to persons under 30.

CONCLUSIONS: Findings suggest that vulnerabilities and opportunities with regard to stability, resilience and wellbeing exist within and persist beyond typical frames of cost, technology and physical infrastructure.

Keywords: Climate, Risk assessment, Community Outreach, Policy and practice, Health co-benefits



ABSTRACT E-BOOK

P-599

Climate » General

Role of meteorological factors in the transmission of SARS-CoV-2 in the United States

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BACKGROUND AND AIM: Improved understanding of the effects of meteorological conditions on the transmission of SARS-CoV-2, the causative agent for COVID-19 disease, is urgently needed to inform mitigation efforts. Here, we estimated the relationship between air temperature, specific humidity (SH), and ultraviolet (UV) radiation and SARS-CoV-2 transmission in 2,669 U.S. counties with abundant reported cases from March 15 to December 31, 2020.

METHODS: Daily air temperature and SH data were extracted from the North America Land Data Assimilation System project, and daily UV radiation data were extracted from the European Centre for Medium-Range Weather Forecasts ERA5 climate reanalysis. County-level daily effective reproductive numbers (R_t) were estimated using a dynamic metapopulation model informed by human mobility data. We applied a distributed lag non-linear model combined with generalized additive models to estimate the associations of short-term meteorological conditions with R_t and the attributable fractions, adjusting for spatiotemporal variations in R_t and potential confounders.

RESULTS: Preliminary analyses showed that lower air temperature (from 20 to 40 °C), lower SH, and lower UV radiation were significantly associated with increased R_t . The fraction of R_t attributable to temperature, SH, and UV radiation were 3.73% (95% eCI: 3.66 - 3.76%), 9.35% (95% eCI: 9.27 - 9.39%), and 4.44% (95% eCI: 4.38 - 4.47%), respectively. In total, meteorological factors contributed to approximately 18% of R_t . The fractions attributable to meteorological factors generally were higher in northern counties than in southern counties.

CONCLUSIONS: Our findings indicate that cold and dry weather and low amount of UV radiation are moderately associated with increased SARS-CoV-2 transmissibility, with humidity playing the largest role.

Keywords: COVID-19, Temperature, Climate, Infectious diseases



ABSTRACT E-BOOK

P-600

Climate » Temperature

The effect of prenatal temperature and PM2.5 exposure on birthweight: weekly windows of exposure throughout the pregnancy

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BACKGROUND AND AIM: Birthweight is a strong predictor of normal growth, healthy development, and survival. Several studies have found associations between temperature, fine particulate matter (PM2.5), and birth weight. However, the relevant timing of exposures varies between studies and is yet unclear. Therefore, we assessed the difference in term birthweight (TBW) associated with weekly exposure to temperature and PM2.5 throughout 37 weeks of gestation.

METHODS: We included all singleton live term births in Massachusetts, U.S between 2004 and 2015 (n=712,438). Weekly PM2.5 and temperature predictions were estimated on a 1 km grid from satellite-based models. We utilized a distributed lag nonlinear model (DLNM) to estimate the difference in TBW associated with weekly exposures to PM2.5 and temperature simultaneously from the last menstrual period to 37 weeks of gestation.

RESULTS: We found a nonlinear association with temperature exposure. We observed positive differences in TBW associated with rises of colder temperatures (2.6g increase, 95% CI 0.1g; 5.1g, for one °C increase from -4 °C) and negative difference in TBW associated with rises of warmer temperatures (7.9g decrease, 95% CI -11.2g; -4.6g, for one °C increase from 23 °C). Temperature effects were larger in the first and final weeks of gestation. We observed a negative difference in TBW associated with PM2.5 exposure. Overall, one µg/m³ increase in prenatal exposure was associated with 3.9g lower TBW (95% CI -5.0g; -2.9g). PM2.5 effects were larger in the final weeks of gestation.

CONCLUSIONS: We found heat and PM2.5 exposure to be related to lower TBW. Our findings suggest that women are more susceptible to both exposures towards the end of pregnancy. Susceptibility to heat was higher in the initial weeks of pregnancy as well. These critical windows of susceptibility can be communicated to pregnant women during routine prenatal visits to increase awareness and target interventions to reduce exposures.

Keywords: birthweight, temperature, air pollution, birth outcomes



ABSTRACT E-BOOK

P-601

Climate » Temperature

Heatwave, heart rate and blood pressure in adults from Santiago, Chile

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BACKGROUND AND AIM: Studies have described associations between ambient temperature and blood pressure and heart rate in the population with comorbidities. However, the evidence is scant regarding the effect of heatwaves in healthy adults. We aim to explore the effect of a heatwave on blood pressure and heart rate in healthy adults.

METHODS: Longitudinal study with 35 adults from Santiago, Chile. We measured heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) in two moments; a day after a heatwave in February and another day without heatwave in March 2021. The indoor temperature was collected the day before the measurements and an average of 12 hours was calculated. Sociodemographic data, home characteristics, and health-related quality of life were obtained from a questionnaire. The bivariate analysis was used to compare both measurements. Multilevel regression models were performed to explore the association between heatwave and heart rate and blood pressure.

RESULTS: The mean (SD) of SBP, DBP, and HR were 121.97 (12.68) mmHg, 77.86 (10.02) mmHg and 75.43 (12.02) mmHg one day after the heatwave and 120.29 (11.88) mmHg, 75.91 (10.02) mmHg and 75.14 (10.25) mmHg after a non-heatwave day, respectively. No statistically significant differences were found between the measurements for SBP (p-value 0.093), DBP (p-value 0.058) and HR (p-value 0.521). The median indoor temperature before the first measurement was 25.8°C (p75, p95 26.8, 27.9°C) and 22.0°C (p75, p95 22.5, 23.6°C) for the second measurement. The mean indoor temperature was positively associated with SBP (β 0.13 IC95% -2.95, 3.19), DBP (β 0.65 IC95% -2.23, 3.54) and HR (β 2.17 IC95% -0.87, 5.21) adjusted for indoor humidity, sex, age and income.

CONCLUSIONS: The data supports the hypothesis that heatwaves may play a role in heart rate and blood pressure in healthy adults. However, this exploratory study did not provide statistically significant evidence.

Keywords: blood pressure, indoor temperature, heart rate, heatwave.



ABSTRACT E-BOOK

P-602

Climate » Temperature extremes and variability

Ambient Heat is associated with higher risk of emergency department visits among US children with health insurance

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BACKGROUND AND AIM: Extreme heat is a recognized threat to public health and the effect of high outdoor temperatures on adults is well characterized. Children are thought to be particularly susceptible to heat, but the evidence remains scarce. Accordingly, we aimed to estimate the association between warm-season temperatures and cause-specific emergency department (ED) visits in US children.

METHODS: We leveraged national de-identified ED visits between May and September of 2016-2020 among children < 18 years of age with commercial health insurance using the OptumLabs® Data Warehouse. We estimated daily population-weighted county average maximum temperature using a validated gridded climate dataset. We used a time-stratified case-crossover study design with a distributed lag nonlinear model to estimate the association between daily maximum temperature and relative rate of ED visits for each of 22 major disease categories, adjusting for relative humidity and federal holidays.

RESULTS: We identified a total of ~1.3 million ED visits for any cause among children with commercial health insurance living in 2,987 US counties. A 10 °C increase in daily maximum temperature was associated with a 25% (95% CI: 18%, 32%) higher rate of ED visits for heat-related illness, a 9% (5%, 13%) higher rate of ED visits for otitis media and externa, and a 9% (3%, 15%) higher rate of ED visits for skin and soft tissue infections. Temperature was not associated with all-cause ED visits and potentially protective associations were observed for multiple outcomes, including respiratory system diseases and mental health.

CONCLUSIONS: In this large, national study of children with health insurance, we found that heat is associated with higher rates of emergency department visits for a range of conditions. These results suggest that children are susceptible to heat and may inform public health and clinical efforts to protect this vulnerable population.

Keywords: extreme heat, children's health, climate, emergency department



ABSTRACT E-BOOK

P-603

Climate » Temperature

Investigating the role of clinical measures before dialysis treatment as mediators in the association between ambient temperature and mortality/hospital admissions

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BACKGROUND AND AIM: Typical thermoregulatory responses among healthy individuals include reduced blood pressure and perspiration. Individuals living with end-stage renal disease (ESRD) are susceptible to physiological fluctuations caused by ambient temperature changes that may increase health complications. We investigated whether systolic blood pressure (preSBP) and interdialytic weight gain change (IDWG) can independently mediate the association between ambient temperature and hospital admissions and between mortality outcomes among ESRD patients.

METHODS: The study population consisted of ESRD patients in Philadelphia County, PA, from 2011 to 2019 (n=1981). Within a time-to-event framework, we estimated the association between daily maximum dry-bulb temperature (TMAX) and, in separate models, all-cause hospital admissions (ACHA) and all-cause mortality (ACM) outcomes during warmer calendar months. The study employed the difference (c-c') method to decompose total effect models for ACHA and ACM using preSBP and IDWG as time-dependent mediators and then applied proportion mediated (PM) using indirect effects. Covariate adjustments for total and direct effect models include age, race/ethnicity, blood pressure medication use, treatment location, preSBP, and IDWG.

RESULTS: Based on Lag 2- Lag 1 temporal ordering, 1°C TMAX increase in was associated with an increased hazard of ACHA by 7.6% (adjusted hazard ratio (HR), 1.076; 95% confidence interval, 1.070-1.082) and ACM 7.5% (adjusted HR, 1.075, 1.050-1.100). Mediation analysis for hospital admission events identified significant indirect effects for all three studied pathways and significant indirect effects for IDWG and conjoined preSBP + IDWG pathways for mortality. The mechanistic path for IDWG, independent of preSBP, demonstrated inconsistent mediation in ACHA (-2.67%) and ACM (-6.26%). PM estimates from the conjoined pathway suggest that it is likely not a candidate path in combined pathway models.

CONCLUSIONS: This work has provided a step toward understanding physiological linkages that may explain or suppress temperature-driven hospital admissions and mortality risks. These findings could help discern candidate heat-adaptation interventions.

Keywords: Survival, temperature, Short-term exposure, Epidemiology, Mortality, Environmental epidemiology



ABSTRACT E-BOOK

P-604

Climate » Temperature

Associations between Heat Index and Child Emergency and Hospital Visits in New York City

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BACKGROUND AND AIM: Emerging literature has documented heat-related impacts on child health, yet few studies have evaluated the effects of heat among children of different age groups or compared emergency department (ED) with hospitalization risks, which may serve to indicate morbidity severity. We examine the differing associations between maximum heat index (a metric that combines maximum temperature and relative humidity) and risk of ED visits and hospitalizations among children by age group.

METHODS: We used New York Statewide Planning and Research Cooperative System (SPARCS) data on children aged 0-18 years admitted to EDs (n = 2,252,550) and hospitals (n = 228,006) during the warm months (May-September) from 2005 to 2011. Using a time-stratified, case-crossover design, we estimated the risk of ED visits and hospitalizations associated with daily heat index for children of all ages and by age group. Heat index was modeled using distributed lag functions accumulated over lag 0 to 5 days using a linear term for ED visits and a piecewise linear term above the threshold of 90F for hospitalization.

RESULTS: The average maximum heat index over the study period was 84.4F (range 48F-135F). Heat index conferred an increased risk of ED visits for children of all age groups, with the strongest effect observed among children 0-4, followed by those 13-18 and 5-12 years. For hospitalizations, an elevated risk was observed when heat index exceeded a threshold of 90F, and the effect was found only among adolescents 13-18 years.

CONCLUSIONS: Heat impacts on child morbidity differ between ED visits and hospitalizations and by age groups. Young children, as well as older children and adolescents, are sensitive to heat effects. Our findings underscore the importance of focusing on children and adolescents in targeting heat illness prevention and emergency response activities, especially as global temperatures continue to rise.

Keywords: Temperature, Children and adolescents, Emergency department, Hospitalization, New York City



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-605

Climate » Other (to be specified with keywords in the keywords section)

Dynamics thresholds for heat-health watch and warning system with extended season

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BACKGROUND AND AIM: A significant number of heat waves with very severe impacts have been observed over the past three decades. The multiplication of the latter during the last decades has incited some countries to elaborate heat-health watch and warning systems (HHWWS). However, these HHWWS cover the hottest months of the year with a unique threshold for the whole summer season. According to some studies, the summers are expected to be longer and hotter in a future climate, with periods of heat waves earlier and later in the season. Besides, the heat effects tend to be more severe when the human body is not acclimatized to hot temperatures. To adapt the system to potential heat waves outside the hot season and consider the meteorological variability within the season, this study proposes a HHWWS with an extended season and evolving thresholds per month.

METHODS: For this, historical health and weather data over the years of Greater Montreal area (Canada) are considered. Splines and distributed lag non-linear model (DLNM) were also used in our approach to the implementation of the system.

RESULTS: The resulting HHWWS provide thresholds for a couple of maximum and minimum temperature (in °C) that range from (23 and 12) in April, to (32 and 21) in July and back to (25 and 13) in October.

CONCLUSIONS: The proposed system is more flexible and adapted over an extended season and with monthly evolving thresholds.

Keywords: Warning systems, Temperature extremes, Environmental epidemiology, climate, thresholds, mortality.



ABSTRACT E-BOOK

P-606

Climate » Other (to be specified with keywords in the keywords section)

Weather indices for heat-health watch and warning systems

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BACKGROUND AND AIM: Extreme heat events have important impacts on human life and health, and have been shown to increase daily mortality and hospitalization. The heat waves of recent years led many countries to establish their heat health watch and warning systems (HHWWS) to prevent the effects of heat. The existing HHWWS usually contain weather indices and their corresponding thresholds. However, the weather indices, which are defined as linear combinations of lagged weather variables, are often unrelated to the variable of interest (over-mortality or over-hospitalization in case of HHWWS). Thus, in order to reduce the subjectivity, it is of interest to construct weather indices which are linked to the variable of interest.

METHODS: Indeed, according to the definition of the weather indices, deriving indices can be seen as a dimension reduction problem. Considering the relationship with variable of interest, the most common example is the supervised dimension reduction methods, in our case, it is more about supervised principal component analysis (SPCA) based methods.

RESULTS: Therefore, the main objective of this study is to determine weather indices by using SPCA based methods. The comparison results show that the obtained weather indices have better performance than the classic indices in warning system.

CONCLUSIONS: These weather indices linked with health variables are then expected to be useful to improve current indices.

Keywords: weather indices, HHWWS, heat wave, mortality



ABSTRACT E-BOOK

P-607

Climate » Temperature extremes and variability

A cold-health watch and warning system, application to the province of Quebec

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BACKGROUND AND AIM: Extreme cold weather has serious impacts on human life and health. However, almost no studies focused on cold warning systems to prevent those health effects. In Nordic regions, winter mortality is generally higher than the rest of the year such as in the province of Quebec in Canada. Therefore, the objective of this study is to focus on developing a cold-system and its application to the province of Quebec.

METHODS: The proposed cold system is not only an adaptation of the current used system in Quebec for heat, but a number of improvements are also proposed. The improvements are mainly about the estimation of over-mortality/over-hospitalization and the lag of cold indicators. The former are calculated by using natural cubic splines, while the latter is chosen by a distributed lag non-linear model.

RESULTS: The final proposed thresholds are between (-15 °C, -23 °C) and (-20 °C, -29 °C) according to the climatic region for over-mortality, and between (-13 °C, -23 °C) and (-17 °C, -30 °C) for over-hospitalization.

CONCLUSIONS: The proposed thresholds and indicators have a high sensitivity and a relatively low number of false alarms, which means they have good performance in detecting health episodes caused by extreme cold.

Keywords: threshold, cold spell, mortality, hospitalization, alert, preparedness.



ABSTRACT E-BOOK

P-608

Chemical exposures » PFAS

Non-targeted metabolomics in evaluating alterations associated with per-fluoroalkyl and polyfluoroalkyl substances (PFAS) exposure in human studies: a scoping review

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BACKGROUND AND AIM: Non-targeted metabolomics has been incorporated into recent epidemiological studies to investigate metabolic mechanisms underlying adverse health effects of per-fluoroalkyl and polyfluoroalkyl substances (PFAS) exposure. The purpose of this review is to summarize the application of non-targeted metabolomics in epidemiological studies that assessed metabolite and metabolic pathway alterations associated with PFAS exposure.

METHODS: We performed a scoping review of human studies that conducted non-targeted metabolomics and PFAS analyses, including original articles published before April 1, 2021 through database searches (PubMed, Dimensions, Web of Science Core Collection, Embase, Scopus), and citation chaining (Citationchaser). We summarized the study characteristics and the metabolites and metabolic pathways reported to be associated with PFAS exposure.

RESULTS: The sample sizes of these studies ranged from 40 to 965 participants involving children and adolescents (n=3), non-pregnant adults (n=5), or pregnant women (n=3). Four studies assessed health endpoints including non-alcoholic liver disease (n=1), alterations in glucose homeostasis or type 2 diabetes (n=2), and cardiometabolic outcomes (n=1). High-resolution liquid chromatography–mass spectrometry was the primary analytical platform to measure both PFAS and metabolome. PFAS were measured in either plasma (n=6) or serum (n=5), while metabolomic profiles were assessed using plasma (n=6), serum (n=4), or urine (n=1). Four types of PFAS (PFOS (n=11), PFOA (n=10), PFHxS (n=9), PFNA (n=5)) and PFAS mixtures (n=7) were the most commonly studied. The most prominent metabolome alterations associated with these PFAS were in metabolites involved in tryptophan metabolism and urea cycle, reflecting exposure-related changes to nitrogen transfer and excretion. Numerous lipid metabolites were suggested to be associated with PFAS exposure, especially key metabolites in glycerophospholipid metabolism which is critical for biological membrane functions. Also changes to fatty acids and carnitines were linked to PFAS exposure, which are relevant to the energy supply pathway of long chain fatty acid oxidation. Other important changes to the metabolome were also reported for metabolites within the TCA cycle, regarding energy generation, purine and pyrimidine metabolism in cellular energy systems.

CONCLUSIONS: Non-targeted metabolomic analysis is demonstrated as a promising application to study human physiological changes associated with PFAS exposures. Multiple PFAS exposures are associated with alterations in amino acid and lipid metabolism with implications for cardiometabolic health, liver and renal function, and neurological outcomes. Future studies may consider prospective design, a more standardized procedure in reporting metabolomic findings, and adjustment for biases.



ABSTRACT E-BOOK

Keywords: PFAS, Metabolomics, Chemical exposures, Obesity and metabolic disorders

P-609

Chemical exposures » PFAS

Association between per- and polyfluoroalkyl substances and liver function biomarkers and daily alcohol consumption in a sample of U.S. adults

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BACKGROUND AND AIM: Per- and polyfluoroalkyl substances (PFAS) are ubiquitous in the environment and in serum of the U.S. population. Studies have suggested adverse effects of PFAS exposure on liver function, but the role of alcohol consumption on this association is unclear. We sought to evaluate these relationships in a sample of the U.S. general population.

METHODS: Using data from the National Health and Nutrition Examination Survey (2003-2016) (N=11,794), we examined the five most historically prevalent PFAS (PFOA, PFOS, PFHxS, PFNA, and PFDA). We estimated odds ratios (OR) and 95% confidence intervals (CI) for the association between PFAS (quartiles and log-transformed continuous, ng/mL) and high levels of liver biomarkers (>95%) using logistic regression models adjusted for demographic characteristics, body mass index (BMI), smoking status, and survey cycle. We evaluated interactions between PFAS and alcohol consumption and sex via stratified analyses, and conducted sub-analyses adjusting for daily alcohol intake among those with available drinking history (N=10,316).

RESULTS: Serum PFOA was positively associated with an elevated level in alanine transferase (ALT) without monotonic trend (OR_{Q4vsQ1}=1.45, CI: 0.99-2.12; p-trend=0.18), and with increased aspartate transaminase (AST) when modeled continuously (OR_{log}=1.15, CI: 1.02-1.30; p-trend=0.03). PFOS and PFHxS were both inversely associated with alkaline phosphatase (ALP) while the trend was statistically significant only for PFHxS (p=0.02). A non-monotonic inverse association was observed with PFOA (p-trend=0.10). The highest quartile of PFOS was associated with increased total bilirubin (OR_{Q4vsQ1}=1.57, CI: 1.01-2.43, p-trend=0.02). No significant association was found between any PFAS and γ -glutamyl transpeptidase. We found no evidence for interactions, and adjustment for daily alcohol consumption did not change our results.

CONCLUSIONS: Consistent with other studies, serum PFAS were associated with liver biomarkers, and alcohol intake did not influence these relationships. However, research in populations with more detailed information on alcohol consumption may clarify its impact.

Keywords: PFAS, epidemiology, biomarkers of exposure, chemical exposures



ABSTRACT E-BOOK

P-610

Chemical exposures » PFAS

Prenatal exposure to per- and polyfluoroalkyl substances and infancy/child growth trajectories through 2 years

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BACKGROUND AND AIM: Prenatal exposure to poly- and per-fluoroalkyl substances (PFAS) has been associated with reduced birth weight, but also with excess adiposity and overweight in childhood. These mixed findings warrant investigation of relationships between prenatal PFAS exposure and dynamic offspring growth. This study aims to investigate the association between prenatal PFAS exposure and early life growth trajectories through 2 years.

METHODS: In a prospective cohort of women and their children from Shanghai, China, we quantified seven PFAS congeners in pregnant women’s serum during the first trimester. Four anthropometric measures, including weight (n=1346), length/height (n=1140), weight-for-length (n=1134), and head circumference (HC, n=1082), were evaluated among children at birth (3 days), 42 days, 6 months, 12 months, and 24 months, and then standardized into z scores. Trajectory groups were identified using group-based trajectory modeling for each measure. Multinomial logistic regression was used to estimate the odds ratio (OR) and 95% confidence interval (CI) for trajectory groups according to log₂-transformed PFAS concentrations.

RESULTS: Five trajectory groups were identified for each anthropometric measure, respectively. In each measure, the trajectory with a stable trend near the null z score was selected as the reference group. Prenatal exposure to PFAS was consistently associated with elevated odds for weight low-rising trajectory characterized by rapid increase from a low birth weight (e.g., perfluorohexane sulfonate (PFHxS): OR=1.54, 95% CI: 1.10-2.14) and length/height high-rising trajectory characterized by increase from a large value (e.g., perfluorononanoic acid (PFNA): OR=1.69, 95% CI: 1.05-2.73). Inverse associations were observed with HC high-stable trajectory characterized by large HC (e.g., perfluoroheptanoic acid (PFHpA): OR=0.75, 95% CI: 0.58-0.96) and HC low-stable trajectory characterized by small HC (e.g., PFHxS: OR=0.70, 95% CI: 0.50-1.00). No association was observed for weight-for-length trajectories.

CONCLUSIONS: We observed associations between prenatal PFAS exposure and unusual growth trajectories in early life, suggesting enduring impact of prenatal PFAS exposure.

Keywords: PFAS, Birth outcomes, Endocrine disrupting chemicals, Multi-pollutant, Environmental epidemiology



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ABSTRACT E-BOOK



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P-611

Chemical exposures » PFAS

Associations of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) and PFAS Mixtures with Adipokines in Midlife Women

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BACKGROUND AND AIM: Perfluoroalkyl and polyfluoroalkyl substances (PFAS) exposure have been associated with obesity and related comorbidities. However, underlying mechanisms are not well understood. We determined if serum PFAS concentrations were associated with adipokine profiles in midlife women.

METHODS: We examined 1,245 women aged 45-56 years from the Study of Women's Health Across the Nation. Concentrations of 11 PFAS were quantified in baseline serum samples collected in 1999-2000. Linear and branched perfluorooctane sulfonic acid isomers (n-PFOS and Sm-PFOS) and their sum (PFOS), linear perfluorooctanoic acid (n-PFOA), perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS), 2-(N-methyl-perfluorooctane sulfonamido) acetic acid (MeFOSAA), and 2-(N-ethyl-perfluorooctane sulfonamido) acetic acid (EtFOSAA) with detection frequencies >60% were included in the analysis. Adipokines including leptin, soluble leptin receptor (sOB-R), free leptin index (FLI, the ratio of leptin to sOB-R), total and high molecular weight (HMW) adiponectin were assessed in 2002-2003. We utilized multivariable linear regressions and Bayesian kernel machine regression (BKMR) to assess individual and overall joint effects of PFAS on adipokines with adjustment for age, race/ethnicity, study site, education, smoking status, physical activity, menopausal status, and waist circumference.

RESULTS: A doubling of PFAS concentrations was associated with 7.8% (95% CI: 2.5%, 13.4%) higher FLI for PFOS, 9.4% (95% CI: 3.7%, 15.3%) for n-PFOA, 5.5% (95% CI: 2.2%, 9.0%) for EtFOSAA and 7.4% (95% CI: 2.8%, 12.2%) for MeFOSAA. Similar associations were found for leptin. Only EtFOSAA was associated with lower sOB-R concentrations (1.4% lower, 95% CI: -2.7%, -0.1%). In BKMR analysis, women with PFAS concentrations at the median and the 90th percentile had 30.9% (95% CI: 15.6%, 48.3%) and 52.1% (95% CI: 27.9%, 81.0%) higher FLI, respectively, compared with those with concentrations fixed at the 10th percentile.

CONCLUSIONS: Some PFAS may alter circulating levels of leptin. Understanding associations between PFAS and adipokines may help elucidate whether PFAS can influence obesity and metabolic disease.

Keywords: PFAS, Mixtures, Mixture analysis, Obesity and metabolic disorders



ABSTRACT E-BOOK

P-612

Chemical exposures » PFAS

Exposure to per- and polyfluoroalkyl substances (PFAS) through drinking water in Barcelona metropolitan area

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BACKGROUND AND AIM: Per- and polyfluoroalkyl substances (PFAS) are a group of water-soluble chemicals of concern due to their persistence, widespread human exposure and associated adverse health outcomes across all life stages. Drinking water is one of the main routes of human exposure to PFAS.

METHODS: We assessed 38 PFAS in 64 drinking water samples sourced from tap water (N=42, one per postal code), bottled (N=11), activated carbon (N=6) and reverse osmosis (N=5) filtered tap water in Barcelona, Spain. Liquid chromatography coupled tandem mass spectrometry was used to determine PFAS. Physico-chemical properties including residual chlorine, total organic carbon and conductivity were also measured. Water consumption habits of study participants (N=39) were collected through online questionnaires.

RESULTS: The most abundant PFAS in unfiltered tap water were perfluoropentanoic acid (PFPeA) [3 ng/L (2.0-5.0)] -among 64% samples above the limit of quantification (LOQ)-, perfluorohexanoic acid (PFHxA) [14 ng/L (10-18)] -31%-, perfluoroheptanoic acid (PFHpA) [3 ng/L (2.25-4)] -52%-, perfluorooctanoic acid (PFOA) [11 ng/L (10-12)] -12%-, perfluorobutane sulfonic acid (PFBS) [9 ng/L (6.5-14.5)] -64%-, and perfluorooctane sulfonate (PFOS) [12.5 ng/L (10-14)] -52%-, with corresponding median (interquartile range, IQR). The median concentration of total PFAS was 29 ng/L (IQR=24-51), among 79% of tap water samples with PFAS >LOQ. Individual PFAS displayed a range of positive correlations (Spearman, two-tailed) between $r=0.36$ ($p=0.02$) and $r=0.67$, ($p<0.001$). Conductivity showed a geographical pattern linked to the tap water source, and a positive correlation ($r=0.75$, $p<0.001$) with total PFAS. Reverse osmosis removed PFAS from tap water, while activated carbon filters did not. PFAS were not detected in bottled water. The mean consumption of water at home was 1.4L/day, and 0.8L/day outside of home. The main source of water was tap (43%) at home, and bottled or filtered (37.5% each) outside.

CONCLUSIONS: Concentrations were below the EU Drinking Water Directive 2020/2184 PFAS Total parametric value (100 ng/L).

Keywords: PFAS, Exposure assessment, Chemical exposures, Water quality



ABSTRACT E-BOOK

P-613

Chemical exposures » PFAS

FluoroMatch: A Comprehensive Software for Non-Targeted PFAS Analysis

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BACKGROUND AND AIM: Per- and polyfluoroalkyl substances (PFAS) are distributed globally in products such as food wrappers, firefighting foam, carpets, and much more. PFAS last in the body for a long time, and some are highly toxic. There are potentially still thousands of undiscovered PFAS. Although the structures can vary dramatically, the vast majority of PFAS have some kind of carbon-fluorine chain (e.g., CF₂) which allows for an automated non-targeted approach. In fact, FluoroMatch is the first software to process non-targeted mass spectrometry data for PFAS.

METHODS: FluoroMatch provides six types of evidence that help build annotation confidence, scoring each identification from A+ to E. Identifications based on class-based MS/MS fragmentation rules from standards score in the A-range (confident), while any other annotations with MS/MS evidence score in the B-range (tentative). FluoroMatch also pulls out hits that fall within a homologous series based on Kendrick mass defect. Thus, any identification that falls in a series of CF₂ units (or other common PFAS series) with a confident or tentative annotation scores in the C-range, and any otherwise unidentified annotations that lie in series score in the D-range. These B, C and D-range annotations are by no means confident, but they illuminate the sheer volume of possible PFAS and provide starting points for the discovery of new compounds.

RESULTS: In leachate data, there were ~25 confident and ~50 tentative identifications, but there were ~170 hits in series with those identifications and a staggering 5000+ other hits in series.

CONCLUSIONS: It is essential to determine what compounds are out there in order to identify and regulate the most concerning ones and to better educate on PFAS health effects. FluoroMatch is a software which automates non-targeted PFAS data-processing and assists researchers in working towards this goal.



ABSTRACT E-BOOK

Keywords: PFAS, Non-targeted, Mass spectrometry

P-614

Chemical exposures » PFAS

Impact of menopause on the associations between high exposures to perfluoroalkyl substances and lipid profile: a mixture-based approach

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BACKGROUND AND AIM: During their reproductive years, females show lower serum PFAS concentrations than males, most likely due to menstrual excretion, previous childbirth with transplacental transfer of PFAS and breastfeeding. Also, females in pre-menopause age have lower levels of low-density lipoprotein cholesterol (LDL-C) and higher levels of high-density lipoprotein cholesterol (HDL-C) compared to males. So far, little is known of the impact of menopause on dose-response relationships. Given the possible role of estrogens in regulating lipid metabolism, there can be an interaction and the aim of our study is to evaluate if the associations of PFAS and serum lipids changes with aging, comparing women in pre- and post-menopausal age groups.

METHODS: A cross-sectional analysis was conducted among highly exposed women, 14,155 mostly pre-menopausal and 4,165 mostly post-menopausal women, based on a cut-off of 50 years. Associations between four PFAS (PFOA, PFOS, PFHxS and PFNA) and non-fasting serum total cholesterol (TC), HDL-C and LDL-C, were assessed through weighted quantile sum (WQS) regression and Bayesian kernel machine regression (BKMR) models, adjusting for potential confounders.

RESULTS: We observed that each PFAS in the WQS index was associated with an increase in the levels of TC in both groups, and pre-menopausal women showed a larger increase of TC per quartile increase of PFAS mixture (4.63, 95% CI 3.46-5.79) than post-menopausal women (β :1.84, 95% CI 0.30-3.38), mainly driven by the effect on LDL-C. WQS analyses revealed a major contribution of PFOS and PFNA to the association with cholesterol levels, although the larger contrast being in PFOA for both groups.

CONCLUSIONS: Investigations of combined exposures to four PFAS showed a strong positive association with all three serum lipid parameters. The large differences between pre- and post-menopausal women may reflect complex relationships between PFAS, estrogens and cholesterol. Analysis on menopausal timing are ongoing.

Keywords: PFAS, Mixtures, Chemical exposure, Female



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-615

Chemical exposures » PFAS

Per- and polyfluoroalkyl substances (PFAS) and non-fasting total cholesterol serum levels among New Jersey volunteer firefighters

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BACKGROUND AND AIM: Increased serum levels of some PFAS have been reported among firefighters compared to the general population; we previously found increased levels of perfluorododecanoic acid (PFDoA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) among a group of volunteer firefighters. PFAS exposure has been associated with adverse health outcomes in humans including dyslipidemia (i.e., abnormal amount of lipids in the blood). Previous studies of career firefighters have found an inverse or null relationship between serum PFAS levels and serum cholesterol. This association is less studied among volunteer firefighters. We examined whether serum PFAS levels among members of a volunteer department are associated with non-fasting total serum cholesterol levels.

METHODS: The Firefighters Cancer Prevention Study (CAPS) enrolled consenting participants from a large suburban New Jersey fire department who completed a survey and provided blood samples. Serum was tested for 11 PFAS and non-fasting total cholesterol serum levels; PFAS detected in >50% of respondents were included (perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), PFNA, perfluorohexanesulfonic acid (PFHxS), PFDA, and PFDoA)). Serum PFAS and cholesterol levels were log transformed and their associations assessed using linear regression. Each PFAS was modeled separately adjusting for age, sex, education, and firefighter service years.

RESULTS: The 135 study participants were majority male (94.8%) and non-Hispanic white (91.1%). Their average cholesterol level was 187.9 mg/dL. There was no association observed between the six PFAS serum concentrations and the non-fasting total cholesterol serum levels. The effect estimates for the association between PFAS and cholesterol ranged from -0.01 (95% CI (-0.07, 0.06) for PFHxS to 0.08 (-0.02, 0.17) for PFDoA.

CONCLUSIONS: Consistent with findings in career firefighters, we did not observe significant positive associations between PFAS serum levels and total serum cholesterol. Further research is needed to explore associations between PFAS serum levels, cholesterol, and other health outcomes among volunteer firefighters.



ABSTRACT E-BOOK

Keywords: PFAS, Occupational Exposures, Occupational Epidemiology

P-616

Chemical exposures » PFAS

Changes in maternal serum concentrations of per- and polyfluoroalkyl substances from pregnancy to two years postpartum

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BACKGROUND AND AIM: Prenatal exposure to per- and polyfluoroalkyl substances (PFAS) is of increasing public health concern due to their potential adverse health effects in pregnant women and their offspring. However, little is known about changes in maternal PFAS concentrations from pregnancy to few years postpartum within the same women.

METHODS: We quantified nine PFAS in 248 blood serum samples prospectively collected from 42 mothers during the 1st, 2nd, and 3rd trimesters of pregnancy and 3 months, 6 months, and 24 months after delivery who participated in the MARBLES (Markers of Autism Risk in Babies – Learning Early Signs) study. To examine how placental and lactational transfers and other factors affected the rate of changes in maternal serum PFAS concentrations between pregnancy and two years postpartum, we separately fit three multiple regression models during pregnancy, lactation (from delivery to 6 months postpartum), and postweaning (from 6 to 24 months postpartum).

RESULTS: Among four PFAS detected in more than 99% of the samples, perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), and perfluorononanoate concentrations decreased at a rate of 6%, 5%, and 6% per month, respectively, during pregnancy. PFOA and perfluorohexane sulfonate concentrations decreased at a rate of 4% and 5% per month, respectively, during lactation, and only PFOS concentrations decreased at a rate of 1% per month during postweaning. We identified sample collection year and maternal age at delivery as common determinants of maternal PFAS concentrations for all three periods. All four PFAS concentrations changed with increasing maternal weight change during pregnancy and lactation, ranging from 2% to 4%, depending on congener.

CONCLUSIONS: Our study showed that maternal serum PFAS concentrations changed at different rates during pregnancy, lactation, and postweaning. Thus, for epidemiologic studies for which only postpartum biomarker measurements are available, our findings might be useful for reconstructing reliable prenatal or early life PFAS exposure.

Keywords: PFAS, maternal serum, pregnancy, lactation, postweaning, determinant



ABSTRACT E-BOOK

P-617

Chemical exposures » PFAS

Using a translational research paradigm to investigate dietary intake of fruit juice on per- and polyfluoroalkyl substances (PFAS) concentrations

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BACKGROUND AND AIM: Certain fruit juices, such as apple juice (AJ), contain bioactive molecules that can impair intestinal drug absorption through inhibition of transporter Organic Anion Transporting Polypeptide 2B1 (OATP2B1). Because some PFAS have been shown to be OATP2B1 substrates, we used a translational research paradigm to explore our hypothesis that higher fruit juice intake is associated with lower PFAS concentrations.

METHODS: Female C57Bl/6 mice were administered perfluorooctane sulfonic acid (PFOS, 5 mg/kg) in buffer or in 4x AJ concentrate, with blood and tissues collected 5 hours after administration. Tissue PFOS was extracted and quantified by LC-MS. Epidemiologic analysis was conducted on 345 adolescents aged 12-19 years and 1,458 adults aged 20-80 years using the National Health and Nutrition Examination Study (NHANES), 2013 - 2014 cycle. Pure (100%) fruit juice intake was assessed by 24h dietary recall. Log-2 transformed serum concentrations of PFOS, perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) were evaluated. Multivariable regression models were used to assess changes in PFAS concentrations in relation to dietary intake of juice, adjusting for covariates.

RESULTS: In mice, 4x AJ co-administration decreased PFOS concentrations in blood, liver, kidney, and brain 5 hours after administration, indicating that 4x AJ can inhibit or delay PFOS absorption. Intake of pure fruit juice more than 1 time in the previous 24h was associated with a 15% (95%CI: -28%, -1%) reduction in serum PFOA concentration compared with no intake of juice among adolescents. No associations were observed between fruit juice intake and PFAS concentrations in adults.

CONCLUSIONS: Combining experimental and epidemiological data, fruit juice consumption might lower PFAS burden. More research is needed to elucidate the effect of fruit juice consumption on PFAS concentrations in humans across age groups.

Keywords: PFAS, juice, translational, exposure reduction



ABSTRACT E-BOOK

P-618

Chemical exposures » PFAS

Dietary intake and blood concentrations of folate and folic acid in relation to serum per- and polyfluoroalkyl substances (PFAS) concentrations

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BACKGROUND AND AIM: Folate may counteract the effects of environmental chemical exposures. This study aimed to explore the associations of dietary folate and folic acid intake with serum concentrations of per- and polyfluoroalkyl substances (PFAS).

METHODS: We included 505 children (aged 3-11), 345 adolescents (aged 12-19), and 1,458 adults (aged 20-80) in the National Health and Nutrition Examination Study (NHANES), 2013 - 2014 cycle. Dietary intake of folate and folic acid in food and supplementation were evaluated by dietary recall in the last 24h and 30 days, respectively. Biomarker concentrations of folate and folic acid in serum and folate in red blood cells were also assessed. We examined serum perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS). Multivariable regression models were used to assess change in log₂-transformed PFAS concentrations in relation to dietary intake and folate and folic acid biomarkers, adjusting for covariates.

RESULTS: Children's dietary supplement intake of folic acid was negatively associated with PFOA, PFOS and PFNA concentrations (for example, PFNA: -13%; 95%CI: -29%, 0.07%). In adolescents, significant negative associations were found for folate in red blood cells and all four PFAS concentrations (for example, PFNA: -25%; 95%CI: -43%, -1%); total serum folate concentration and PFNA; and dietary intake of folate in food and PFOA and PFHxS concentrations. In adults, significant negative associations were found for dietary supplement intake of folic acid and serum concentrations of PFOA, PFOS and PFNA (PFNA: -10%; 95%CI: -18%, -2%); folate concentrations in red blood cells and all four PFAS concentrations; as well as serum folic acid and total folate concentrations and PFOA, PFOS and PFNA.

CONCLUSIONS: Dietary intake and biomarkers of folate and folic acid were negatively associated with select PFAS concentrations in the U.S. population. These findings may have important implications for reducing PFAS body burden.



ABSTRACT E-BOOK

Keywords: PFAS, folate, folic acid, exposure reduction

P-619

Chemical exposures » PFAS

Multimorbidity and PFAS Exposure in an Electronic Health Record Cohort

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BACKGROUND AND AIM: Despite discontinued manufacture, per and poly-fluoroalkyl substances (PFAS) are a health concern for many communities due to their long half-lives. Several studies have associated PFAS with health effects, but few have examined whether PFAS exposure increases multimorbidity

METHODS: A random sample of 10,168 patients from the University of North Carolina Healthcare System was evaluated for prevalence of multiple chronic health conditions and potential exposure to PFAS using electronic health records. PFAS exposure was assessed using data from the Unregulated Contaminant Monitoring Rule 3 based on residential zip code. We used logistic regression and cumulative link models (logit link) to associate public water system PFOA and PFHpA testing above the minimum reporting level with multimorbidity, i.e. the co-occurrence of two or more chronic diseases out of 17 chronic diseases determined by ICD-9 and ICD-10 codes. Models were adjusted for age, race, sex, smoking, socioeconomic status, and county-level confounders such as access to healthy foods and healthcare. Results are presented as the odds ratio (OR) and associated 95% confidence interval (CI).

RESULTS: Increased prevalence of multimorbidity (OR = 1.32; 95% CI = 1.09-1.60) was associated with residing in a zip code served by a public water system that reported results above the MRL for PFOA or PFHpA. Exposure to either of these PFAS increased the odds of having an additional chronic condition by 38% (OR = 1.38; 95% CI = 1.17-1.62). Among diseases with at least 5% prevalence in our participants, hypertension had the strongest association with PFAS exposure (OR = 1.45; 95% CI = 1.18-1.80).

CONCLUSIONS: This study demonstrates that exposure to PFAS via public water systems is associated with multimorbidity. These associations indicate the potential for PFAS to affect multiple organ systems and highlight the ongoing need to study these “forever chemicals”. This abstract does not represent EPA policy.

Keywords: PFAS, multi-morbidity, electronic health records



ABSTRACT E-BOOK

P-620

Chemical exposures » PFAS

PFAS in American Indian and Alaska Native Communities

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BACKGROUND AND AIM: Systemic environmental health disparities exist for residents of U.S. Tribal lands including access to safe public drinking water and differences in drinking water quality as compared to non-Tribal lands. Per- and polyfluoroalkyl substances (PFAS) are a leading emerging concern for drinking water. However, knowledge about PFAS contamination on Tribal lands is lacking, a shortcoming in environmental health research given the extent of PFAS contamination.

METHODS: We comprehensively identified existing PFAS water testing programs, including academic institutions and federal agencies, to identify all existing testing of drinking and/or groundwater on Tribal lands and to understand factors that prompted testing. We examined the proximity of Indian Reservations to active U.S. military installations. Military installations, Indian Reservations, and known PFAS contamination site levels were mapped with ArcGIS using publicly available data.

RESULTS: We identified limited existing PFAS testing on Tribal lands, including partnerships with academic research institutions, and completed and planned testing by government entities. Spatial analysis identified 58 Reservations were within six miles of an active military installation, including at least 18 installations with identified PFAS contamination and six with over 100,000 ppt PFAS detected in groundwater.

CONCLUSIONS: Tribal Nations and their public water systems have been overlooked for systematic testing of PFAS, a large data gap. Tribal lands near military installations may be at increased risk of contamination. While efforts for increased testing by federal agencies exist, current programs are voluntary with little incentive for Tribal Nations to participate. While the EPA's 2023-2025 testing under the Unregulated Contaminant Monitoring Rule will have increased Tribal PWS inclusion, there is need for timelier PFAS testing. Recognition of the risks posed by PFAS contamination should inform policy change to protect American Indian and Alaska Native health.

Keywords: PFAS, environmental disparities, policy



ABSTRACT E-BOOK

P-621

Chemical exposures » PFAS

Geographic and Demographic Variability in Serum PFAS Concentrations for Pregnant U.S. Women

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BACKGROUND AND AIM: The National Children's Study (NCS) Vanguard Study pilot tested recruitment methods and protocols designed for the NCS Main Study. Over 1,000 pregnant women from seven counties throughout the U.S. were recruited during 2009 and 2010 to assess relationships between environmental and other exposures and children's health in a nationally representative longitudinal birth cohort study. Women had at least one home visit during pregnancy to collect biomonitoring specimens, environmental samples, and questionnaire data.

METHODS: Here we analyzed data from the NCS Vanguard Study Vanguard Data and Sample Archive Access System for PFAS concentrations in the serum of 427 pregnant women. Geographic variability in serum concentrations was investigated through summary statistics and tests of difference between sampling locations. The cohort was organized into self-reported demographic groups based on income, home age, and drinking water source. Variability in serum concentrations between these groups was used to target spatial mapping analyses that incorporated public data from the U.S. census, drinking water measurements, and PFAS-related industry locations.

RESULTS: Statistically significant differences in serum concentration means were observed among the seven counties. Higher PFOA serum concentrations were observed in lower income participants in Montgomery County, PA whereas the opposite was observed in other counties. Spatial analyses demonstrated that these lower income participants were likely exposed to contaminated drinking water from aqueous film-forming foam use at a nearby military base, explaining higher serum levels.

CONCLUSIONS: Our analysis of NCS Vanguard Study data improves understanding of relative importance of PFAS exposure sources and associations at the community and household levels. By better identifying vulnerable populations and locations with high potential PFAS exposures, this work contributes to risk management strategies that maximize public health protection.

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

Keywords: PFAS, pregnant women, spatial analysis



ABSTRACT E-BOOK

P-622

Chemical exposures » PFAS

Pregnancy per- and polyfluoroalkyl substances (PFAS) and hypertensive disorders of pregnancy in the Project Viva cohort

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BACKGROUND AND AIM: Exposure to environmental chemicals may increase the risk of cardiovascular disease. However, data on associations between per- and polyfluoroalkyl substances (PFASs) and hypertensive disorders of pregnancy (HDP) are limited and inconsistent. We sought to determine the extent to which early-pregnancy PFAS concentrations are prospectively associated with HDP risk in a large cohort.

METHODS: We studied 1,537 pregnant women from the Project Viva cohort in Boston, Massachusetts, USA. Using maternal plasma samples collected from 1999-2002 at a median of 9.7 gestational weeks, we quantified concentrations of eight PFAS [perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexane sulfonate (PFHxS), perfluorononanoate (PFNA), 2-(N-ethyl-perfluorooctane sulfonamide) acetate (EtFOSAA), 2-(N-methyl-perfluorooctane sulfonamide) acetate (MeFOSAA), perfluorodecanoate (PFDeA), perfluorooctane sulfonamide (FOSA)]. PFDeA and FOSA were detected in <50% of samples and were not included in further analyses. We assessed HDP using clinical data and defined preeclampsia and gestational hypertension according to the National High Blood Pressure Education Program recommendations. We used multinomial logistic regression to estimate associations of log₂-transformed continuous PFAS concentrations with categories of HDP [gestational hypertension, preeclampsia, normotensive (ref)], adjusting for age, race/ethnicity, education, smoking, marital status, and parity.

RESULTS: A total of 56 (4%) of women developed preeclampsia and 106 (7%) developed gestational hypertension. We observed higher risk of gestational hypertension per doubling of concentrations of



ABSTRACT E-BOOK

PFOS (odds ratio [OR] 1.28, 95% confidence interval [CI]: 0.96, 1.70), PFOA (OR 1.36, 95% CI: 0.99, 1.86), and PFHxS (OR 1.22, 95% CI: 1.01, 1.48). Associations with other PFAS were consistent in direction but smaller in magnitude (e.g., EtFOSAA: OR 1.14, 95% CI: 0.95, 1.38). We did not observe associations between PFAS concentrations and preeclampsia.

CONCLUSIONS: Our results support the hypothesis that PFAS exposure during pregnancy may increase the risk of gestational hypertension. However, we did not observe associations between PFAS exposure and preeclampsia.

Keywords: PFAS, hypertensive disorders of pregnancy, gestational hypertension, preeclampsia, pregnancy



ABSTRACT E-BOOK

P-623

Chemical exposures » Pesticides

Environmental Epidemiology for Action: Analysis of Cancer Mortality, Exogenous Poisoning in a Municipality with Mining and Agrotoxics in Brazil

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BACKGROUND AND AIM: Brazil has about 98% of niobium deposits in the world. It is also the main consumer of pesticides in the world. Goiás (GO) is a Brazilian state with a population of 7 million inhabitants. GO is the third largest Brazilian mineral producer, the main producer of asbestos and nickel, a major producer of phosphate rock, niobium and gold. Catalão (CT) is a municipality in the state of GO, with 100 thousand inhabitants. Mining is an important factor in the economy of CT. One of the metals explored is niobium. CT has a profile aimed at agriculture and pesticides are widely used, substances in human drinking water have been identified such as: DDT, Atrazine, Aldrin, 2,4D. Given this environmental situation, it is essential to know the health profile of the population, using environmental epidemiology. **AIM:** to analyze data on cancer mortality and exogenous intoxications in the municipality of Catalão

METHODS: Descriptive study. Data were collected at the Brazilian Institute of Geography IBGE and data Ministry of Health. Period: 2010 to 2019

RESULTS: Mortality rates for general cancer in CT were similar to GO. They were differentiated in the 30 - 39 yo group in CT, they were 30% higher than the GO. Mortality from liver cancer in CT for the age group 30 to 39 yo: 1.18 / 100.000, while in GO they were 0.52 / 100.000. About exogenous intoxications: in GO, 57% of the 9,391 cases occurred in the black population. When analyzed by pesticides, 65% were in the black population. In CT, 28% were registered as work-related, 66% of metal poisonings occurred in children up to 9 yo.

CONCLUSIONS: In view of the various environmental factors existing in the municipality, environmental epidemiology is a fundamental tool to guide specific analyzes and studies with this population, aiming at the implementation of public policy.

Keywords: Pesticides, Chemical exposures, Water quality, Policy and practice, Mortality, Children's environmental health



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-624

Outcomes » Childrens environmental health

Environmental Exposure to Melamine-Related Compounds and Kidney Outcomes in Children

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BACKGROUND AND AIM: Melamine is used in a variety of consumer and industrial applications, and exposure is ubiquitous. Melamine is a known nephrotoxicant in high doses, but it is unclear whether environmental levels or melamine analogues can impact pediatric kidney health.

METHODS: We performed a cross-sectional study of 344 children (170 girls; 174 boys) aged 4-7 years within the GAPPs PATHWAYS Study relating urinary melamine, ammelide, and cyanuric acid (CA) concentrations with urinary concentrations of kidney injury-related biomarkers. Participants were recruited from an urban site (Seattle; n=163) and a rural site (Yakima; n=181) in Washington State. Biomarkers included total protein, albumin, creatinine, kidney injury molecule-1 (KIM-1), n-acetyl- β -D-glucosaminidase (NAG), neutrophil gelatinase-associated lipocalin (NGAL), and epidermal growth factor (EGF). Associations between melamine-related compounds and injury biomarkers were modeled in separate regressions controlling for specific gravity, urine collection time, study site, and sociodemographic factors. Additional regressions examined interactions by sex and site.

RESULTS: Melamine, ammelide, and CA mean (SD) concentrations were 5.58 (11.8), 0.04 (0.10), and 49.0 (152.0) ng/mL, respectively. Compared to Seattle, Yakima participants had higher levels of ammelide and CA but lower levels of most kidney-related biomarkers. Girls had higher levels of most kidney-related biomarkers than boys. In the total population, ten-fold higher melamine was protectively associated with a 12.8% (95% CI: 1.55%, 25.4%) higher EGF and ten-fold higher CA was associated with 7.34% (2.43%, 12.0%) and 12.3% (0.02%, 23.1%) lower urinary total protein and NAG, respectively. Sex interaction analyses showed male-specific associations between melamine and higher KIM-1 as well as female-specific associations between ammelide and higher NAG and NGAL. Site interaction analyses showed that the associations with CA were specific to Yakima.

CONCLUSIONS: These data suggest mixed associations between pediatric kidney health and melamine-related compounds that were at times sex-specific or site-specific. Potential public health implications of these findings require further study.

Keywords: Children's environmental health, environmental epidemiology, molecular epidemiology, pesticides



ABSTRACT E-BOOK

P-625

Outcomes » Other (to be specified with keywords in the keywords section)

Mortality and morbidity by work-related pesticide poisoning in Brazil, 2009-2019

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BACKGROUND AND AIM: Pesticide poisoning is a key public health problem in Brazil, which is one of the worlds' largest consumer. **OBJECTIVE:** To analyze the records of work-related pesticide poisoning from the Brazilian official database.

METHODS: Pesticide poisoning data from 2009-2019 from the Information System of Notifiable Diseases (SINAN) was gathered, and mortality and morbidity coefficient among agricultural workers calculated for 2018. Notification of suspected and confirmed poisoning cases is mandatory for health services in Brazil through the SINAN system.

RESULTS: From 2009-2019, 23,011 work-related pesticide poisoning were notified in SINAN, with an upward trend over the years, soaring from 1,467 cases in 2009 to 2,842 in 2018 (+94%). But pesticide poisoning is vastly underreported in Brazil, and it is estimated that for every notification there is another 50 cases unregistered. There is a considerable regional difference in the sensitivity of health services to identify poisoning cases and register in SINAN, and states with stronger surveillance systems had more cases notified. Most pesticide poisoning cases registered in SINAN occurred among male workers (79%) aged 26-45 years (50%), who worked in agriculture (70%) and had at most elementary educational level (57%). The morbidity coefficient was, respectively, 30 and 24 (x 100.000) among women and men. The highest coefficient was observed among workers aged 14-25 years and 26-35 years, respectively, 270 and 73 x 100.000. Lethality was 0.7%, and mortality coefficient was 0.001 x 100.000 agricultural workers. Considerable incomplete data was observed in SINAN, especially regarding "work relation", and "final outcome".

CONCLUSIONS: As Brazilian agricultural production and pesticide use steadily grow, it is necessary to strengthen health surveillance and promotion on pesticide exposure and foster farmer's technical support and training to reduce occupational exposure, health impacts, and burden of disease.

Keywords: Pesticides, Chemical exposures, Occupational exposures, Occupational epidemiology, Outcomes, Mortality



ABSTRACT E-BOOK

P-626

Other » Other (to be specified with keywords in the keywords section)

Pesticide exposure and health in horticultural production: identification of determinants for surveillance in Argentina

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BACKGROUND AND AIM: Pesticides have been widely used for horticulture production in Argentina. The aim of this study was to assess the social, demographic and productive protective factors of pesticide exposure in the Green Belt of Cordoba (GBC), Argentina, and their health impacts on horticultural workers, for preventive purposes.

METHODS: A population-based study was conducted in a representative sample of horticulturist in the GBC (n=137, 95% CI) (2013-2017). Pesticide exposure determinants were assessed thru social, demographic, productive and labor characteristics, including two indices of intensity (IEI) and cumulative exposure (CEI) developed by our research group. Health conditions were studied thru the presence of self-reported symptoms and marker diseases. For the analysis, two steps were performed: a) Multiple Correspondence Analyses (MCA) were achieved to identify exposure profiles; b) Logistic Regression Models (LRM) were fitted to estimate the association between the presence of symptoms and marker diseases with pesticides exposure determinants.

RESULTS: The symptoms prevalence was 73.2% and 45% have did marker disease. MCA identified two different profiles regarding sociodemographic work features, occupational exposure level according to IEI and CEI, symptoms and diseases (74.6% of explained variation on first and second factors). LRM showed protective factors for the presence of symptoms: to used less than 10 pesticides (OR: 0.06; p <0.05), the correct use or personal protective equipment during handling pesticides procedures (OR: 0.07; p <0.05), while another model also showed that having a low CEI is a protective factor (OR = 0.15; p <0.02). The presence of marker diseases presented two protective factors: the lifetime uses of less than 10 different pesticides (OR: 0.03; p <0.05) and spraying pesticide less than 3 days per month.

CONCLUSIONS: A high burden of symptoms and diseases was identified. The protective factors identified allow the implementation of surveillance programs with this population, however it is necessary to review the productive model.

Keywords: Occupational epidemiology, Pesticides, Exposures



ABSTRACT E-BOOK

P-627

Chemical exposures » Pesticides

Increasing Agricultural Use of 2,4-D and Population Biomarkers of Exposure: National Health and Nutrition Examination Survey Findings, 2001-2012

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BACKGROUND AND AIM: The emergence of herbicide resistant weeds precipitated a 527-million-pound increase in use of glyphosate between 1996 and 2011 and led to the widespread use of secondary herbicides such as 2,4-D. The objective of this study was to examine trends in 2,4-D urine biomarker concentrations to determine whether increases in agricultural use of 2,4-D have resulted in increases in population exposure.

METHODS: NHANES data with available urine 2,4-D biomarker measurements from survey cycles between 2001 and 2012 were utilized. Urine 2,4-D values were dichotomized using the highest limit of detection (LOD) across all cycles (0.40 ug/L). The amount of 2,4-D applied in the US was estimated by compiling publicly available pesticide application data. Logistic regression models adjusted for confounders were fitted to evaluate the association between agricultural use of 2,4-D and higher exposure level.

RESULTS: Of the 12,059 participants included in the study, 3855 (31.25%) had urine 2,4-D levels above the dichotomization threshold. The frequency of higher level of exposure significantly increased from 17.0% to 39.8% over the series of surveys ($p < .0001$). Adjusted odds ratio for higher 2,4-D exposure level associated with pounds of 2,4-D utilized in crop applications (per million pounds) was 1.065 (95% CI 1.043-1.087). For children ages 6-11 ($n=1887$), the adjusted odds ratio was 1.095 (95% CI 1.055-1.137), while for participants age 60 and older ($n=2529$), the adjusted odds ratio was 1.095 (95% CI 1.069-1.121). For women of childbearing age (20-44) ($n=2063$), the odds ratio was 1.081 (95% CI 1.049-1.115).

CONCLUSIONS: As average annual 2,4-D use increased, the odds of having higher urine 2,4-D levels increased. With the expectation of increasing agricultural use of 2,4-D, the consistent association between agricultural use and human exposure is concerning, particularly with respect to more highly exposed vulnerable populations.

Keywords: Exposure assessment-biomarkers of exposure, Environmental epidemiology, Pesticides



ABSTRACT E-BOOK

P-628

Chemical exposures » Pesticides

Pesticide levels in Soil of a small Guarani settlement in Brazil

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BACKGROUND AND AIM: Pesticide uses skyrocket in Brazil in the last 20 years, our aim is to present an overview of the contamination at a small native settlement called “Tehoe Oco’y = Guaranis” (Native Americans) living near Itaipu HE Dam, Parana State.

METHODS: In order to access the presence and the effects of some pesticides (glyphosate acephate, metamidophos and methomil) on the natural attenuation of the natural system, i.e. the potential for (bio) degradation and / or immobilization of contaminants we developed a biosensor based on the attenuation of fluorescence of proteins. High sorption capacity in soil mineral fraction: low mobility in soils with high values of Cation Exchange Capacity; Competitive sorption with elements such as P, copper and zinc.

RESULTS: High levels of pesticides were found in the soils, and the contamination coming from the soy and corn plantations in located very close to the guarani village seems evident, Dynamics of sorption/desorption of glyphosate in soils presents a relevant variation considering the mineral fertility profile of Brazilian agricultural soils and their levels of P, Zn and Cu; The levels of P, Cu and Zn required for the displacement of glyphosate to the soil solution are 5 times lower than the concentrations found in Brazilian agricultural soils; Levels of glyphosate found in the soil and the P and Cu levels influenced the kinetics of the degradation enzymes in the samples; Sorption dynamics of glyphosate alters the kinetics enzyme by varying the desorbed concentration (present in the soil solution);

CONCLUSIONS: Soil studies on the mobility of high toxicity metals potentially affects the fate of glyphosate. We need to review the agronomic recommendations of mineral fertilization and liming observing the management of pesticides. Importance of ecological (functional) studies on the impact of these contaminants on the maintenance and quality of environmental services, where natural attenuation is factor of their resilience;

Keywords: Herbicides, Fate, Soils, Native Americans



ABSTRACT E-BOOK

P-630

Other » Other (to be specified with keywords in the keywords section)

Prenatal Metal Mixtures and Child Blood Pressure in the Rhea Mother-Child Cohort

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BACKGROUND AND AIM: Blood pressure (BP) in childhood is an important risk factor for cardiovascular disease in adulthood. *In utero* exposure to metals has been associated with higher BP in childhood. However, most studies have evaluated elements individually and measured BP at a single time point. The objective of the current study was to investigate the impact of a complex mixture of metals on child BP trajectories and elevated BP at age 11.

METHODS: The current study included 176 mother-child pairs from the Rhea Study in Heraklion, Greece who had three BP measurements in childhood (at ages 4, 6, and 11). We focused on eight metals (antimony, arsenic, cadmium, cobalt, lead, magnesium, molybdenum, selenium), which were measured by inductively coupled plasma mass spectrometry in maternal urine samples collected during pregnancy (median gestational age at collection: 12 weeks). Covariate-adjusted Bayesian Varying Coefficient Kernel Machine Regression and Bayesian Kernel Machine Regression were used to simultaneously evaluate these eight metals in relation to the change in BP from age 4 to 11 and elevated BP at age 11, respectively.

RESULTS: J-shaped associations were observed between molybdenum and both systolic and diastolic BP at age 4. Similar associations were identified for both molybdenum and lead in relation to elevated BP at age 11. Positive associations between molybdenum and BP at age 4 (for concentrations >40-80 µg/L) were stronger at high levels of lead. Lead was positively associated with BP measures at age 4, but only at high levels of molybdenum.

CONCLUSIONS: Co-exposure to high levels of molybdenum and lead during the prenatal period may contribute to increased BP at age 4, which in turn may contribute to elevated BP in adolescence.

Keywords: Metals, mixtures, blood pressure, childhood, BKMR, BVCKMR



ABSTRACT E-BOOK

P-631

Chemical exposures » Fluoride

Systematic Review of Fluoride Exposure and Neurodevelopmental and Cognitive Health Effects

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National Institute of Environmental Health Sciences

BACKGROUND AND AIM: People of all ages are exposed to fluoride from a variety of sources including dental products, drinking water, food, beverages and pharmaceuticals. In some developed countries, fluoride is added to municipal water systems to prevent tooth decay. The National Toxicology Program (NTP) conducted a systematic review of the human, experimental animal, and mechanistic literature to evaluate the extent and quality of the evidence about whether fluoride exposure is associated with neurodevelopmental and cognitive effects.

METHODS: A systematic review protocol was developed and utilized following the Office of Health Assessment and Translation (OHAT) approach for conducting literature-based health assessments.

RESULTS: The literature search and screening process identified 159 published human studies, 339 published experimental animal studies, and 60 in vitro/mechanistic studies. While the animal data provide some evidence of effects of fluoride on neurodevelopment, the human evidence base is large, directly addresses cognitive neurodevelopmental effects, and is most informative concerning the effects of fluoride on cognitive neurodevelopment in children.

CONCLUSIONS: The human body of evidence provides a consistent and convincing pattern of findings that higher fluoride exposure (e.g., >1.5 mg/L in drinking water) is associated with lower measures of cognitive neurodevelopment, primarily in measures of children's IQ. When focusing on findings from studies with fluoride exposures in ranges typically found in drinking water in the United States (0.7 mg/L for optimally fluoridated community water systems), effects on cognitive neurodevelopment of children are inconsistent, and therefore unclear. The evidence for effects of fluoride exposures on cognition in adults is also limited. The evidence from animal studies is difficult to directly relate to the observed cognitive effects in humans, and the mechanisms underlying fluoride-associated cognitive neurodevelopmental effects are not well characterized.

Keywords: Fluoride, systematic review, children's IQ



ABSTRACT E-BOOK

P-632

Chemical exposures » Mixtures

Cumulative risk assessment for public schools in a predominantly poor, minority and heavily industrialized area of Louisiana

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BACKGROUND AND AIM: This research aimed to characterize environmental conditions of public schools in St. John the Baptist Parish, Louisiana, US.

METHODS: Estimates of health risks, both cancer and non-cancer, were derived for children at all school locations in the parish, from: 1) inhalation of chloroprene for all relevant schools (< 2.0 miles from an industrial source), and 2) inhalation of all facility emissions for all schools in the parish (cumulative risks). Risks of concern were identified based on EPA recommended guidelines (1 cancer per 10,000 people exposed). Other data such as biomonitoring data, health statistics, and state investigations were evaluated to determine if community exposures and expected adverse health outcomes are or may be occurring.

RESULTS: Health statistics suggest that adverse health outcomes associated with industry emissions may be occurring. Air monitoring data, risk estimates and biomonitoring data suggest that chloroprene air concentrations exceed health-based guidelines. In addition, health symptoms impacting students at one site have been associated with ethylene oxide. Community asthma-, and cancer-specific health statistics support a need for further investigation of potential acute and chronic impacts.

CONCLUSIONS: Given the number of chemicals released, their emitted volumes, and variability in the mixtures residents are exposed to, it is difficult to quantify risk without some degree of error. And while no clear relationship between health and exposure measures can be determined, proactive measures should be taken to reduce children's exposures. Gaps in our understanding of long-term health impacts of early-life exposures to chloroprene and different chemical mixtures, a history of industrial accidents in the area, and audit determinations documenting lax state regulatory oversight, enforcement, and risk communication, should propel school administrators to move children away from high-risk locations, as potential lifelong impacts on developing children could outweigh any economic benefits these emissions pose for industry.

Keywords: Cumulative risk assessment, chloroprene, ethylene oxide, schools, industry



ABSTRACT E-BOOK

P-633

Chemical exposures » Fluoride

Prenatal Fluoride Exposure and Autism Spectrum Disorder-Like Behaviors in a Sample of Canadian Preschool Aged Children: The MIREC Study

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BACKGROUND AND AIM: A growing body of evidence indicates that prenatal exposure to fluoride is neurotoxic to child development. However, epidemiologic research examining fluoride's effect on autism spectrum disorder (ASD) is lacking. Our aim was to examine the association of prenatal fluoride exposure with ASD-like behaviors in a sample of preschool aged children living in regions with fluoridated and non-fluoridated community water.

METHODS: We analyzed 502 mother-child pairs from the Maternal-Infant Research on Environmental Chemicals (MIREC), a prospective multicentered Canadian birth cohort, with available data on prenatal fluoride exposure, ASD-like behaviors, and covariates. We measured fluoride exposure by averaging maternal urinary fluoride adjusted for specific gravity (MUFsg) across three trimesters. We assessed children's ASD-like behaviors at 3-4 years of age using the parent-reported Social Responsiveness Scale-2 (SRS-2) Preschool Form, with higher scores indicating more behavioral symptomatology. Covariate adjusted linear and quantile regression models were used to estimate the difference in the relationship between MUFsg and SRS-2 conditional mean and quantile subscale T-scores, respectively. We adjusted all regression models for baseline maternal age, second-hand smoke, marital status, parity, child sex, study site, and the HOME score that was assessed at child follow-up visit.

RESULTS: Mean MUFsg concentration was 0.53 mg/L (SD=0.38), and mean SRS-2 Total T-score was 45.3 (SD=6.2). In multiple linear regression, a 1 mg/L increase in MUFsg concentration was not statistically associated with SRS-2 Total T-score ($\beta=0.12$; 95% CI, -1.36, 1.60; $P=0.87$). Likewise, we observed no statistical association for all other SRS-2 subscale T-scores. In quantile regression, there was no statistical association between MUFsg and SRS-2 Total T-score across percentiles: 0.1, 0.3, 0.5, 0.7 and 0.9. Effect modification by sex was not observed.

CONCLUSIONS: In this Canadian cohort, we found no evidence of a statistical association between prenatal fluoride exposure and ASD-like behaviors among preschool aged children.

Keywords: biomarkers of exposure, children's environmental health, epidemiology, fluoride, neurodevelopmental outcomes



ABSTRACT E-BOOK

P-634

Chemical exposures » Pesticides

Military status as an effect modifier of the association of chlorpyrifos exposure with self-reported balance problems

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BACKGROUND AND AIM: Chlorpyrifos has been widely used within the US military; however, it is unclear whether exposure poses a specific concern for military personnel. Our aim is to determine the association between urinary 3,5,6-trichloropyridinol with self-reported balance problems stratified by military affiliation.

METHODS: This is a cross-sectional analysis of the United States Centers for Disease Control and Prevention's National Health and Nutrition Examination Survey (NHANES) 1999-2002 data, including adults ≥ 40 years, $N=1279$. 3,5,6-trichloropyridinol, a metabolite of chlorpyrifos, was measured in urine. Military affiliation (ever/never), balance problems in the past year, and other variables were obtained via questionnaire. Statistical analyses accounted for the complex survey design and utilized the pesticide subsample weights. Adjusted regression models included age, sex, race/ethnicity, body mass index, and urinary creatinine as covariates. The adjusted associations between 3,5,6-trichloropyridinol with balance were determined; this was stratified by military affiliation.

RESULTS: Geometric mean urinary 3,5,6-trichloropyridinol was 15.31 $\mu\text{g/g}$ creatinine (95% confidence interval (CI): 11.17, 20.98) and was slightly, but not significantly, higher among those with a military affiliation (15.92; 95% CI: 7.48, 33.88) versus not (15.19; 95% CI: 10.68, 21.57). There was also no association of 3,5,6-trichloropyridinol with balance problems within the past year among the full population (odds ratio (OR)= 1.01; 95% CI: 0.98, 1.04) or those with no military affiliation (OR= 1.04; 95% CI: 0.88, 1.23). However, the association of 3,5,6-trichloropyridinol among those with a military affiliation (OR=1.40; 95% CI: 1.08, 1.81) was statistically significant.

CONCLUSIONS: We identified a significant association of urinary 3,5,6-trichloropyridinol with self-reported balance problems among US adults with a military affiliation, suggesting military affiliation may be an effect modifier this association. More extensive studies are recommended to confirm and expand upon these results.

Keywords: chlorpyrifos, postural balance, military personnel, NHANES



ABSTRACT E-BOOK

P-635

Chemical exposures » Mixtures

Prenatal exposure to toxicants and child language development in the Norwegian Mother, Father and Child Cohort Study (MoBa)

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BACKGROUND AND AIM: Prenatal toxicant exposures have been associated with increased risk of language difficulties in children. Much of this work has yet to explore which toxicant among correlated exposures might be most influential; therefore, we examined the effect of prenatal exposure to phthalates, organophosphate esters (OPEs), and organophosphorous pesticides (OPPs) on children's language development from toddlerhood to the preschool period.

METHODS: The study included 1022 pregnant women that were selected from the MoBa cohort run by the Norwegian Institute of Public Health. Prenatal concentrations of toxicant metabolites (6 phthalates, 4 OPEs, and 6 dialkylphosphate pesticides) were measured in maternal urine collected at 17 weeks gestation. Children's language was assessed with parent report on the Ages and Stages Questionnaire at 18 months, and teacher report on the Child Development Inventory at preschool age. We used structural equation models to account for multiple exposures on each developmental outcome separately and also ran multigroup analyses to examine potential child sex differences.

RESULTS: Prenatal low molecular weight phthalates were associated with better language development at 18 months ($\beta=.08$, 95% CI: 0.01, 0.14); however, they were associated with more adverse language development in the preschool period ($\beta=-.11$, 95% CI: -0.22, 0.00). OPPs were associated with worse language development at 18 months ($\beta=-.09$, 95% CI: -0.16, -0.02), and a slight negative association in preschool ($\beta=-.10$, 95% CI: -0.21, 0.01). High molecular weight phthalates and organophosphate esters were not associated with language development at either age, nor were there differences by child sex for any toxicant. Follow-up analyses will consider developmental trajectories.

CONCLUSIONS: In models accounting for mixed exposures, we found that prenatal toxicants were associated with language development in a potentially age-dependent manner, but that did not vary by child sex. Differences in associations by child age may reflect patterns of brain development in early life.

Keywords: pesticides, phthalates, neurodevelopmental outcomes, mixtures analysis



ABSTRACT E-BOOK

P-636

Air pollution » Particulate matter

Meta-analysis for effect modification by sex on the associations between fine particulate matters and cardiovascular outcomes in adults

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BACKGROUND AND AIM: Exposure to particulate matter with aerodynamic diameter no larger than 2.5 μm (PM_{2.5}) can cause cardiovascular diseases (CVDs) but evidence for more vulnerable sex remains unclear in aiding clinical recommendations or public health approaches. We systematically reviewed observational studies and conduct meta-analysis to assess whether certain sex/gender is more vulnerable.

METHODS: English-written studies published between 1995 and 2020 were searched from 4 databases. Population-based observation studies conducting sex subgroup analysis for the impacts of short-term or long-term ambient PM_{2.5} exposure on target CVDs were included. Random-effects meta-regression analyses were used to pool risk ratios (RRs) for long-term exposure and percent changes in outcomes for short-term exposure for a 10 $\mu\text{g}/\text{m}^3$ increase in PM_{2.5} concentration. Quality of evidence of risk differences by sex was rated following the Grading of Recommendations Assessment, Development and Evaluation (GRADE).

RESULTS: Data were synthesized for 5 outcomes. The difference in RRs of all CVD mortality for a 10 $\mu\text{g}/\text{m}^3$ in long-term PM_{2.5} concentration between men and women was not significant (1.02; 95% CI, 0.97 to 1.08). The difference in percent changes in daily mortality associated with a 10 $\mu\text{g}/\text{m}^3$ increase in short-term PM_{2.5} concentration between men and women was not significant (-0.09; 95% CI, -0.38 to 0.19). The differences in percent changes in hospitalization/ER visits between men and women were not significant for ischemic heart disease (0.07; 95% CI, -0.83 to 0.98) and cardiac arrest (1.85; 95% CI, -1.48 to 5.30). The GRADE assessment found that there was low quality of evidence for gender difference for the risks of CVD outcomes from PM_{2.5} exposure. A major limitation of the studies was the lack of measuring disparities in exposure between sex groups.

CONCLUSIONS: This review of observational studies indicates there is currently very limited evidence of effect modification by sex/gender for the effects of PM_{2.5} on CVD outcomes in adults.

Keywords: Environmental disparities, Particulate matter, Long-term exposure, Short-term exposure, Cardiovascular diseases



ABSTRACT E-BOOK

P-637

Air pollution » Particulate matter

Chronic exposure to PM_{2.5} and COVID-19 mortality during the first year of the epidemic in Colombia: an ecological study

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BACKGROUND AND AIM: The objective was to determine the association between chronic exposure to fine particulate matter (PM_{2.5}) and COVID-19 mortality in Colombia.

METHODS: Ecological study using data at the municipality level, as units of analysis. COVID-19 data were obtained from official reports up to and including March 6th, 2021. PM_{2.5} long-term exposure was defined as the 2014-2018 average of the estimated concentrations at municipalities obtained from the Copernicus Atmospheric Monitoring Service Reanalysis (CAMSRA) model. We fit a negative binomial model for the mortality rate adjusting for sociodemographic and health conditions.

RESULTS: Estimated mortality rate ratios (MRR) for long-term average PM_{2.5} were not statistically significant in the model. We found that having 10% or more of the population over 65 years of age (MRR=1.16 95%CI 1.00-1.35), and the percentage of urban population (MRR=1.01 95%CI 1.01-1.01) are the main demographic factors associated with death rate at the municipality level. The poverty index and prevalence of chronic diseases, which were associated with COVID-19 mortality during the first months of the epidemic, are no longer statistically significant.

CONCLUSIONS: There was no evidence of an association between long-term exposure to PM_{2.5} and COVID-19 mortality rate at the municipality level in Colombia. Demographics did have evidence of an ecological effect on COVID-19 mortality.

Keywords: Air Pollution, Particulate Matter, Lon-term exposure, Mortality, Other (COVID-19)



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-638

Air pollution » Particulate matter

Associations between PM_{2.5} and term low birth weight in a North Carolina cohort and effect modification by extreme heat events

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BACKGROUND AND AIM: Low birth weight (LBW) can be an indicator for poor health outcomes, including neonatal mortality, and may be caused by environmental exposures. Previously, exposure to high ambient temperatures was linked with increased odds of LBW, while results looking at fine particulate matter (PM_{2.5}) exposure have been mixed. Our objective is to determine if a relationship exists between PM_{2.5} exposure during pregnancy and term LBW and then to see if that relationship is modified by concurrent exposure to extreme heat events.

METHODS: We used North Carolina birth registry data linked to exposure data using geocoded addresses obtained from the birth records (2002-2015) for live, full-term (≥37 weeks gestation), singleton births (n=1,280,064). LBW was defined as weighing <2,500g. PM_{2.5} concentrations were obtained using EPA's CMAQ downscaler and were averaged over trimester and entire pregnancy. Extreme heat events were defined as a census-tract specific daily maximum heat index > 95th percentile for at least 2 consecutive days. We computed census-tract specific 95th percentiles using heat index data for the summer months (1981–2010). For inclusion in a trimester analysis, portions of that trimester had to occur between May-September. We estimated risk differences (RD) and 95% confidence intervals (CI) with interaction terms for total number of extreme heat events during the corresponding exposure period, adjusting for Medicaid and maternal age.

RESULTS: We observe generally null relationships between PM_{2.5} and term LBW for all trimesters (RD per 10,000 [95% CI]) ranged from -1 [-8, 6] to 1 [-5, 6]) and the pregnancy (1 [-5, 8]). These results persisted when extreme heat events were included as an interaction term (Pregnancy:1 [-5, 8]).

CONCLUSIONS: Preliminary analyses did not indicate a relationship between PM_{2.5} and term LBW or effect measure modification by extreme temperature days.

This abstract does not reflect CDC, ATSDR, or EPA policy.

Keywords: Air pollution, birth outcomes, particulate matter, climate, environmental epidemiology



ABSTRACT E-BOOK

P-640

Air pollution » Particulate matter

Socioeconomic disparities in fine particulate matter exposure in Quebec, Canada

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BACKGROUND AND AIM: Racial-ethnic disparities in environmental exposures have been widely documented in the United States, but not in Canada.

To investigate changes over 2001 to 2016 in disparities in exposure to ambient fine particulate matter (PM_{2.5}) and its components, i.e. black carbon, mineral dust, ammonium, nitrate, organic matter, and sulfate by socioeconomic status in Quebec, Canada.

METHODS: The gridded annual ambient PM_{2.5} and its components for 2001, 2006, 2011, 2016 estimated by satellite measurements of column aerosol optical depth and the GEOS-Chem chemical transport model were aggregated to census tracts in metropolitan areas and local centers for community services in the other regions. The population-weighted mean annual PM_{2.5} exposures were calculated for income, educational attainment, or immigration status subgroups for the four years.

RESULTS: PM_{2.5} exposures increased slightly from 2001 to 2011 and then decreased to 2016 for all subgroups of income, education, and immigration status. Among the PM_{2.5} components, ammonium and sulfate concentrations decreased the most and organic matter increased slightly between 2001-2016. Immigrants were more exposed to PM_{2.5} than non-immigrants, and most educated populations were exposed to the highest PM_{2.5} levels. People from low-income families also lived in higher PM_{2.5} environments. Although from 2001 to 2016, the PM_{2.5} disparity between the most and the least educated, immigrant and non-immigrant, low-income and median-income subpopulations decreased from 0.85 to 0.63 µg/m³, 0.44 to 0.13 µg/m³, and 2.28 to 1.53 µg/m³ respectively, the PM_{2.5} remained higher for the most educated/low-income/immigrant groups in 2016 who tend to live in more polluted urban centers. Similar patterns of disparity were observed with PM_{2.5} components.

CONCLUSIONS: Disparities in ambient particulate exposure have decreased in Quebec since 2001 but immigrants, low-income, and high-educated populations remain exposed to higher levels. Whether similar trends are seen for other pollutants like those from road traffic remains an open question.

Keywords: fine particulate matter, environmental disparity



ABSTRACT E-BOOK

P-641

Air pollution » Particulate matter

Particulate Matter Air Pollution in Kolkata, India: Trends and application of Low Cost Sensors

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BACKGROUND AND AIM: Kolkata is a megacity in Eastern India with seasonal severe air pollution in the post-monsoon and winter months. Low cost sensors (LCS) which measure particulate matter offer an opportunity for neighborhood-level understanding of PM loadings and exposure, indoor/outdoor monitoring, and identification of hotspots. However, the performance of optically based LCS is sensitive to relative humidity, the optical properties of the particles being detected, and overall pollution loadings. Therefore, in-field calibration is required.

METHODS: We demonstrate in-field calibration for two LCS PM measurement networks in Kolkata, India using co-location with reference grade monitors.

RESULTS: We show that very good agreement between optically based LCS and federal equivalent methods for PM₁₀ and PM_{2.5} measurement is possible when a calibration is developed using co-located data and random forest regression. LCS correctly diagnosed days as being in or out of attainment 93% of the time.

CONCLUSIONS: Opportunities exist for LCS to complement reference grade monitoring networks in India to support pollution control.

Keywords: Air Pollution, Sensors, PM₁₀, PM_{2.5}, Kolkata, India



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Air pollution, residential greenness and metabolic dysfunction during early pregnancy in the **INfancia y Medio Ambiente (INMA) Cohort**

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BACKGROUND AND AIM: Despite being studied extensively, the role of air pollution in gestational diabetes remains unclear, and there is limited evidence of the beneficial impact of residential greenness on metabolic dysfunction during pregnancy. Our objective was to examine associations of both air pollution and residential greenness on glucose intolerance and abnormal serum lipids among pregnant women.

METHODS: We used data from more than 2,200 mothers from Gipuzkoa, Sabadell and Valencia who were enrolled in the Spanish INfancia y Medio Ambiente (INMA) Project from 2003–2008. We obtained spatiotemporally resolved estimates of fine particulate matter (PM_{2.5}) and nitrogen dioxide (NO₂) exposures in early pregnancy and estimated residential greenness using satellite-based Normal Difference Vegetation Index (NDVI) within 100-, 300- and 500-meter buffers surrounding the mother's residence. We applied mixed models with random effect for cohort to separately evaluate associations



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between each of the three exposures of interest (PM_{2.5}, NO₂, or NDVI) and a) glucose intolerance (defined as either impaired glucose tolerance (IGT) or gestational diabetes mellitus (GDM)) and b) abnormal lipid levels.

RESULTS: No associations were observed between a 5 µg/m³ increase in first trimester PM_{2.5} exposure and glucose intolerance (OR = 1.0, 95% CI: 0.9, 1.2), high cholesterol (OR = 1.0, 95% CI: 0.9, 1.2), or high triglycerides (OR= 1.0, 95% CI: 0.9, 1.2). Null associations were also observed for a 10 µg/m³ increase in NO₂ exposure. We also observed no association between NDVI and any of the metabolic outcomes and results were similar irrespective of buffer size.

CONCLUSIONS: Given the lack of evidence in our study, other investigations are needed to assess effects of air pollution and residential greenness on metabolic dysfunction during pregnancy.

Keywords: Particulate matter, oxides of nitrogen, green space, pregnancy outcomes



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Inequities in exposure to ambient fine particulate matter in Canada

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BACKGROUND AND AIM: Exposure to fine particulate matter (PM_{2.5}) is associated with various adverse health outcomes. Previous cross-sectional analyses of environmental injustice in Canada found inequitable exposure to PM_{2.5} in low-income populations, visible minorities and immigrants. We expand on this literature by investigating if communities with different demographic characteristics benefit equitably from changes in ambient concentrations of PM_{2.5} from 2001 to 2016 in Canada.

METHODS: We use census tract level estimates of average annual PM_{2.5} derived from satellite-based observations to investigate how the spatial distribution of PM_{2.5} has evolved over time. We use decennial census data to determine if demographic characteristics are associated with changes in exposure to PM_{2.5}, accounting for geographic boundary changes between census periods.

RESULTS: Ambient PM_{2.5} concentrations have decreased from 2001 (median of 9.1 µg/m³ across tracts) to 2016 (median of 6.4 µg/m³ across tracts), with varying provincial patterns. Across census tracts, ranked estimates of PM_{2.5} in 2001 and in 2016 are correlated (Spearman correlation coefficient = 0.75). Tracts with higher concentrations of PM_{2.5} in 2001 tend to remain among the most polluted tracts in 2016. Accounting for provincial differences and baseline PM_{2.5}, census tracts with greater proportions of individuals with lower education, unemployed individuals or individuals who have lower income experience smaller absolute decreases in PM_{2.5} from 2001 to 2016.

CONCLUSIONS: Identifying demographic groups that benefit least from changes in ambient concentrations of PM_{2.5} provides direction for research on reducing environmental injustice due to differential exposure.

Keywords: Environmental justice, Particulate matter, Socio-economic factors



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Long-term PM_{2.5} exposure and diagnosis of amyotrophic lateral sclerosis: a population-based case-control study in Denmark

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BACKGROUND AND AIM: Evidence for an association between fine particle (PM_{2.5}) exposure and neurodegenerative diseases is increasing. Whether PM_{2.5} exposure is relevant in amyotrophic lateral sclerosis (ALS) pathogenesis is still unknown. Only two epidemiological studies have evaluated long-term PM_{2.5} exposure effects in ALS. We aim to assess long-term PM_{2.5} exposure and ALS incidence and identify potential critical windows of exposure.

METHODS: We leveraged data from the Danish National Patient Registry (NPR) on prospectively collected ALS cases (1989-2013). One-to-five controls per case were selected through the Danish Civil Registry, matched on sex, and year of birth. We estimated 1-, 5-, and 10-year PM_{2.5} average exposures at residential address, lagged one-year pre-diagnosis. We also estimated 1-year exposure averages from the date of diagnosis to 10 years pre-diagnosis. All exposures were estimated using predictions from a validated spatio-temporal model. We used conditional logistic regression to estimate odds ratios (OR) and 95% confidence intervals (CI) for the 1-, 5-, and 10- years exposures, adjusting for individual socioeconomic status, place of birth, civil status, and residence area. This analysis will be followed by a distributed lag analysis using the estimated 1-year exposure averages dating back to 10-years pre-diagnosis.

RESULTS: Our analysis included data from 2,195 cases and 6,690 controls. In the preliminary analysis of the 1-, 5-, and 10-years exposure windows, we found no association between ALS diagnosis and PM_{2.5}. The estimated ORs per 1 µg/m³ increase in PM_{2.5} were 1.00 (95%CI: 0.96–1.04), 0.99 (95%CI: 0.96–1.03), and 0.99 (95%CI: 0.95–1.02) for 1-, 5-, and 10-year averaged PM_{2.5} exposure respectively.

CONCLUSIONS: Our preliminary results suggest no association between PM_{2.5} and ALS diagnosis. However, averaging long-term exposure decreases temporal exposure contrasts. Our lagged analysis will be important to more precisely analyze windows of exposure dating back to 10 years pre-diagnosis and crucial to verify our preliminary findings.

Keywords: ALS, air pollution, particle matter, windows of exposure



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Assessing Personal PM_{2.5} Exposure and Respiratory Virus Infections among Farmworkers in the Southeastern United States

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BACKGROUND AND AIM: Occupational studies have identified exposure to particulate matter (PM) air pollution as an emerging concern among crop farmworkers, with previous data suggesting that harvesting tasks contribute to the highest occupational PM exposures among this population. Particulates from agricultural dust may be composed of multi-pollutant mixtures of pesticides, heavy metals, mineral silicas, and microbes. Moreover, chronic respiratory conditions, as well as mortality attributable to acute respiratory infections, are notably elevated among crop farmworkers. In the United States, this workforce is comprised primarily of migrant and immigrant populations that face a multitude of social inequities.

METHODS: Our pilot study uses personal air samplers to assess occupational exposure to respirable agricultural dust (PM_{2.5}) among a hard-to-reach and vulnerable population of mostly Mexican-American farmworkers harvesting crops in the southeastern US. Participants worked in fernery harvesting, nursery greenhouses, and strawberry harvesting. We conduct prospective, weekly follow-up of participants during influenza season to determine the incidence of acute respiratory symptoms and viral respiratory infections.

RESULTS: We collected nasal swab biospecimens from symptomatic participants and tested these samples for SARS-Cov-2 and 20 different respiratory pathogens using a panel array (Biofire). Thus far, we have collected n=30 occupational PM_{2.5} exposure samples. A majority of occupational PM_{2.5} exposure levels were above the US EPA limit for annual PM_{2.5} concentration, with four participants exposed above the OSHA PEL. Of the participants that enrolled in weekly follow-ups (n=20), four participants reported acute respiratory symptoms. Molecular analysis of collected biospecimen were positive for human rhinovirus (n=2), SARS-Cov-2 (n=1), and two samples are pending laboratory analysis.

CONCLUSIONS: Follow-up of participants and chemical analysis of PM_{2.5} filters is ongoing. To our knowledge, this is the first study to assess occupational PM_{2.5} exposure and incidence of respiratory infections in Southeastern US-hired farmworkers, while characterizing the chemical composition of occupational dust exposures.

Keywords: COVID-19, Epidemiology, Exposure assessment, Infectious diseases, Particulate matter, Occupational exposures



ABSTRACT E-BOOK

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Air pollution » Particulate matter

Spatial variations in PM_{2.5} oxidative potential in Toronto and Montreal, Canada

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BACKGROUND AND AIM: Particulate matter air pollution is a recognized threat to human health. Recently, measures of particulate air pollution have been developed that incorporate information on the effects that particles may have inside the human respiratory tract.

Among these is particle oxidative potential (OP), which is a measure of the ability of PM to cause oxidative reactions. OP can be quantified using assays that measure the ability of PM to deplete antioxidants in a synthetic respiratory tract lining fluid model. An alternative approach considers the ability of particles to generate reactive oxygen species (ROS) in the respiratory tract, as estimated using a mathematical model and concentrations of transition metals.

The aim of our study was to develop land-use regression models to characterize the spatial distribution of ROS-generating capacity of PM_{2.5} and two measures of OP.

METHODS: We conducted large-scale spatial monitoring campaigns across Montreal and Toronto, Canada and developed land use regression models to predict the spatial distribution of ROS-generating capacity of PM_{2.5} and the ability of PM_{2.5} extracts to deplete the antioxidants ascorbate (OPAA) and glutathione (OPGSH).

RESULTS: In Montreal, the best models explained 54% of variation in ROS, 45% in OPAA and 31% in OPGSH. In Toronto, models explained 63% of variation in ROS, 77% in OPAA, and 44% in OPGSH. Variables that were identified as predictors across multiple models included distance to PM_{2.5} and NOX emitting facilities, total traffic counts, and distance to highways.

CONCLUSIONS: These results contribute to existing knowledge of within-city spatial variations in particle oxidative potential using an unprecedented number of sensors. Exposure surfaces generated by these models can be applied in future studies of the health impact of PM_{2.5}. Future work could clarify the sources of the most harmful components of PM_{2.5} to human health to aid in targeted reductions of emissions.

Keywords: particulate matter, oxidative potential, land use regression



ABSTRACT E-BOOK

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Air pollution » Particulate matter

The influence of heating energy on indoor air quality and its association with socioeconomic status in rural Beijing

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BACKGROUND AND AIM: Solid fuel combustion for cooking and heating is a dominant source of indoor fine particulate matter (PM_{2.5}). To improve ambient air quality, China is implementing a national program to replace traditional coal stoves with clean energy devices and ban further use of coal for space heating. To date, the impact evaluation of this program on indoor air quality is very limited.

METHODS: Three-hundred households among 50 rural villages spanning four districts in Beijing, including 10 treated villages (electricity-based space heating) and 40 untreated villages (coal-based space heating), were recruited to monitor indoor PM_{2.5} concentrations (PMS7003 Plantower) for 58 to 110 days during the wintertime heating season (November to March). A 24-h filter-based measurement of PM_{2.5} (Ultrasonic Personal Aerosol Samplers, Access Sensor Technologies, USA) was co-located in a subsample of 3 households per village. Outdoor PM_{2.5} concentrations were measured concurrently (2 sensor-based and 1 filter-based measurement per village). Filter-based PM_{2.5} samples were analyzed for mass, black carbon, and elemental composition.

RESULTS: Overall, indoor PM_{2.5} concentrations were lower in treated villages than untreated villages, while no strong trends were observed for outdoor PM_{2.5}. Indoor PM_{2.5} concentrations followed similar diurnal trends in both treated and untreated villages, although PM_{2.5} concentrations were more elevated overnight in untreated villages, possibly due to solid fuel burning in space heating stoves. Elemental composition will provide insight on infiltration of outdoor PM_{2.5} and its contribution to indoor air quality.

CONCLUSIONS: Indoor air quality in treated villages was better compared to untreated villages, with the strongest evidence for this coming from the observed differences in diurnal patterns of indoor PM_{2.5} concentrations, indicative of overnight solid fuel burning in space heating stoves in untreated villages. The clean heating energy program shows benefit on indoor air quality even though it aims on improve ambient air quality.

Keywords: Indoor fine particulate matter, coal combustion, household energy transition, outdoor contribution, socioeconomic status, Beijing



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

A Longitudinal Study on the Impact of Indoor Temperature on Proximal Heat-Related Symptoms in Older Adults Living in Non-Air-Conditioned Households

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BACKGROUND AND AIM: Heat waves result in a significant health burden, causing particular concern for at-risk populations such as older adults. Outdoor temperatures are often assessed as the exposure of interest and are used for heat warning systems despite individuals spending most of their time indoors. Additionally, many studies utilize ecological designs, where death or hospitalizations are the studied outcomes. Proximal outcomes should also be assessed to better understand early symptoms for refining prevention efforts. In this study, we assessed the relationship between indoor temperature and proximal symptoms in individuals 60 years and older living in non-air-conditioned households in Montérégie, Quebec during the 2017-2018 summer months.

METHODS: We recruited 277 participants and gathered continuously measured temperature and humidity data from nearable sensors and health-related questionnaires administered by health professionals across three periods of increasing outdoor temperatures, where the reference measurement (T1) occurred during a cool period with a target temperature of 18°C-22°C and two measurements (T2 and T3) occurred during warmer periods with a target temperature of 28°C-30°C and 30°C-33°C, respectively. We collected information on stress, fatigue and other heat-related symptoms. We used Generalized Estimating Equations with Poisson regression models to estimate risk ratios for the relationship between temperature and heat-related symptoms.

RESULTS: We found that higher indoor temperatures increased the risk of dry mouth, fatigue, thirst, more frequent urination, and dark urine as well as trouble sleeping compared to the reference cool-period. With the exception of dark urine and depression, we identified a non-linear relationship with identified thresholds varying across symptoms of interest.

CONCLUSIONS: This study identified that increasing indoor temperatures are an etiologic factor in the development of these proximal symptoms. By considering the prevalence of these early-stage outcomes and indoor temperature exposures, adaptation strategies may be improved to minimize the burden of heat among vulnerable communities.

Keywords: Environmental epidemiology, temperature, temperature extremes



ABSTRACT E-BOOK

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Climate » Temperature

Seasonal Confounding in Studies of Temperature and Preterm Birth: A Simulation Study

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BACKGROUND AND AIM: Seasonal patterns of conception may confound associations between seasonally-varying exposures, such as temperature and air pollution, and birth outcomes. Our aim was to evaluate three commonly-used study designs (time-stratified case-crossover, time-series, and case-control) and seasonality adjustment methods in this context.

METHODS: Simulations were conducted under the null, i.e., there was no causal acute effect of 7-day average temperature on preterm birth. Pseudo birth data were generated from the empirical seasonal patterns of conception of births in the United States (based on publicly available data 1982-1988, with birth dates and reported gestational ages) and then analyzed using a case-crossover, matched case-control (matching on location), or time-series approach, with and without adjustment for seasonality. Conditional logistic regression was used for case-crossover and matched case-control designs, and Poisson regression was used for the time-series design. Seasonality control in the case-control models was adjustment for the study month of conception. In the time-series, we added the number of pregnancies-at-risk (gestational weeks 20-36 weeks) as an offset and logarithms of a weighted probability of birth to adjust for seasonality.

RESULTS: In the presence of seasonality of conception, we observed a 1.8% positive bias in the regression coefficient of mean temperature per 10°C increase in the warm season for the case-crossover approach. For the time-series design, the seasonality of conception created a 4.5% positive bias for each 10°C increase in mean temperature, in the warm season analysis. However, the pregnancy-at-risk approach completely adjusted for this bias. No bias was observed in the matched case-control design with or without adjusting for study month. Variance of the coefficients increased in the adjusted models and was higher in the case-control design.

CONCLUSIONS: This study suggests that there might be slight residual confounding by seasonality in the time-stratified case-crossover design. Both the adjusted model of time-series and case-control can provide unbiased estimates.

Keywords: Birth outcomes, Methodological study design, Environmental epidemiology



ABSTRACT E-BOOK

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Outcomes » Mortality

Excess mortality in the Colorado Front Range during the COVID-19 pandemic and a concurrent intense wildfire season

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BACKGROUND AND AIM: COVID-19 has had a substantial public health impact in the United States. In the western US, the pandemic has coincided with some of the worst wildfires in history. The current analysis aimed to estimate excess mortality in the Front Range region of Colorado during the convergent disasters of the COVID-19 pandemic and an intense wildfire season.

METHODS: We obtained weekly death counts from 2010-2020 for the study area from the state's vital statistics program. We modeled all-cause mortality and deaths due to cardiovascular, respiratory or kidney disease, cancer, diabetes, deaths of despair (suicide and overdose), and other causes. To estimate excess deaths, we fit quasipoisson generalized additive models for each cause with a smoothing term for week to account for temporal trends using data from January 2010 through the first week in March (prior to the first case of COVID-19 in the state). We then predicted expected deaths from the second week in March through December 2020. We defined excess deaths as the difference between the observed count and the upper limit of the 95% prediction interval for each week.

RESULTS: In 2020, we estimated 3740 excess deaths, which exceeded the observed number of COVID-19 deaths (n = 3159). Most excess deaths occurred at the beginning of the pandemic (March-April) and from October through December. When examining specific causes, the timing of excess deaths varied. Excess cardiovascular disease deaths (n = 257) occurred throughout the pandemic. Excess deaths of despair (n = 103) peaked in July and August.

CONCLUSIONS: Our results suggest there may be important environmental factors contributing to excess deaths during the pandemic. We hypothesize that some excess deaths may be attributable to pandemic lockdown policies or exposure to high temperatures or wildfire smoke. Future work will further examine the confluence of heat, wildfires, and COVID-19 on mortality risk in Colorado.



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Keywords: COVID-19, wildfires, socioeconomic factors, mortality

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Other » Other (to be specified with keywords in the keywords section)

Health Disparities Among Older Adults Following Tropical Cyclone Exposure in Florida, USA, 1999-2016

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BACKGROUND AND AIM: As tropical cyclones (TCs) become more frequent and severe in much of the world, research is needed to identify subpopulations who are particularly vulnerable to their adverse health impacts. This study investigated whether hospitalization risks from TCs in Florida (FL), USA varied across age and sex.

METHODS: We obtained county-level TC data for all storms in FL during the study period in which windspeed exceeded strong gale force winds (a 9 on the Beaufort scale or ~21m/s). We included hospitalization data among pay-per-service Medicare beneficiaries in FL for respiratory illnesses and cardiovascular disease (CVD), as well as 5 other broad causes, from 1999-2016. We used distributed lag non-linear mixed-effects models to estimate the relative risk (RR) for TC exposure by comparing hospitalizations occurring in TC-periods (from 2 days before to 7 days after) to matched non-TC-periods. We first quantified overall associations between TC exposure and cause-specific hospitalization risk. We then separately modeled associations between TC exposure and hospitalizations in subgroups defined by individual-level characteristics.

RESULTS: Preliminary results show that TC exposure was associated with overall increased risk of respiratory hospitalizations (RR: 4.01, 95% CI: 2.91, 5.53) comparing TC to non-TC periods, but not CVD (RR: 0.79, 95% CI: 0.93, 1.09) hospitalizations, confirming that risk patterns in FL are similar to national patterns identified in previous studies. However, stratified models showed limited evidence of modification by individual-level characteristics for either respiratory or cardiovascular disease hospitalizations: we did not find differences in risk of hospitalization between men and women nor across age groups (65-74, 75-84, and ≥ 85 years).

CONCLUSIONS: These findings contrast with those from other environmental exposures, including air pollution, whose effects have been shown to vary across different subgroups. To better understand the impact of TCs on population and subgroup health, future research should focus on understanding specific mechanisms and causal pathways.

Keywords: Natural disasters, environmental disparities, tropical cyclones, climate change, hospitalizations



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Ambient Heat and Risks of Emergency Department Visits among Adults in the United States

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BACKGROUND AND AIM: Days of extreme heat are associated with increased risk of death and hospitalization among older adults. However, the impacts of heat on young and middle-aged adults remain poorly documented. We aimed to quantify the association between heat and all-cause and cause-specific emergency department (ED) visits in the conterminous US among adults aged 18 years and older.

METHODS: We analyzed de-identified data from ~22 million ED visits between 2010 and 2019 among adults aged 18 years and older with health insurance living in 2,939 US counties using the OptumLabs® Data Warehouse. We estimated daily population-weighted county average maximum ambient temperature and defined days of extreme heat as those with daily maximum temperature exceeding the 95th percentile of county-specific daily warm-season (May to September) maximum temperature. We used hypothesis-driven and data-driven approaches to evaluate the association between warm-season ambient temperature and all-cause and cause-specific ED visits using a case-crossover study design with a distributed lag nonlinear model.

RESULTS: Days of extreme heat over the subsequent five days were associated with a relative risk of 1.08 (95% CI: 1.07, 1.08) for all-cause ED visits, 1.61 (95% CI: 1.58, 1.65) for heat-related illness, and 1.28 (95% CI: 1.24, 1.33) for renal disease, compared to the temperature of minimum morbidity. The association for extreme heat was more pronounced among males and in counties in the US Northern Great Plains. In the data-driven analysis, we identified several previously unrecognized conditions that were statistically significantly associated with extreme heat, including allergic reactions, anxiety disorders, open wounds of extremities, urinary tract infections, and skin infections.

CONCLUSIONS: These results suggest that in this large population of adults with commercial health insurance, the adverse health effects of extreme heat are not limited to the older adults or to disorders previously recognized as associated with heat.

Keywords: Temperature, Temperature extremes, Climate, Epidemiology



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ABSTRACT E-BOOK



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Climate » Natural disasters

Applications of Synthetic Tracks for North Atlantic Tropical Cyclone Health Impact Assessment

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BACKGROUND AND AIM: Tropical Cyclones (TCs) can cause immense harm to people, so estimating their potential health impacts is an essential part of disaster planning. Potential TC-associated exposures and health impacts are mediated by TC frequency, location, and intensity, and thus cumulative landfall hazard. These TC features are influenced by recurring climate patterns like the El Niño Southern Oscillation (ENSO) and Atlantic Multidecadal Oscillation (AMO). However, each combination of climate patterns comprises few years in the reliable historical record, making existing observations poor representations of true risk profiles, and risking emergency preparedness “blind spots.” Here we aim to overcome this challenge in TC health impact assessment (HIA) by generating large synthetic North Atlantic TC datasets using resampled historical data representing multiple ENSO and AMO interactions. We further explore public health applications of this approach.

METHODS: We have developed a TC HIA approach which explores different phases of recurring climate patterns while accounting for these challenges. We draw on a climatology- and statistics-based resampling algorithm to generate synthetic TC tracks representative of specific recurring climate patterns. We model these scenarios using combinations of ENSO (positive, neutral, or negative) and AMO (positive or negative) phases in historical data. We use projected maximum county-level experienced wind speeds in a Bayesian exposure-response model to estimate all-cause mortality among U.S. Medicare recipients.

RESULTS: We have integrated algorithmically-generated TC tracks with an exposure-response model to create HIAs under varying climate pattern scenarios. Our approach is modular with respect to TC data, demographics, and exposure-response models, allowing adaptation for multiple TC HIA tasks. Our approach accommodates centuries of synthetic tracks without major obstacles to further scaling.

CONCLUSIONS: We have demonstrated synthetic TC track applications for exploring TC activity and public health risk under varying climate pattern scenarios. Our approach could, with minor modifications, be extended to other climate and public health outcomes.

Keywords: Tropical Cyclones, Risk Assessment, Prediction, Modeling, Climate, Natural Disaster



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Are Cooling Centers Optimally Placed to Serve Vulnerable Populations? An analysis of 77 US Cities

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BACKGROUND AND AIM: Although extreme heat can affect anyone, some people are more exposed and/or more susceptible than others. In urban settings, cooling centers are frequently used to mitigate the negative health effects of extreme heat. However, how well cooling centers serve those at greatest risk remains unknown. We compared the distribution of cooling centers versus perceived need based on markers of urban heat island and population vulnerability in multiple cities across the US.

METHODS: We identified the location of 935 cooling centers across 77 populous US cities from publicly available sources. Within each city, we estimated average land surface temperature (LST) from MODIS and the CDC's Social Vulnerability Index (SVI) within a 1-mile walking network of each cooling center and compared those values to average values across the corresponding city. We then meta-analyzed results across cities overall and grouped by National Climate Assessment (NCA4) regions to evaluate climate-relevant regional differences.

RESULTS: Nationally, LST around cooling centers was 3.3°F cooler than the city-wide average. The largest differences were seen in the Northwest and Southwest where LST near cooling centers was on average >5°F cooler than the city average. In contrast, the average SVI of populations living near cooling centers was greater than the city average (0.61 versus 0.55), suggesting that, nationally, cooling centers are preferentially located somewhat closer to vulnerable populations. Regionally, cooling centers were located closest to more vulnerable populations in the Northern Great Plains and in the Southeast.

CONCLUSIONS: These results suggest that there may be room for improvement in the placement of cooling centers closer to those subgroups of the population most likely to be adversely impacted by days of extreme heat.

Keywords: Temperature Extremes, Environmental Disparities, Spatial Statistics, Environmental Justice



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Impacts of Extreme Heat on Agricultural Worker Health: Economic Impacts and Policy Implications

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BACKGROUND AND AIM: Exposure to extreme heat is known to severely affect human health, resulting in heat rash, heat exhaustion, acute kidney injury (AKI), mental health challenges, and even fatal conditions such as heat stroke. The existing regulations designed to protect agricultural workers against exposure to unsafe heat levels are insufficient to meet the rapidly evolving challenge of extreme temperature exposures. The rapidly evolving challenge of extreme heat exposure is predicted to increase in severity and frequency over the next decade. U.S. agricultural production contributes \$1.1 trillion to the U.S. GDP. The economic and health impacts of failing to adapt and enforce protective policies, resulting in workplace absenteeism and farmworker hospitalizations, could result in profit losses, changes to food production, and increased food prices.

METHODS: This peer-reviewed literature review examined the effects of extreme heat exposure on the health of agricultural workers (many of whom are underserved migrant laborers), and the areas in which existing policy must be adapted for future temperature projections. We examined the physiology of excess heat exposure and worker performance. We focused on the National Library of Medicine climate literature, with attention to California farmworker health research and regulations.

RESULTS: Policy interventions to create protections for these workers include provision of climate-controlled rest areas, adequate housing, hydration, health training (including appropriate languages), and hot-weather workplace attire for agricultural workers. Considerations should also be made to other high-heat occupations such as rural firefighting.

CONCLUSIONS: A 2-4 degree Celsius temperature increase by 2050 will result in a rise in the proportion of unsafe working days in the US from 25 to 40%. Existing national policy must be updated to reflect rapidly-approaching and drastic changes in heat patterns.

Keywords: Climate, temperature extremes, policy and practice, non-chemical stressors



ABSTRACT E-BOOK

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Climate » Natural disasters

Identifying and addressing drinking water challenges in well-reliant communities after natural disasters: lessons from a Louisiana flood

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BACKGROUND AND AIM: The 2016 Louisiana flood caused extensive structural damage to private drinking water wells, which were submerged under several feet of contaminated surface water for days. Well-reliant communities, which make up 13% of Louisiana's population, are solely responsible for ensuring the safety of their water. The aims of this study are to evaluate private well user preparedness and recovery, and develop recommendations for flood-prone well-reliant communities.

METHODS: A convenience sample of flood-impacted well owners was surveyed and offered free well water testing ten weeks after flood waters subsided (n=106). Surveys collected information to characterize knowledge gaps, risk perceptions, flood impacts, resource accessibility, and well maintenance barriers; while water tests evaluated total coliform and E. coli.

RESULTS: Surveyed well owners needed information on well testing labs (90%), water contamination (77%), and water treatment (78%). Of respondents with flooded wells (n=75), one-third resided in low flood risk zones, indicating a need for improved risk determinations. After the flood, over half (57%) of flood-impacted well users (n=75) continued consuming well water after the flood; yet, 26% had water which tested positive for total coliforms. 69% of well users who resumed well water consumption (n=43) disinfected their water, but testing indicated that microbes can continue to regrow or re-enter wells.

CONCLUSIONS: Results suggest that well owners lack the knowledge, means, resources, or motivation to protect well water and treat water adequately after floods. In addition, disinfection methods may be either insufficient, will not work due to well system failures, or are conducted incorrectly. Recommendations are made to enhance emergency response communications, and to improve well water surveillance. As the likelihood that more frequent and severe flooding events will increase, officials need to update and enhance technical resources, and provide well user training to facilitate well user preparedness, self-reliance and resilience.

Keywords: Flood, private well, well water, disaster preparedness, natural disaster



ABSTRACT E-BOOK

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Climate » Temperature extremes and variability

Extreme temperatures and mortality in 326 Latin American cities

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BACKGROUND AND AIM: Despite well-documented temperature-mortality impacts in North America, Europe, and China, few studies have examined the impact of extreme temperatures on health on a multinational level in Latin America. This study aims to characterize the impacts of ambient heat and cold on all-cause mortality in a large sample of cities across Latin America.

METHODS: We estimated population-weighted daily mean ambient temperature for each city using the ERA5-Land climate reanalysis with ~9 km horizontal grid resolution. For each city, we constructed a time series of daily all-cause mortality counts using individual-level mortality records. We used distributed lag (0-21 days) nonlinear conditional Poisson models to estimate city-specific associations between daily temperatures above (“heat”) and below (“cold”) the city-specific minimum mortality temperature and all-cause mortality, overall and stratified by age (0-49, 50-64, and 65+ years). We combined city-specific estimates using a random effects meta-analysis to estimate the attributable fraction (AF) of total deaths from heat or cold.

RESULTS: We analyzed 326 cities with ≥100,000 residents from Argentina, Brazil, Chile, Costa Rica, El Salvador, Guatemala, Mexico, Panama, and Peru over 4-14 years between 2002-2015. The AF of total deaths from heat was 0.67% (95% confidence interval [CI] 0.58% to 0.74%). The AF of total deaths from cold was 5.09% (95% CI 4.64% to 5.47%). AFs from heat and cold were particularly high among individuals aged 65+ years: 0.81% (95% CI 0.75% to 0.86%) and 6.82% (95% CI 6.41% to 7.18%), respectively.

CONCLUSIONS: In Latin American cities, a substantial proportion of deaths are attributable to extreme temperatures. Older populations are particularly vulnerable. Within Latin America’s intertwined 21st century challenges of climate change, high urbanization, and a rapidly increasing number of individuals aged 65 years or older, policy makers in these settings must prioritize actions to prevent present and future health risks of extreme temperatures.



ABSTRACT E-BOOK

Keywords: climate change, temperature, heat, cold, latin america, urban health

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Air pollution » Wildfires

Wildfire exposure *in utero* and use of respiratory medications in early childhood

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BACKGROUND AND AIM: Wildfire smoke exposure is a growing concern as wildfires escalate in the western U.S. and abroad (bushfires in Australia). While gestational particulate matter exposure has been linked to increased incidence of childhood respiratory diseases, this association has not been examined with respect to wildfire smoke. Here, we use prescription claims data to investigate the relationship of childhood respiratory illness and *in utero* exposure to wildfire smoke.

METHODS: The cohort consisted of infants (N≈182,000), born (2010-16) in one of the Metropolitan Statistical Areas (MSAs) of California, Oregon, Washington, Idaho, Nevada, or Montana and followed up to 8 years. We required had continuous prescription coverage and estimable birthdates via claims data in IBM's MarketScan Commercial Claims Database. Our two outcomes were filled prescriptions of 'upper respiratory' and 'lower respiratory' medications. Using prescription claims, pediatric respiratory drugs (e.g., fluticasone, albuterol) were classified as 'upper respiratory' or 'lower respiratory' based on active ingredients, mode of administration, and drug class. Wildfire exposure, classified as number of smoke days during each trimester, for each MSA was determined from National Oceanic Atmospheric Association's Hazard Mapping System. First, second, and third trimesters were defined as 280-197, 196-99, and 1-98 days before estimated birthdate, respectively. We used proportional hazards models to assess the relationship of trimester-specific *in utero* wildfire smoke exposure and first use of respiratory medication. Models are adjusted for sex, birth season, birthyear, meteorological variables, and seasonality.

RESULTS: Preliminary results suggest that gestational wildfire smoke is associated with both upper and lower respiratory medication usage during childhood. These associations are modified by season of birth and may differ by birthyear. Sensitivity analyses will account for preterm birth.

CONCLUSIONS: Our results suggest that incidence of childhood respiratory illness, as indicated by respiratory medication usage, is impacted by *in utero* exposure to wildfire smoke. This abstract does not necessarily represent EPA policy.



ABSTRACT E-BOOK

Keywords: Air pollution, Wildfires, Children's environmental health, Respiratory outcomes, Natural disasters, Climate

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Climate » General

Exploring community-level health impacts of extreme temperatures and air pollution in older adult and immigrant populations living in Edmonton, AB

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BACKGROUND AND AIM: Climate change and air pollution pose a significant challenge to public health as the health impacts of these exposures are felt at a local scale and depend on socio-environmental context. However, knowledge of what factors promote or reduce resilience to these exposures in Edmonton, AB (pop 972,223) is largely missing. Assessing the relationship between exposures to air pollution and extreme temperatures and community health, we will generate novel insights into the development of climate change and air pollution resilience in older adults and immigrants. Findings will inform community-level planning for effective, targeted adaptation measures and lay groundwork for developing a real-time vulnerability index based on climate change.

METHODS: This exploratory ecological study assessed spatial differences in the association between climatic and air pollution variables (extreme temperatures, ambient air pollution) and health events (cardiovascular, respiratory, mental health, and musculoskeletal outcomes) among Edmonton's Dissemination Areas using generalized linear models. Community-level factors (demographics, socioeconomic status, social isolation, active living environment, health facility availability) were explored in terms of confounding and effect modification.

RESULTS: Preliminary results indicate certain air pollutants are associated with a higher risk for increased rates of health events per capita, as well as increasing age. We observed a healthy immigrant effect; areas with higher proportions of immigrants demonstrated lower rates of cardiovascular, mental health, and injury events. Material and social deprivation, access to green space, and active living environment were identified as critical community-level factors in specific relationships.

CONCLUSIONS: The effects of air pollution and climate change exposures on a northern metropolitan's community health depend on specific exposures, outcomes, and community characteristics. We need to further characterize how population composition and community characteristics (i.e. access to healthcare, social support) drive local health risk to target higher risk populations with meaningful approaches to reduce the health impact of climate change and air pollution.



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ABSTRACT E-BOOK

Keywords: climate change, air pollution, community health, older adults, immigrants



ABSTRACT E-BOOK

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Climate » Natural disasters

Medium and long-term mortality effects of an anthropogenic earthquake: a difference in difference analysis

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BACKGROUND AND AIM: The moment magnitude (Mw) of 5.4 earthquake occurred in Pohang City on 15 November 2017. The earthquake and its aftershocks caused the most damage in Korea since the seismic observations began in 1905, and were estimated to be associated with a fluid injection activity at the Pohang geothermal plant. The aim of this study is to estimate the medium and long-term mortality effects of the 2017 Pohang City earthquake.

METHODS: Mortality and population data were archived from Korean Statistical Office and cause-specific age standardized mortality rates were calculated. We selected Jeonju and Jeju cities as controls, which are similar in population size but located 200km and 370km away from Pohang City. We divided the study period into 45 weeks before (reference) and after (period 1:0-14 weeks; period 2: 15-29 weeks; period 3:30 to 45weeks) the earthquake and used difference-in-difference analysis to estimate how earthquake affect daily mortality rate of Pohang City.

RESULTS: Non-accidental, respiratory, and pneumonia mortality rates of Pohang City have increased around 10 weeks after the earthquake. Compared to Jeonju City, we found increased risks (RR, 95% CI) of non-accidental (Period 2: 1.12 (0.98, 1.27)) and pneumonia (Period 1: 1.61 (1.11, 2.35); Period 2: 1.71 (1.16, 2.54)) mortalities in Pohang City after the earthquake. Compared to Jeju City, we found increased risks of non-accidental (Period 2: 1.10 (0.96, 1.26)), respiratory (Period 2: 1.47 (1.04, 2.07)) and pneumonia (Period 1: 1.52 (1.01, 2.31); Period 1: 1.64 (1.06, 2.54)) mortalities in Pohang City after the earthquake. The effects were greater in elderly population (aged over 60).

CONCLUSIONS: We found increase in non-accidental, respiratory, and pneumonia mortalities in Pohang City after the 2017 earthquake. Follow-up studies with health insurance data of Pohang City residents may confirm our study findings.

Keywords: earthquake, mortality, difference-in-difference, anthropogenic, health effect



ABSTRACT E-BOOK

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Climate » Temperature

Socioeconomic level and associations between heat exposure and all-cause and cause-specific hospitalization in 1,814 Brazilian cities: A nationwide case-crossover study

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BACKGROUND AND AIM: Little is known about socioeconomic disparities in vulnerability to heat. We aimed to evaluate whether there were socioeconomic disparities in vulnerability to heat-related all-cause and cause-specific hospitalization among Brazilian cities.

METHODS: We collected daily hospitalization and weather data in the hot season (city-specific 4 adjacent hottest months each year) during 2000–2015 from 1,814 Brazilian cities covering 78.4% of the Brazilian population. A time-stratified case-crossover design modeled by quasi-Poisson regression and a distributed lag model was used to estimate city-specific heat–hospitalization association. Then meta-analysis was used to synthesize city-specific effect estimates according to different socioeconomic quartiles or levels.

RESULTS: We included 49 million hospitalizations (58.5% female; median [interquartile range] age: 33.3 [19.8–55.7] years). For cities of lower middle income (LMI), upper middle income (UMI), and high income (HI) according to the World Bank’s classification, every 5°C increase in daily mean temperature during the hot season was associated with a 5.1% (95% CI 4.4%–5.7%), 3.7% (3.3%–4.0%), and 2.6% (1.7%–3.4%) increase in all-cause hospitalization, respectively. The inter-city socioeconomic disparities in the association were strongest for children and adolescents (0–19 years) (effect estimates: 9.9% in LMI cities vs 5.2% in HI cities). The disparities were particularly evident for hospitalization due to certain diseases, including ischemic heart disease (effect estimates: 5.6% in LMI cities vs 0.5% in HI cities), asthma (3.7% vs –6.4%), pneumonia (8.0% vs 3.8%), renal diseases (9.6% vs 4.9%), mental health conditions (17.2% vs 5.5%), and neoplasms (3.1% vs –0.1%). The disparities were similar when stratifying the cities by other socioeconomic indicators (urbanization rate, literacy rate, and household income).

CONCLUSIONS: Less developed cities displayed stronger associations between heat exposure and all-cause hospitalizations and certain types of cause-specific hospitalizations in Brazil. This may exacerbate the existing geographical health and socioeconomic inequalities under a changing climate.

Keywords: Temperature, Socio-economic factors (non-chemical stressors), Environmental disparities, Environmental justice, Big data



ABSTRACT E-BOOK

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Climate » Other (to be specified with keywords in the keywords section)

Text-mining Analysis of Health related to climate change in the abstracts of PUBMED from 1990 to 2019

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BACKGROUND AND AIM: This study attempts to understand the overall research trends in health related to climate change using a text mining method, which aims at extracting and processing meaningful information from vast texts through natural language processing and data mining techniques from structured or unstructured text data. Climate change, such as global warming and extreme weather events, has become a reality around the world and is expected to continue for a considerable period of time. The effects of climate change on health and disease have been suggested.

METHODS: This study used the following keywords to search for articles of health related climate change published in 1990 to 2019 in PubMed: climate change, health, disease. We established a term-document matrix which describes the frequency of terms that occur in documents after removing special characters, numbers and stop-words. To investigate systematically the research trend of climate change studies, we made bigram from the term-document matrix and conducted frequency analysis and LDA(Latent Dirichlet Allocation) topic modeling.

RESULTS: The keywords as global warming, public health, human health, infectious disease, vector borne disease, and greenhouse gas were ranked at the top with some ranking variations from 1990 to 2019. Particulate matter and sustainable development have increased in frequency since 2015. In terms of disease, the keywords of high frequency changed in the order of skin cancer, respiratory disease, cardiovascular disease, and mental illness within 1990 to 1999.

CONCLUSIONS: We could see that the field of study of climate change and health with the times and including researches in 2020, new emerging infectious diseases and pandemics are expected to emerge as new keywords.

Keywords: Climate change, systemic review, text mining analysis, topic modeling, research trend



ABSTRACT E-BOOK

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Climate » Temperature

Seasonal variation in mortality and the role of temperature: a multi-country multi-city study

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BACKGROUND AND AIM: Although seasonal variations in mortality have been recognised for a long time, the role of temperature remains unclear. We aimed to assess seasonal variation in mortality and to examine the contribution of temperature.

METHODS: We compiled daily data on all-cause, cardiovascular, and respiratory mortality, temperature, and indicators on location-specific characteristics from 719 locations in tropical, dry, temperate and continental climate zones. We fitted time-series regression models to estimate the amplitude of seasonal variation in mortality on a daily basis, defined as the peak-to-trough ratio (PTR) of maximum mortality estimates to minimum mortality estimates at day-of-year. Random-effects multivariate meta-analysis was used to summarise location-specific estimates for each climate zone. We estimated PTR with and without temperature adjustment, with the differences representing the seasonal effect attributable to temperature. We also evaluated the effect of location-specific characteristics on PTR across locations by using random-effects meta-regression models.

RESULTS: Seasonality estimates and responses to temperature adjustment varied across locations. Unadjusted-PTR for all-cause mortality was 1.05 (95% confidence interval (CI): 1.00–1.11) in the tropical zone and 1.23 (95% CI: 1.20–1.25) in the temperate zone; adjusting for temperature reduced the PTR estimates to 1.02 (95% CI: 0.95–1.09) and 1.10 (95% CI: 1.07–1.12), respectively. Furthermore, unadjusted-PTR was positively associated with average annual mean temperature, and adjusting for temperature in PTR moved the estimate towards the null.



ABSTRACT E-BOOK

CONCLUSIONS: This study suggests that seasonality of mortality is importantly driven by temperature, most evidently in temperate/continental climate zones, and that warmer locations show stronger seasonal variations in mortality, which is related to a stronger effect of temperature. On behalf of the MCC collaborative research network.

Keywords: Seasonality of mortality, temperature, a multi-country multi-city study



ABSTRACT E-BOOK

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Climate » Temperature

Ambient temperature and injury-related deaths in Japan from 1979 to 2015

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BACKGROUND AND AIM: Although substantial evidence suggested that high and low temperatures were adversely associated with non-accidental mortality, limited studies have focused on exploring the adverse impacts of ambient temperature on injury-related deaths. In this study, we aimed to investigate the short-term associations for all and cause-specific injury deaths in all 47 prefectures of Japan from 1979 to 2015.

METHODS: We conducted a two-stage meta-regression analysis. First, we performed the prefecture-specific time-stratified case-crossover analyses to examine the association between temperature and all and four selected causes of injury deaths (suicide, transport accident, falls, and drowning). Then, we used a multivariate meta-regression model to combine the effect estimates across all prefectures in Japan.

RESULTS: A total of 2,416,707 injury deaths were included in this study. We found a J-shaped association curve for total injury deaths, in which the risks increased for mild cold (the 34th percentile; RR=1.04, 95% CI= 1.02, 1.07) and extremely hot (the 99th percentile; RR=1.33, 95% CI= 1.28, 1.39), compared to the risk at the 70th percentile of temperature, respectively. However, the shapes of the association curves varied depending on the cause-specific injury deaths. For example, we found that the risks for suicide and transport accidents monotonically increased as temperature increases, while the J- or U-shaped association curves were estimated for falls and drowning.

CONCLUSIONS: Both low and high temperature may be important drivers of increased risk of injury deaths. We suggest that preventive measures against injury deaths in conjunction with non-accidental mortality need to be considered in climate change adaptation policies in Japan.

Keywords: Temperature, Mortality, Epidemiology



ABSTRACT E-BOOK

P-670

Climate » Temperature

Temporal Change in minimum mortality temperature under climate change: a multi-country multi-community observational study

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BACKGROUND AND AIM: Minimum mortality temperature (MMT) and MMT percentile (MMTP) are important indicators for human adaptation to climate. Several studies reported that the MMT and MMTP have changed over time, but the changing direction has been heterogeneous over locations. We examined the temporal change of the MMT and MMTP in a global scale and investigated the heterogeneity over communities, countries, regions, and climate zones.

METHODS: Daily time-series data for mortality and ambient temperature for 699 communities in 34 countries from 1986 to 2015 were analyzed by a two-stage meta-analysis. First, we used a generalized linear model with quasi-Poisson distribution to estimate the MMT in each of the 5-year non-overlapping subperiods for each community. Then, we pooled the subperiod-specific MMTs over communities using mixed effects meta-regressions to estimate the temporal change of the MMT (1) for the whole population, (2) by climate zone, (3) by region and (4) by country. Moreover, we estimated the temporal change of the MMTP in the same way.

RESULTS: The MMT and MMTP have decreased over the subperiods for the whole population (linear slope (LS)=-0.182, p-value (p) =0.184 for MMT; LS=-0.021, p=0.035 for MMTP). Such decreasing trends were more prominent in the temperate climate zone (LS=-0.268, p=0.042 for MMT; LS=-0.025, p=0.01) than in others (i.e., tropical, dry, and continental). Region-specifically, the decreasing trends were observed in North Europe, Central Europe, South Europe, South Africa, Middle-East Asia, South-East Asia and Australia while increasing trends were found in North America, Central America, South America and East Asia. Country-specific results closely followed the region-specific results.

CONCLUSIONS: We found the MMT and the MMTP have decreased over time for the entire study population, but the changing direction was largely heterogeneous over climate zones, regions, and countries. Our results suggest that human adaptation may largely depend on regional and country-specific characteristics.

Keywords: Climate Change, Minimum Mortality Temperature, Adaptation, Heterogeneity



ABSTRACT E-BOOK

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Exposures » Environmental disparities

Social and built environment antecedents to disparities in adult nature engagement

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BACKGROUND AND AIM: Antecedent factors which forge adult nature engagement are underexplored given the human health benefits strongly associated with nature exposure. This qualitative study contributes first-hand insights into the phenomenon of nature engagement to explain how health disparities partially attributable to uneven nature access unfold far upstream of quantitative measure-based analyses.

METHODS: Using a phenomenological approach to qualitative research, we probed experiential pathways and attitudes toward nature engagement among adults purposefully sampled across U.S. region, age span, and population density. We conducted ten semi-structured focus group interviews with consenting participants (N=126) in four U.S. metropolitan regions, with discussions recorded, transcribed, and analyzed qualitatively after Braun and Clarke's phases of thematic analysis (2006).

RESULTS: Findings show the existence of a general—though not universal—exposure model which structures adult nature engagement for most individuals. Experiential factors including early life exposures outdoors, parental or other personal mentorship, and organizational affiliation were found highly influential in socializing individuals to nature and in soldering attachment to nature which continued to manifest into adulthood. In contrast, changing demographics, social dynamics, metropolitan growth, urban renewal, and modern lifestyle demands explained alienation from nature. Urban, low-income individuals encountered a distinct model which precludes opportunities to benefit equally from nature contact.

CONCLUSIONS: Formative influences and causes of separation remain valid under each exposure model but in different combinations and weights, framing who gets to experience nature and how this occurs as an environmental justice as well as epidemiological concern. Identifying patterns and uniquenesses in nature access across regions and subpopulations can inform intervention potentials in public health policy and urban planning decisions targeted to specific use.

Keywords: Green space, built environment, environmental disparities, methodological study design, socio-economic factors



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ABSTRACT E-BOOK



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Exposures » Environmental disparities

Environmental factors associated with changes in county-level diabetes prevalence in the United States, 2004-2017

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BACKGROUND AND AIM: The prevalence of diabetes among adults in the United States (US) has increased steadily in recent years. Although individual risk factors and diagnostic and treatment changes are important, evidence suggests that contextual risk factors have contributed to these increases. We hypothesize that poor environmental quality might also explain increases in diabetes prevalence in the US.

METHODS: We obtained age-adjusted estimates of diabetes prevalence among adults from the CDC for all US counties for 2004-2017 and examined changes in these estimates over time within four county strata using the US Department of Agriculture's Rural Urban Continuum Codes (RUCC) classifications: RUCC1 (metropolitan urbanized), RUCC2 (non-metro urbanized), RUCC3 (less urbanized), and RUCC4 (thinly populated). We obtained estimates of the county-level environmental quality index (EQI) from the US EPA representing 2006-2010, reflecting five domains: air, water, land, sociodemographics, and built environment. Analysis of changes in diabetes prevalence using growth mixture modeling is in progress; we will compare latent classes of county-level diabetes prevalence trajectories with EQI measures.

RESULTS: A total of 3,137 counties were included in this analysis (RUCC1 n = 1166, RUCC2 n = 306, RUCC3 n = 1026, RUCC4 n = 639). Mean (SD) percentage change in age-adjusted diabetes prevalence between 2004-2017 was: 6.8 (23)% (RUCC1), 10.8 (25)% (RUCC2), 12.6 (32)% (RUCC3), and 5.4 (34)% (RUCC4); each RUCC strata included counties where diabetes prevalence decreased. Except for RUCC4 (thinly populated) counties, mean EQI values were higher among counties that had a net decrease in diabetes prevalence compared to those with an increase between 2004-2017.

CONCLUSIONS: There was substantial heterogeneity in the percent change in age adjusted diabetes prevalence across all RUCC strata between 2004-2017. Environmental quality may be related to this increase.

Keywords: environmental epidemiology; obesity and metabolic disorders



ABSTRACT E-BOOK

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Methods » Environmental justice

Summarizing and Visualizing Neighborhood Vulnerability to Environmental Exposures Using ToxPi

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BACKGROUND AND AIM: Toxicological environmental exposures can cluster by neighborhood and contribute to health outcomes. A greater understanding of which neighborhood characteristics increase vulnerability to environmental exposures can guide resource allocation across neighborhoods. The Toxicological Prioritization Index (ToxPi) is an analytic framework that integrates data across different domains to create a summarized index measure. Originally developed for chemical exposures, ToxPi has been applied to social and physical determinants of health in past studies to characterize their relative contributions to neighborhood vulnerability to various health outcomes. We aimed to characterize neighborhood vulnerability to environmental exposures by applying this approach to New York City (NYC) data.

METHODS: The index score is constructed from four equally-weighted domains using census-tract level data from the U.S. Census American Community Survey and the CDC 500 Cities Project. The domains included the following features we conceptualized as contributors to vulnerability to environmental exposures: 1) Demographics: age, sex, race/ethnicity, residential segregation, immigrant composition, disability status, occupation, mobility; 2) Economic characteristics: income, poverty, unemployment, vehicle availability; 3) Residential density: population density and housing characteristics (vacancy, age, type, density/overcrowding); and 4) Health behaviors, status, and access: health behaviors, health outcomes, preventive health and screening visits, health insurance coverage. Additionally, the relative contributions of each domain are accessed within census tracts in visual profiles.

RESULTS: In total, 59 features are used to construct the vulnerability index. Generated profiles of vulnerability detail contributions of different data domains for the index score within each census tract, providing greater information than typical indices which provide only a single summarized metric of vulnerability.

CONCLUSIONS: Vulnerability index scores at the neighborhood level can be driven by different domains, as demonstrated by different observed drivers of vulnerability across NYC census tracts. Methods such as ToxPi integrate and visualize the contributions of demographic, economic, residential density, and health domains to neighborhood vulnerability.

Keywords: neighborhood vulnerability index, data integration, data visualization, social determinants of health



ABSTRACT E-BOOK

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Exposures » Environmental disparities

Exposure to concentrated animal feeding operations (CAFOs) and risk of mortality in North Carolina, USA

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BACKGROUND AND AIM: Concentrated animal feeding operations (CAFOs) have emerged as an environmental justice issue due to disproportionate siting in low-income and minority communities. However, CAFOs' impact on health is not fully understood. We examined risk of cause-specific mortality associated with CAFOs in North Carolina (NC) for 2000-2017 and health disparities.

METHODS: We obtained data on individual-level cause-specific mortality and on permitted animal facilities. We estimated associations between exposure to CAFOs and cause-specific mortality using logistic regression, controlling for demographics (e.g., age) and area-level covariates. To estimate exposure to CAFOs, we considered (1) a binary indicator (presence or absence) of CAFOs within a buffer around individual residence based on several buffer sizes, and (2) four levels of exposure (no, low, medium, and high) based on the number of CAFOs within 15km around each residence. We considered individual-level (sex, race/ethnicity, age, education) and community-level (median household income, urbanicity, and region) factors.

RESULTS: Under all buffer sizes used to estimate CAFO exposure, people living near CAFOs had significantly higher risk of cardiovascular mortality than other persons. Comparing those living near CAFOs to the no exposure group, odds ratios (ORs) for cardiovascular mortality were 1.01 (95% confidence interval (CI) 1.00, 1.03), 1.04 (1.03, 1.06), and 1.06 (1.05, 1.07) for low, medium, and high CAFOs exposure, respectively, indicating a trend of higher risk with higher exposure. Those in the high CAFOs exposure group had significantly higher risk of anemia and kidney disease mortality than those with no exposure. Results suggest higher mortality risk from CAFOs for some subpopulations, however differences were not statistically significant.

CONCLUSIONS: Findings provide evidence of excess mortality risk from CAFOs in NC. These results have implications for future studies of environmental justice and CAFOs.

Keywords: CAFOs, Environmental justice, Health disparities, Mortality, Vulnerable population



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Exposures » Environmental disparities

Opioids, environmental, demographic, and socioeconomic indicators and COVID-19 mortality rates in the United States: an ecological study

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BACKGROUND AND AIM: The spread of the COVID-19 pandemic throughout the world presents an unprecedented challenge to public health inequities. People who use opioids may be a vulnerable group disproportionately impacted by the current pandemic, however, the limited prior research in this area makes it unclear whether COVID-19 and opioid use outcomes may be related, and the extent to which environmental factors, such as particulate matter (PM_{2.5}) and temperature, play a role in explaining COVID-19 mortality. The objective of this study is to evaluate the association between opioid-related mortality, environmental factors, and COVID-19 mortality across U.S. counties.

METHODS: Data from 3,142 counties across the U.S. were used to model the cumulative count of deaths due to COVID-19 up to June 2, 2020 as well as the number of opioid overdoses per 100,000 persons. PM_{2.5} exposure data was derived from the Environmental Protection Agency's Air Quality System Downscaler model; median household income; health statuses relating to smoking, excessive drinking, access to places of physical activity, and diabetes; unemployment status; and rural status were obtained from the County Health Rankings database. A multivariable negative-binomial regression model was employed to evaluate the adjusted COVID-19 mortality rate ratios (aMRR).

RESULTS: In multivariable models, counties with higher rates of opioid overdose per 100,000 persons were found to be significantly associated with higher rates of COVID-19 mortality (aMRR: 1.0134; 95% CI [1.0054, 1.0214]; P=0.001). Counties with higher average daily PM_{2.5} exposure also saw significantly higher rates of COVID-19 mortality (aMRR: 1.0695; 95% CI [1.0194, 1.220]), while counties with higher maximum average temperature was associated with lower mortality (aMRR: 0.9784; 95% CI [0.9682, 0.9889]).

CONCLUSIONS: In an ecological study of US counties, we found that higher rates of opioid overdose and higher PM_{2.5} levels were associated with higher rates of COVID-19 mortality.

Keywords: Air pollution, Temperature, Pharmaceuticals, Infectious diseases, Socio-economic factors



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Other » Other (to be specified with keywords in the keywords section)

COVID-19 Safety Precautions and Food Purchasing in a Food Desert Neighborhood

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BACKGROUND AND AIM: Measure most frequent food purchasing locations in the South End of Albany, New York, a low-income majority-minority neighborhood classified as a food desert, and compare differences in the implementation of COVID-19 safety precautions at these locations.

METHODS: Over six weeks in October and November 2020, mask usage was observed at neighborhood corner stores and the two nearest supermarkets (Market 32 and Walmart). Data included type of mask wear (i.e. mask worn properly, nose out, mask visible but not worn, and no mask visible), sex, age group, day, and time.

RESULTS: The South End Community Health Survey of 185 households in 2 public housing complexes observed residents were more likely to visit corner stores weekly or more for food (50%) versus supermarkets outside the neighborhood (39%) ($p=.04$). At Walmart and Market 32 respectively, 84.4% ($n=775$) and 74.6% ($n=752$) of adults observed wore a mask covering their mouth and nose. Significantly less people wore masks over their mouths and noses at corner stores (48.9%; $n=777$) than both market sites ($p<.0001$).

CONCLUSIONS: In addition to lack of access to fresh fruits and vegetables, obtaining food in a food desert neighborhood may have placed an added health burden on underserved communities via potential increased COVID-19 exposures, offering an additional social determinant of health pathway for the increased impact of the pandemic on communities of color.

Keywords: Mask, COVID-19, Food Systems, Safety



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Exposures » Environmental disparities

A pilot study of glyphosate, and preterm birth among blacks and whites

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BACKGROUND AND AIM: Glyphosate was first registered as an herbicide in the United States in 1974. It has since been linked to birth defects in animal models. Additionally, in vitro studies suggest that glyphosate has anti-androgenic and anti-estrogenic activities including the ability to interfere with aromatase activity. One observational human study found a statistically significant correlation between higher maternal glyphosate levels and shortened gestational length. However, no studies have investigated potential race-disparities in gestational glyphosate exposure or effects.

METHODS: A nested case control pilot study enrolled 26 women with a preterm birth (<37 weeks completed gestation) and 26 term births matched by race from a larger cohort study. Second trimester urine samples, collected at 18-22 weeks of gestation, were analyzed for specific-gravity corrected glyphosate using liquid chromatography-tandem mass spectrometry. Logistic regression was used to estimate the association between gestational urinary glyphosate concentrations and preterm birth, adjusted for age, race, body mass index, season of specimen collection, education level and reported organic food consumption.

RESULTS: Geometric mean glyphosate concentrations were 0.07 ng/mL (95% CI: 0.04-0.13) for preterm and 0.06 ng/mL for term births (95% CI: 0.03-0.10). Fewer term whites (n=4, 31%) were in the middle (range: 0.04-0.11 ng/mL) and highest (range: 0.17-1.25 ng/mL) tertiles of glyphosate exposure than term Blacks (n=7, 54%), although the difference was not statistically significant (p=0.43). Higher urinary glyphosate was associated with lower odds of preterm birth (odds ratio=0.75, 95% confidence interval 0.16-3.68), adjusted for covariates, although also not statistically significant. The odds varied by race, with OR=0.60 (95% CI: 0.11-3.4) among whites and OR=1.40 (95% CI: 0.28-7.02) among Blacks, although the interaction was not statistically significant.

CONCLUSIONS: Glyphosate exposure varied by maternal race with elevated exposure in Blacks. There was no association found between urinary glyphosate levels and preterm birth, suggesting that glyphosate may not be a preterm birth risk factor.

Keywords: Glyphosate, Pregnancy Outcomes, Risk Assessment, Exposure assessment-biomarkers of exposure



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Exposures » Environmental disparities

Environmental equity and COVID-19 experiences among a nationally representative cohort

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BACKGROUND AND AIM: We assessed associations of (1) individual environmental exposures and (2) an environmental inequity construct with diverse COVID-19 experiences. We also assessed whether discrimination experience and race/ethnicity (a proxy for structural racism) modified these relationships.

METHODS: We conducted a nationally representative survey (n=1267) to collect individual-level COVID-19 experience data: personal/family history, health care access/sick leave, assistance from government/non-profit sources, volunteering/caretaking, and vaccination willingness (all dichotomized). We linked individual data to environmental exposure data: annual average particulate matter (PM_{2.5}; continuous), county-level greenspace (dichotomous), county-level toxic release inventory (TRI) sites (dichotomous), county-level heat wave days, and individual-reported climate stress. We assessed associations between each environmental exposure and COVID-19 experience using logistic regression models adjusted for individual and population-level sociodemographic factors. We assessed effect measure modification by discrimination experience and race/ethnicity. We used structural equation models to assess whether environmental inequity (latent construct) was associated with each COVID-19 experience. The latent environmental inequity construct was defined using environmental exposures as indicators. We included a covariance term between the environmental inequity construct and a demographic context latent variable.

RESULTS: The environmental inequity construct was not associated with COVID-19 experiences, but individual environmental exposures associated with COVID-19 experiences included: climate stress with health care access (adjusted odds ratio (aOR)=0.75; 95% confidence interval (CI)=0.57,0.99) and vaccination willingness (aOR=2.86; 95%CI=2.13,3.84); TRI sites and vaccination willingness (aOR=1.35;



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95%CI=0.96,1.89); and PM2.5 with volunteering/caretaking (aOR=1.16; 95%CI=1.02,1.32). Associations modified by race/ethnicity or discrimination experience included: climate stress with health care access, receiving assistance, and willingness to vaccinate; TRI with vaccination willingness; greenspace with health care access and receiving assistance; heat wave days with vaccination willingness; and PM2.5 with personal/family health outcomes and receiving assistance. **CONCLUSIONS:** Although a combined environmental inequity construct was not associated with COVID-19 experiences, individual environmental exposures were associated with COVID-19 experiences and associations were modified by discrimination and racism experiences.

Keywords: Environmental disparities, environmental justice, COVID-19, multi-pollutant/multi-media



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Other » Other (to be specified with keywords in the keywords section)

Socioeconomic Disparities in SARS-CoV-2 Serology Testing in New York City

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BACKGROUND AND AIM: There are uncertainties concerning the longevity of antibodies to SARS-CoV-2, with accurate assessment necessary for informing testing, vaccination efforts, and reopening plans. In New York City (NYC), disparities exist in SARS-CoV-2 testing and outcomes. Here, we characterize the spatial and temporal distribution of antibody test prevalence and antibody positive prevalence in NYC and investigate if antibody testing was disproportionately lower among socioeconomically vulnerable populations.

METHODS: The number of antibody tests performed and the number of positive antibody tests were downloaded through December 10, 2020 from the NYC Coronavirus Data Repository. An index of socioeconomic status (SES) was created from Zip Code Tabulation Area level data downloaded from 2015-2019 American Community Survey 5-year estimates. The index includes median household income, median gross rent, percentage <15% poverty, proportion working class, civilian unemployment, >1 occupant per room, and an education measure. Spatial generalized linear mixed models accounting for random effects with a Besag-York-Mollie conditional autoregressive prior were performed to examine the association between SES and antibody testing and positivity.

RESULTS: The distribution of antibody tests performed per 100,000 residents of ZCTA decreased over the study period, with the least tests performed in Staten Island (mean: 1014 tests, standard deviation: 304 tests) and the most testing performed in Queens (1180, 317). Antibody positive prevalence was consistently highest in the Bronx (26%, 1.0%), and lowest in Manhattan (16.4, 1.9) and Staten Island (15.0, 3.3). While increasing SES was not significantly associated with the number of antibody tests performed, increasing SES was associated with decreasing antibody positive prevalence.

CONCLUSIONS: There is increased burden of COVID-19 disease on vulnerable communities, as well as potential gaps in providing appropriate resources and public health measures. Future efforts to characterize the impact of COVID-19 must utilize serologic data to understand the extent and impact of the disease in vulnerable communities.

Keywords: SARS-CoV-2, Antibody Testing, Disparities



ABSTRACT E-BOOK

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Exposures » Socio-economic factors (non-chemical stressors)

The impact of neighborhood racial/ethnic residential segregation on tobacco use in the Atherosclerosis Risk in Communities (ARIC) study

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BACKGROUND AND AIM: In the US, race/ethnicity is highly correlated with residential location, with Whites and racial/ethnic minorities often living segregated from one another. This differential residential location may contribute to important disparities in health behaviors, such as tobacco use. We examined associations of neighborhood racial/ethnic residential segregation with tobacco smoking.

METHODS: We studied 14,107 White and Black adults aged 45-64 who participated in the Atherosclerosis Risk in Communities (ARIC) study from 4 US communities: Forsyth Co., NC; Jackson, MS; Minneapolis, MN; and Washington Co., MD. Neighborhood racial/ethnic composition and residential segregation (G statistic) were estimated using 2000 US census tract data. We estimated odds ratios (OR) and 95% confidence intervals (CI) for current tobacco smoking using mixed-effects logistic regression models.

RESULTS: Overall 29% of participants were current tobacco smokers (27% of White participants and 32% of Black participants). After adjustment for age, sex, education, neighborhood population size and neighborhood income, a 10% increase in Non-Hispanic Black residents in a neighborhood was associated with a higher odds of current tobacco smoking among Black participants (OR: 1.07 [95% CI: 1.01, 1.14]) but not White participants (OR: 1.00 [95% CI: 0.94, 1.07]). Black participants living in a cluster of neighborhoods where minority populations (race/ethnicity other than non-Hispanic White) were overrepresented had a 54% (95% CI: 1.09, 2.16) higher odds of tobacco use compared to their counterparts in non-clustered neighborhoods. Among White participants, living in a cluster of neighborhoods where minority populations were underrepresented was associated with a lower odds of tobacco smoking (OR: 0.87 [95% CI: 0.75, 1.00]).

CONCLUSIONS: Neighborhood factors, in particular, living in predominantly minority and segregated neighborhoods contributed to tobacco use among Black adults. These findings support the need for neighborhood-level tobacco control interventions to reduce tobacco use in the US.

Keywords: Socio-economic factors, Epidemiology, Environmental disparities, Spatial statistics



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Exposures » Environmental disparities

Community Socioeconomic Deprivation and Unconventional Natural Gas Development in Pennsylvania

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BACKGROUND AND AIM: Past research has analyzed proximity to unconventional natural gas development (UNGD) in Pennsylvania in relation to adverse birth outcomes, asthma exacerbations, and migraine headache, but few studies have considered issues of environmental justice. Here, we investigated if higher UNGD density or shorter distances to UNGD were related to community socioeconomic deprivation (CSD).

METHODS: The location of all UNGD wells in the Marcellus Shale from 2005-2019 were retrieved from Enverus DrillingInfo data aggregation service. An index of CSD was created from county subdivision-level data from the 2005-2009 American Community Survey. The CSD index measures the proportions of the population not in the labor force, in poverty, without car ownership, on public assistance, unemployed, and those with less than a high school education. Population-weighted centroids of county subdivisions were constructed from census block population estimates. We assessed exposure to wells within 5 km of each population center, accounting for both density of wells and distance to the nearest well.

RESULTS: Overall, the number of new wells drilled annually decreased through the study period, from 4626 wells in 2005 to 483 in 2019. Over the entire study period, more wells were drilled in communities in the highest quartile (most deprived) of the CSD index (mean: 31.9 wells, SD: 53.7 wells) compared to the lowest quartile (mean: 23.7, SD: 50.2). Distance to the nearest drilled well was also shortest among the most deprived areas (mean: 10.7 km, SD: 17.4 km) and farthest among the least deprived areas (mean: 15.8 km, SD: 23.5 km).

CONCLUSIONS: We observed disproportionately high exposure to UNGD among areas with the highest degrees of social deprivation, underscoring impacts in vulnerable communities.

Keywords: Socioeconomic status, Marcellus Shale, Natural Gas Drilling



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Exposures » Environmental disparities

Blood metal trends in the Strong Heart Family Study: 1997-2009

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BACKGROUND AND AIM: Although some metal exposures (Pb, Cd) have declined over time in the general US population, it is not known if American Indian (AI) communities experienced similar declines attributable to similar sources. Our objectives were to a) characterize trajectories of blood metal changes over time, and b) to identify characteristics of participants who experienced larger declines in blood metal concentrations in the Strong Heart Family Study (SHFS).

METHODS: As, Cd, Pb, Mn, Hg, Ni, Se, and Zn were measured in whole blood samples from 310 SHFS participants at visit 3 (1997-1999) and visit 5 (2006-2009). We estimated the percent reduction in geometric mean of each metal across subgroups, used growth mixture models to identify trajectory classes of blood metal change, and evaluated the probability of trajectory class membership by subgroup via generalized estimating equations and logistic regression.

RESULTS: Overall, percent geometric mean declines were 13% (As), 15% (Cd), 39% (Pb), 7% (Mn), 28% (Ni), 3% (Se), and 19% (Zn). Cd declines were largest for former smokers (26%), participants >30 years old (19%), and participants from North/South Dakota (30%). Pb declines were largest for participants from Arizona and Oklahoma (51%), former smokers (45%), and participants <30 years old (44%). The adjusted odds of being in the Cd High-Decreasing trajectory were higher for females vs. males (odds ratio 1.10, 95% CI 0.50, 2.40) and participants from North/South Dakota vs. Arizona (8.15, 95% CI 1.74, 38.0). The odds of being in the Pb High-Decreasing trajectory were lower for females vs. males (odds ratio 0.61, 95% CI 0.32, 1.16) and participants from Oklahoma vs. Arizona (0.57, 95% CI 0.22, 1.48).

CONCLUSIONS: Substantial variability in the recent decline in blood metal concentrations exists across subgroups within the SHFS, indicating that declines in metal exposures in recent decades were not uniform across these AI communities.

Keywords: metals, American Indian, lead, arsenic, trends



ABSTRACT E-BOOK

P-683

Exposures » Environmental disparities

Gender and Sexual Orientation Disparities in Smoking, Cadmium Exposure, and Estimated GFR: National Health and Nutrition Examination Survey 2005-2014

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BACKGROUND AND AIM: Chronic kidney disease (CKD) is a progressive disease characterized by structural, molecular, and functional nephron changes that eventually result in permanent loss of function. CKD can lead to heart disease, stroke, and end stage kidney disease. Studies have linked cadmium exposure to decreased glomerular filtration rate (GFR) and renal pathogenesis. The main non-occupational pathway for cadmium exposure is from tobacco smoke. Lesbian, gay, and bisexual (LGB) individuals have one of the highest subpopulation smoking rates, yet studies have not examined if they have higher cadmium exposure or renal disease burden. The aim of this study was to evaluate gender and sexual orientation disparities in cadmium exposure and estimated glomerular filtration rate (eGFR) in the National Health and Nutrition Examination Survey (NHANES) from 2005-2014 in 16,576 individuals.

METHODS: The analysis used a combination of geometric means and survey linear regression to evaluate cadmium burden and eGFR.

RESULTS: The percentage of smokers among LGB participants was higher (44.2%) than in straight participants (28.7%). Comparing geometric mean blood cadmium of males showed that straight men have the lowest cadmium levels (0.297 ng/L) and bisexual men have the highest cadmium levels (0.347 ng/L). Among females, straight females have the lowest cadmium levels (0.354 ng/L) and gay females have the highest cadmium levels (0.446 ng/L). There were statistically significant differences between odds ratios of low eGFR by gender and sexual orientation. Compared to straight males, the odds ratio for low eGFR among gay males was 0.824 (95% CI 0.820, 0.827; $p < 0.0003$) bisexual males was 0.634 (95% CI 0.549, 0.555; $p < 0.0001$), straight females was 0.844 (95% CI 0.843, 0.845; $p < 0.0001$), gay females was 0.783 (95% CI 0.778, 0.788; $p < 0.0001$), and bisexual females was 1.092 (95% CI 1.089, 1.096; $p < 0.0001$).

CONCLUSIONS: This analysis highlights the need for additional research specifically addressing disparities related to gender identity and sexual orientation.

Keywords: NHANES, cadmium, kidney disease, sexual orientation, gender, disparities



ABSTRACT E-BOOK

P-684

Exposures » Socio-economic factors (non-chemical stressors)

Gray Matter Structures Mediate Associations between Neighborhood Socioeconomic Status and Cognition in Adolescents: Application of a Mediation Analysis Method

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BACKGROUND AND AIM: Over the last few years, significant developments have been taking place in high-dimensional neuroimaging data analysis.

METHODS: To determine which neuroimaging features may mediate effects of neighborhood socioeconomic status (SES) on cognitive assessments, we analyzed data from the Adolescent Brain Cognitive Development (ABCD) study and conducted mediation analysis with the Causal Inference Test (CIT). To facilitate this analysis, we extended the data reduction method, Partition, for application to high-dimensional neuroimaging data. Unlike the previously proposed version that directs reduction based on attribute correlation only, we adopted a strategy for the extension that combines spatial distance with attribute correlation.

RESULTS: We performed computer simulation studies to contrast the new version with the original approach and found that incorporating spatial information substantially increased data reduction for the same level of information capture and improved computational efficiency. Neuroimaging data were reduced via the modified Partition approach, yielding 88% reduction for 80% information capture. A sulcal depth feature in the superior frontal language area was identified as consistent with causal mediation (CIT $P = 0.04$). For this feature, there was strong evidence of marginal associations for i) neighborhood vs cognitive, ii) neighborhood vs sulcal depth, and iii) sulcal depth vs cognitive ($P = 6.91e-11, 6.11e-06, \text{ and } 9.63e-04$, respectively).

CONCLUSIONS: These results suggest that higher socioeconomic status of a neighborhood may lead to less sulcal depth in the superior frontal language area, resulting in improved cognitive performance.

Keywords: Big data, Causal inference, Socio-economic factors



ABSTRACT E-BOOK

P-685

Exposures » Environmental disparities

Environmental inequality of personal exposure to PM_{2.5} and black carbon (BC) within- and between- communities in rural Beijing, China

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BACKGROUND AND AIM: Socioeconomic and spatial patterning of personal exposure to air pollution have not been well documented in rural Chinese settings where household solid fuel use is still a major contributor to air pollution. To better understand how air pollution exposures are distributed in settings like these, we investigated personal exposure patterning by social, demographic, and economic factors within- and between- villages in rural Beijing, where a heating energy program is underway to substitute coal with electricity and natural gas.

METHODS: We randomly recruited 446 participants in 50 villages from four (of 13) districts in Beijing and measured 24-h personal exposure to fine particulate matter (PM_{2.5}) and black carbon (BC). We administered a comprehensive survey to collect detailed household socio-demographic information, stove and fuel use patterns, and applied principle component analysis (PCA) to construct a composite index (wealth index) to better represent participants' socioeconomic status (SES).

RESULTS: Overall, geometric mean (95% confidence interval) exposures to PM_{2.5} and BC were 75 (68-82) and 2.6 (2.4-2.8) µg/m³, respectively, ranging at the village-level from 23-387 µg/m³ and from 0.8-11 µg/m³, respectively. Within villages, the highest measured PM_{2.5} exposures were, on average, 20 times higher than the lowest (range: 3.5-187). Overall, PM_{2.5} and BC exposures did not vary systematically by SES, although they were slightly concentrated among the poorest 20% of participants, who represented 23% of PM_{2.5} and 25% of BC exposure by total personal exposure, while the wealthiest 20% represented 17% of PM_{2.5} and 14% of BC exposure by total personal exposure.

CONCLUSIONS: SES did not show a pronounced association with the disparities of exposures to household air pollution in this study. This study addresses critical knowledge gaps on how exposures to household air pollution are distributed by social and demographic factors and aids design of interventions to control household air pollution emissions in settings like rural Beijing.

Keywords: Environmental inequality, personal exposure, fine particulate matter (PM_{2.5}), black carbon (BC), residential coal combustion, socioeconomic status



ABSTRACT E-BOOK

P-686

Birth and Pregnancy Outcomes » Birth outcomes

Exposure to heat during pregnancy and preterm birth in North Carolina: disparities by residential greenness, urbanicity, and socioeconomic status

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BACKGROUND AND AIM: Although previous literature suggested beneficial impacts of residential greenness on the association between heat exposure and several health outcomes, research is very limited for birth outcomes. We investigated the association between exposure to heat/heat waves during the last week of gestation and preterm birth (PTB) in North Carolina (NC) from 2003 to 2014. We evaluated disparities by residential greenness, urbanicity, and socioeconomic status (SES) in this association.

METHODS: We obtained individual-level birth certificate data for NC from May to September for the years 2003-2014. We estimated daily mean temperature at each maternal residential address using Parameter-elevation Regressions on Independent Slopes Model (PRISM) data. We created 3 definitions of heat waves (≥ 95 th, 97th, 99th percentile for warm-season temperature, for ≥ 2 consecutive days). The Normalized Difference Vegetation Index (NDVI) was used to assess residential greenness. We applied Cox proportional hazard models to estimate the association between heat/heat waves exposure and PTB after controlling for covariates. We evaluated whether the association between heat and risk of PTB varied by several individual and community characteristics.

RESULTS: Of the 546,441 births, 8% were preterm births. Heat exposure during the last week before delivery was significantly associated with risk of PTB. A 1°C increase in temperature during the last week before delivery was associated with a hazard ratio of 1.01 (95% CI: 1.00, 1.02). Higher risk of heat for PTB was associated with some characteristics such as infants living in areas that were urbanized, low SES, or in the Coastal plains. We found significantly higher risk of PTB in areas with low greenness for urbanized area. For heat waves, we did not find significantly positive associations with PTB.

CONCLUSIONS: Findings provide evidence that heat exposure during pregnancy increases the risk of PTB. These results have implications for future studies of disparity factors in the heat and birth outcomes associations.

Keywords: Heat, Heat waves, Greenness, Preterm birth, Urbanicity, Vulnerable population



ABSTRACT E-BOOK

P-687

Birth and Pregnancy Outcomes » Pregnancy outcomes

A Prospective Study of Arsenic and Manganese Exposure and Maternal Blood Pressure During Gestation

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BACKGROUND AND AIM: Pregnancy is a sensitive time for maternal cardiovascular functioning. This study examines the associations between arsenic and manganese exposures to maternal blood pressure (BP) measured during pregnancy.

METHODS: Pregnant women (N=1,522) were recruited for a prospective cohort in Bangladesh (2008-2011). Drinking water arsenic and manganese were measured at <16 weeks gestation and toenail measurements were made one-month post-partum. BP (systolic and diastolic) levels were measured during monthly home visits. Linear mixed models estimated the associations between repeated BP measurements, arsenic, and manganese.

RESULTS: Drinking water and toenail arsenic showed a positive dose-response association with maternal BP. Each natural log increase in drinking water arsenic was associated with 1.27 mmHg systolic (95% CI: 1.20 – 1.34) and 1.16 mmHg diastolic (95% CI: 1.11-1.20) increase in BP per month of gestation after adjusting for covariates. Each natural log increase in toenail arsenic levels was associated with a 1.28 mmHg systolic (95% CI: 1.15 – 1.44) and 1.14 mmHg diastolic (95% CI: 1.05 – 1.23) increase in BP per month of gestation after adjusting for covariates. Drinking water manganese exposure had a non-linear association with maternal BP. Drinking water manganese in the 2nd quartile (160-589 µg/L) was associated with a 1.70 mmHg increase in systolic (95% CI: 1.21-2.38) and 1.39 mmHg in diastolic (95% CI: 1.09-1.76) BP per month of gestation after adjusting for covariates. Each natural log increase of toenail manganese was associated with a 1.21 mmHg of systolic and 1.54 mmHg of diastolic increase in BP over gestation (systolic 95% CI: 1.06-1.37, diastolic 95% CI: 1.15-2.05), after adjusting for covariates.

CONCLUSIONS: Arsenic and manganese exposure during pregnancy was associated with increases in maternal systolic and diastolic BP. Elevated gestational BP can increase risks of adverse birth outcomes and CVD later in life for the mother.

Keywords: Cardiovascular diseases, Pregnancy outcomes, Water quality, Heavy metals, Environmental Epidemiology



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-688

Omics Technologies » Epigenomics

Newborn DNA Methylation Signatures Related to Prenatal Smoking Exposures in the PACE Consortium

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BACKGROUND AND AIM: The Pregnancy and Childhood Epigenetics (PACE) Consortium previously identified several thousand differentially methylated cytosine-phosphate-guanine sites (CpGs) in newborn blood associated with maternal sustained smoking during pregnancy. This study extends the previous PACE meta-analysis by examining newborn methylation in relation to more detailed prenatal smoking exposures.

METHODS: Sixteen studies participated, including 10 not in the previous meta-analysis. For 7,790 infants, we had questionnaire information on prenatal smoking and DNA methylation measured in newborn blood using Illumina's 450K (14 studies) or EPIC (2 studies) array. The following prenatal smoking exposures were assessed (coded yes/no, unless otherwise specified): maternal sustained smoking, dose-response (0, 1-4, 5+ cigs/day), secondhand smoke (SHS), paternal smoking around conception, paternal former smoking (i.e., quit before conception), and maternal former smoking. Cohort-specific analyses were conducted for each exposure using robust linear regression, adjusting for relevant confounders. Using METAL, the primary meta-analysis combined results for CpGs on the 450K array.

RESULTS: Comparing 1,094 maternal sustained smokers to 5,231 non-smokers, we identified 6,669 CpGs (False Discovery Rate, FDR<0.05) related to sustained smoking and found evidence of a dose-response for 6,486. Results for maternal sustained smoking did not materially differ by infant sex. One CpG was significantly associated with SHS. None were significantly associated with paternal smoking around conception or paternal or maternal former smoking. In secondary analyses meta-analyzing 361,222 CpGs unique to the EPIC array, 97 were significantly related to maternal sustained smoking and 1 related to maternal former smoking. Follow-up analyses include look-ups in published studies, associations with gene expression, functional enrichment, and pathway analyses.

CONCLUSIONS: This large meta-analysis examines a broad range of prenatal smoking exposures. We identified novel signals, including almost 100 from the EPIC array. Maternal prenatal smoking exposures are more likely to affect the newborn methylome than paternal smoking, suggesting that in utero exposures more directly impact newborn methylation.

Keywords: Epigenomics, chemical exposures - general, molecular epidemiology, international collaboration



ABSTRACT E-BOOK

P-689

Omics Technologies » Epigenomics

Infant sex and DNA methylation: differentially methylated regions and positions across umbilical cord blood, artery, and placenta samples

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BACKGROUND AND AIM: Environmental exposures during embryogenesis may cause epigenetic dysregulation. Fetal sex may act as an effect modifier of the association between prenatal conditions and changes in DNA methylation (DNAm); therefore, it is important to understand sex-specific DNAm patterns. Autosomal cord blood and placental DNAm at several loci has been consistently associated with sex. However, there is limited research regarding differentially methylated regions (DMRs) and comparing sex-specific DNAm across tissues. This study leverages data from the PRogramming of Intergenerational Stress Mechanisms (PRISM) cohort to identify sex-associated DNAm profiles in cord blood, placenta, and umbilical artery samples.

METHODS: DNAm was measured using the Illumina HumanMethylation450 BeadChip in cord blood (N = 179), placenta (N = 229), and umbilical artery samples (N = 229). Sex-associated DMRs were identified using DMRcate and differentially methylated positions (DMPs) were identified using limma. Analyses were replicated in an independent cord blood dataset (GEO Accession GSE129841).

RESULTS: A total of 183, 257, and 419 DMRs and 2,119, 2,281, and 3,405 DMPs (pBonferroni < 0.05) were identified in cord blood, placenta, and artery samples, respectively. Common DMRs were identified across tissues: 39 DMRs overlapped in all three tissues. The majority of DMRs (cord blood: 61%; placenta: 69%; artery: 67%) were annotated to small nucleolar RNAs (snoRNA) genes. In a cord blood replication analysis, 85% of DMRs overlapped with those identified in PRISM. Overall, female sex was associated with higher methylation of DMRs and DMPs in cord blood and artery samples, but male sex was associated with higher methylation levels in placenta samples.

CONCLUSIONS: Common sex-associated DMRs and DMPs were identified in cord blood, placenta, and artery samples. Further research may provide insights to biological mechanisms that contribute to sex-specific DNAm signatures across fetal tissues, as well as the influence of dimorphism in the epigenome on environmental-induced dysregulation.



ABSTRACT E-BOOK

Keywords: children's environmental health, omics technologies, epigenomics, female, male

P-691

Birth and Pregnancy Outcomes » Other (to be specified with keywords in the keywords section)

High Fidelity: Delivery and use of an LPG stove intervention during pregnancy in the HAPIN trial

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BACKGROUND AND AIM: Most previous cookstove trials have reported low intervention adoption and/or high continued traditional stove use, limiting interpretation of results. The Household Air Pollution Intervention Network (HAPIN) trial randomized 3195 pregnant women in resource-poor settings of four countries to a liquefied petroleum gas (LPG) stove and fuel intervention or to control. We assessed implementation fidelity (the extent to which the intervention was delivered as intended) and adherence (the extent to which it was adopted by participants) at the first trial endpoint: the end of the gestational period.

METHODS: We tracked intervention fidelity through questionnaires at baseline (< 20 weeks gestation) and at two post-intervention visits (at 24-28 and 32-36 weeks of pregnancy), data collected by study staff (e.g. visual observations at fuel deliveries), and temperature-logging stove use monitors (SUMs) downloaded twice monthly.

RESULTS: Over a median [Q1, Q3] follow-up period of 150 [131, 168] days per household, median time to repair for stoves requiring maintenance was 0 [0, 0] days (same day repair), and 87.2% of LPG refills were delivered within one week of request. 96.1% of intervention households reported LPG stove use at both follow-up visits. In the 70.0% of intervention households that retained traditional stoves after receiving their LPG stove, the median rate of traditional stove use was 0.0 [0.0, 1.6] days per 100 days of observation (using SUMs). In 70.6% of these households, traditional stoves were used on fewer than one in every 100 days of observation (Guatemala: 83.3%; India: 85.4%; Peru: 59.6%; Rwanda: 70.2%).

CONCLUSIONS: The HAPIN intervention was largely delivered as intended, and participant adherence to the LPG stove intervention during pregnancy was high. Any observed differences in pollutant exposures or health outcomes between control and intervention groups are unlikely to be due to implementation failures during the gestational period.



ABSTRACT E-BOOK

Keywords: Air Pollution, Birth Outcomes, Community-engaged research, International Collaboration, Methodological study design, Particulate Matter

P-692

Birth and Pregnancy Outcomes » Birth outcomes

Solar activity and number of live births in Massachusetts neonates 2000-2015

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BACKGROUND AND AIM: Previous studies have shown a possible effect of solar energy on pregnancy and fetal growth. The objective of the present study is to investigate the impact of solar and geomagnetic activity on the number of live births in Massachusetts, USA neonates during 2000 to 2015.

METHODS: Non-linear distributed lag models (DLNM) along with quasi-poisson models based on a variation of the time-series design were applied to determine the potential impact of week-to-week solar activity level [represented by total interplanetary magnetic field strength (IMF)] and geomagnetic activity level [represented by Kp index] on conceptions resulting in live births using Massachusetts Birth Registry 2000-2015 and identify the critical window of vulnerability. Factorized month variable and natural spline of year with 17 knots were included in the models to adjust for long-term trend and seasonal effect. We also investigated the association between same exposures and conceptions resulting in preterm birth within the same cohort.

RESULTS: For IMF, we observed a non-linear exposure lag-response relationship during gestational weeks 13 to 35, with the strongest effect on live birth-identified conceptions (LBIC) occurs around week 25-30. During this window, per IQR increase in IMF level is associated with 0.4% decrease in LBIC. On the other hand, for Kp index, the non-linear exposure lag-response relationship were observed during gestational week 13 to 28. The strongest effect of Kp index on LBIC occurs around 18-23 and per IQR increase in Kp index is associated with 0.2% decrease in LBIC. We also identified non-linear positive relationships between exposures and preterm birth-identified conceptions (PBIC) during gestational weeks 20-30.

CONCLUSIONS: Increased level of prenatal exposure to solar and geomagnetic activity were associated with decreased number of weekly live birth-identified conceptions as well as increased number of preterm birth-identified conceptions. Middle to late pregnancy appears to be window of vulnerability regarding these exposures.

Keywords: Solar activity, geomagnetic field, fetal growth, pregnancy, critical window, live birth bias



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-693

Omic Technologies » Other (to be specified with keywords in the keywords section)

Associations of prenatal exposure to NO₂ and near roadway residence with placental gene expression

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BACKGROUND AND AIM: The placenta serves as a critical interface between maternal and fetal environments mediating effect of maternal environmental exposures on fetal growth and development. Traffic-related air pollution (TRAP) is a ubiquitous exposure that has been related to several adverse health outcomes. We examined associations of maternal prenatal TRAP exposure (using NO₂ and near roadway residence) and genome-wide placental gene expression.

METHODS: Placental samples were collected from CANDLE (Memphis, TN) (n=776) and GAPPS (Seattle and Yakima, WA) (n=205) cohorts in the ECHO-PATHWAYS consortium. NO₂ exposure was characterized using a spatiotemporal model and separately averaged for each trimester and the first and last month of pregnancy. Confounder adjusted cohort-specific linear models were fit for >11,000 protein-coding genes and each exposure (NO₂ exposure window, linear distance and proximity <150 m to three roadway types). Offspring sex-specific associations were examined using interaction terms. False discovery rates (FDR)<0.10 were used for statistical significance.

RESULTS: Mean NO₂ levels were 8.2 (SD=3.2) and 7.8 (SD=3.9) ppb while mean distances to nearest roadways were 466 (SD=521) and 525 (SD=926) meters in CANDLE and GAPPS, respectively. Despite no NO₂ main effects, In GAPPS, expression of B4GALNT2 and ADGRG2 was associated with linear distance to A3 roadways (FDR p-values=0.057 and 0.096, respectively) and expression of ZFP92 (FDR p-value=0.058) was associated with close proximity to A3 roadways. Offspring sex and first trimester NO₂ interaction was observed in CANDLE for RASSF7 (interaction FDR p-value=0.067) where positive association was observed only for male infants. In GAPPS, positive association of STRIP2 expression with second trimester NO₂ was observed only among male infants (interaction FDR p-value=0.021).

CONCLUSIONS: We found suggestive associations of near roadway residence with placental gene expression. Offspring sex may modify associations of NO₂ with placental expression. Identified genes play roles in cell signaling, a potential mechanism for effects of prenatal TRAP exposure on placental function.



ABSTRACT E-BOOK

Keywords: Transcriptomics, Epidemiology, Traffic-related, Air pollution

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Birth and Pregnancy Outcomes » Birth outcomes

The Role of Immigrant Enclaves and Ambient Air Pollution Exposure in the Immigrant Birthweight Paradox

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BACKGROUND AND AIM: Foreign-born Black and Latina women have higher birthweight infants than their US-born counterparts, despite generally worse socioeconomic status and prenatal care access, i.e. immigrant birthweight paradox (IBP). Residence in immigrant enclaves and associated socio-cultural and economic benefits may be drivers of IBP. Yet, enclaves are known to have higher air pollution, a risk factor for lower birthweight. We investigated IBP accounting for both residential immigrant composition and air pollution exposure.

METHODS: In the Boston-based Children's HealthWatch cohort of non-smoking women-child dyads (n=2,116), we obtained birthweight-for-gestational age z-scores (BWGAZ) for US-born births from 2006-2015. Using maternal address, we estimated trimester-specific PM_{2.5} concentrations, proximity to major roadways, and immigrant orientation level based on census-tract percentages of foreign-born, non-citizen, and linguistically-isolated households (proxy for immigrant enclave). We fit multivariable linear regressions of BWGAZ by maternal nativity and sequentially adjusted for immigrant orientation and ambient air pollution sources. We also examined effect modification of IBP by immigrant orientation.

RESULTS: Fifty-one percent of women were foreign-born. Immigrant orientation was negatively correlated with PM_{2.5} concentrations and proximity to major roads. Overall, children of foreign-born women had 0.19 (95% CI: 0.10, 0.28) higher mean BWGAZ than those of US-born mothers,



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demonstrating IBP in our cohort. BWGAZ did not significantly change after adjustment for immigrant orientation and air pollution sources. However, we found an additive effect of immigrant orientation on maternal nativity (p -interaction: ≤ 0.01), with IBP observed only in moderate (0.27, 95% CI: 0.09, 0.46) and high (0.29, 95% CI: 0.15, 0.44) immigrant-oriented tracts.

CONCLUSIONS: Foreign-born women in higher immigrant-oriented areas had higher BWGAZ, supporting the role of immigrant enclaves on IBP. Prenatal air pollution exposure did not impact associations observed in this study. Future research should consider the role of immigrant enclaves and their spatial correlation with potential protective resources and environmental risk factors.

Keywords: Air pollution, Particulate matter, Birth outcomes, Environmental disparities, Exposures, Environmental epidemiology



ABSTRACT E-BOOK

P-695

Birth and Pregnancy Outcomes » Birth outcomes

Maternal cigarette smoking cessation and infant term low birth weight

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BACKGROUND AND AIM: Smoking cessation during pregnancy is hypothesized to improve birth outcomes. However, the effect of the cessation time on birth weight among full-term infants merits further attention. We aimed to examine the association of maternal trimester-specific smoking cessation with term low birth weight (TLBW, <2500g).

METHODS: We included 183,099 singleton, non-anomalous live births of 37-42 weeks gestation in Western New York between 2004-2018. Based on the self-reported average cigarettes per day during three months before pregnancy and during each trimester, we categorized pregnant women into six mutually exclusive groups: non-smokers; those who quit during the 1st, 2nd, or 3rd trimester; those who smoked throughout pregnancy; and inconsistent smokers. We examined the association between smoking cessation categories and TLBW using logistic regression, adjusting for potential confounders. We further explored the joint effect of smoking and illegal drug use during pregnancy on TLBW.

RESULTS: Overall, 13.7% of pregnant women smoked throughout pregnancy; 3.4%, 1.8%, and 0.7% reported quitting smoking during the 1st, 2nd, or 3rd trimester, respectively. Compared to non-smokers, cessation during the 3rd trimester and smoking throughout pregnancy were associated with 1.73 (95% CI: 1.25, 2.39) and 2.28 (95% CI: 2.09, 2.49) times higher odds of TLBW, respectively. The associations were more pronounced for heavy smokers (≥ 10 cigarettes/day) than light smokers (1-9 cigarettes/day). Quitting smoking during the 1st trimester (OR=0.88, 95% CI: 0.71, 1.09), 2nd trimester (OR=1.22, 95% CI: 0.96, 1.56), or inconsistent smoking (OR=1.28, 95% CI: 0.71, 2.32) was not associated with TLBW. Infants of mothers who smoked throughout pregnancy and used illegal drugs had 2.84 (95% CI: 2.47, 3.25) times higher odds of TLBW compared to non-smokers without illegal drug use.

CONCLUSIONS: Delayed smoking cessation, smoking throughout pregnancy, and the combination of smoking and illegal drug use were associated with an increased risk of TLBW.

Keywords: Cigarette smoking, Birth weight, Full-term infants, Illegal drug use



ABSTRACT E-BOOK

P-696

Birth and Pregnancy Outcomes » Birth outcomes

Pre-conception and Prenatal Exposure to Ambient PM_{2.5} with Newborn Telomere Length in Cord Blood

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BACKGROUND AND AIM: Telomere length (TL) at birth determines TL in a later life and has been linked to midlife risk of cardiovascular disease, but its own determinants remain unclear. We aim to examine the association and to identify the sensitive window of pre-conception and prenatal exposures to fine particulate matter (PM_{2.5}) with cord blood TL in a heavily air-polluted area in China.

METHODS: In 2017, 107 pregnant women admitted for delivery at Anzhen Hospital in Beijing, China, were interviewed for demographics, addresses, and lifestyle factors. Weekly levels of ambient PM_{2.5} exposure from the three months before pregnancy to the end of pregnancy were estimated from a validated spatiotemporal model. PM_{2.5} exposure levels based on home and work addresses were combined by work routines. Cord blood leukocyte TL was measured using quantitative polymerase chain reaction. We used distributed lag models (DLMs) to analyze the association and to identify the sensitive window of ambient PM_{2.5} exposure with cord blood TL with adjusting for potential confounders. DLM analyses were also conducted in stratified subsamples by newborn sex.

RESULTS: PM_{2.5} levels (median: 85 µg/m³) in the three months before LMP was positively ($r=0.16$) correlated with cord blood TL, while PM_{2.5} levels (median 78 µg/m³) in the whole pregnancy was inversely ($r=-0.15$) correlated with cord blood TL, although none of the correlation was significant ($P>0.05$). From DLM, we found PM_{2.5} exposure was significantly associated with cord blood TL in three sensitive windows: 6-12 weeks before pregnancy (positive association), 6-18 weeks during pregnancy (inverse association), and 39-40 weeks during pregnancy (inverse association). These associations were more evident in female than male newborns.



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CONCLUSIONS: Preconception and prenatal exposure to ambient PM_{2.5} exposure may shorten cord blood TL, especially for female fetuses. Future studies with larger sample size are needed to replicate our findings.

Keywords: Particulate matter, Birth outcomes, Environmental epidemiology, Modeling



ABSTRACT E-BOOK

P-697

Birth and Pregnancy Outcomes » Pregnancy outcomes

Associations Between Prenatal Fluoride Exposure and Performance IQ in Canadian Preschool Aged Children: A Multilevel Modeling Approach

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BACKGROUND AND AIM: Prenatal fluoride exposure is associated with reduced IQ in children, especially Performance IQ (PIQ; nonverbal intelligence), but studies have not accounted for hierarchical clustering. We examined the association between sex-specific prenatal fluoride exposure and PIQ using multilevel modeling (MLM) to account for nesting of 448 mother-child pairs within 184 postal codes and six cities.

METHODS: Our sample was from the Maternal-Infant Research on Environmental Chemicals (MIREC) prospective Canadian birth cohort. Variables included maternal urinary fluoride (MUF; adjusted for dilution), PIQ scores at age 3-4 years from the WPPSI, and participant level covariates (HOME scores, maternal education level, and maternal race). A series of three-level MLMs were fit to estimate associations between within-postal code and within-city centered MUF and PIQ.

RESULTS: Median MUF concentration was 0.44 mg/L (IQR= 0.35), with average PIQ of 102 (SD= 14) for boys and 105 (SD= 14) for girls. A three-level intra-class correlation revealed that 3.8% and 9.1% of the variance in PIQ was accounted for by nesting of dyads in postal codes and cities, respectively. The interaction between child sex and MUF and the covariate effects were fixed across postal codes and cities in the optimal model. The interaction between child sex and within-postal-code MUF was significant ($p < .05$). For boys, a 1 mg/L increase in within-postal-code MUF was significantly associated with PIQ, $B = -7.9$ (95% CI: -13.6, -2.2); for girls, the association was not significant, $B = 1.7$ (95% CI: -5.0, 8.5). Centering MUF within city resulted in a weaker effect among boys ($B = -5.7$ 95% CI: -10.2, -1.2), and a stronger, but nonsignificant effect among girls ($B = 3.3$, 95% CI: -2.7, 9.3).

CONCLUSIONS: For boys, the stronger effect of MUF in postal codes than cities shows the importance of accounting for hierarchical clustering in the MIREC cohort to examine associations between prenatal fluoride exposure and PIQ.

Keywords: biomarkers of exposure, children's environmental health, epidemiology, fluoride, neurodevelopmental outcomes



ABSTRACT E-BOOK

P-698

Birth and Pregnancy Outcomes » Birth outcomes

Prenatal lead exposure, telomere length in cord blood and DNA methylation age in the PROGRESS cohort

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BACKGROUND AND AIM: Lead is a ubiquitous pollutant with deleterious effects on human health and remains as a major current public health concern in countries in development. Telomere length shortening has been related with aging in newborns. DNA methylation levels with specific CpG sites could be used as "epigenetic clocks" to predict biological age. The aim of this study was to examine the associations of prenatal lead exposures with telomere length and DNA methylation age in cord blood.

METHODS: The study included 507 mother-child pairs from the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) study, a birth cohort in Mexico City. Maternal blood and bone lead levels were measured using inductively coupled plasma-mass spectrometry and X-ray fluorescence, respectively. Telomere length was measured using quantitative PCR and DNA methylation age was calculated using Horvath epigenetic clock.

RESULTS: Average maternal age was 28.5 ± 5.5 years and 51.5% reported low socioeconomic status. Mean telomere length and DNA methylation age were 1.2 ± 1.3 relative units and -2.6 ± 0.1 years (mean \pm SD), respectively. No associations were found between maternal blood and bone lead concentrations with telomere length and DNA methylation age in newborns. However, maternal blood lead levels showed positive correlations with gestational age and mother's age in the third trimester and at delivery, respectively. A negative correlation was observed between monocytes and maternal blood lead concentration in the second trimester.

CONCLUSIONS: No association was observed between telomere length and DNA methylation age in newborns with lead concentrations in the mother. Maintaining a healthy environment is the basis for increasing quality of life and life expectancy of the populations from low and middle income countries, prevent disease, and promote human health.

Keywords: Heavy metals, Birth outcomes, Epigenomics, Environmental epidemiology



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ABSTRACT E-BOOK



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P-699

Birth and Pregnancy Outcomes » Birth outcomes

Household Use of Cooking Biomass Fuels and Adverse Birth Outcomes in Rural Bangladeshi Children

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BACKGROUND AND AIM: Studies have examined the association between the use of solid fuel for cooking and birth outcomes, however, data on the potential effect of cooking biomass fuel according to fuel type and cooking time is limited.

METHODS: In this birth cohort study, pregnant women who were 18 years or older with an ultrasound confirmed singleton pregnancy of ≤ 16 weeks gestation were recruited from two Bangladesh clinics between January 2008 and June 2011. The newborn size metrics were measured at the time of delivery. Exposure to cooking biomass fuels during pregnancy was assessed by an administered questionnaire. We assessed associations between household use of cooking biomass fuels and birth size and adverse birth outcomes including low birth weight (LBW), preterm birth, small for gestational age (SGA), and large for gestational age (LGA).

RESULTS: A total of 1,137 participants were using biomass fuels, crop residues (30.3%) and fuelwood (69.7%), for cooking, respectively. After adjusting for covariates, the use of crop residues for cooking was associated with a 0.13 SD decrease in birth length (95% CI: 0.25, - 0.01), a 0.14 SD decrease in head circumference (95% CI: -0.26, -0.01), and increased risk for LBW (OR: 1.52, 95% CI: 1.07, 2.15) compared with the use of fuelwood. We also found a negative association between time spent cooking and a decrease in head circumference (0.1 SD, 95% CI: -0.18, -0.02).

CONCLUSIONS: The use of crop biomass for cooking was associated with a reduced birth size and increased risk for LBW in Bangladeshi children. Future studies are warranted to confirm our findings.

Keywords: cooking biomass, birth outcomes, prenatal exposure, environmental epidemiology, household air pollution, Bangladesh



ABSTRACT E-BOOK

P-700

Chemical exposures » Endocrine disrupting chemicals

Exposure to endocrine disrupting chemicals (EDCs) and cardiometabolic indices during pregnancy: the HOME Study

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BACKGROUND AND AIM: Toxicology studies have identified pregnancy as a window of susceptibility for endocrine disrupting chemicals (EDCs) and women's cardiometabolic health. No study in humans, however, has examined EDC mixtures and cardiometabolic health during pregnancy. We used the Health Outcomes and Measures of the Environment (HOME) Study to examine whether bisphenol A (BPA), polybrominated diphenyl ethers (PBDEs), per- and polyfluoroalkyl substances (PFAS), and phthalates are associated with blood pressure, fasting plasma glucose, and lipids in 388 pregnant women.

METHODS: We measured PBDEs and PFAS in serum at 16 weeks gestation, while BPA and phthalates were quantified in urine at 16 and 26 weeks. We used linear regression and Bayesian Kernel Machine Regression (BKMR) to estimate associations of individual EDCs and their mixtures with cardiometabolic health during pregnancy.

RESULTS: A 10-fold increase in BDE-28 was associated with a 13.1 mg/dL increase in glucose (95% CI 2.9, 23.2) in linear regression. The BKMR model also identified BDE-28 as having a positive association with glucose. BDE-28, BDE-47, and BDE-99 were positively associated with cholesterol in both single- and multi-pollutant models, whereas a suggestive negative association was noted with BDE-153. Mono-n-butyl phthalate (β = -7.9 mg/dL, 95% CI -12.9, -3.0) and monobenzyl phthalate (MBzP) (β = -6.3 mg/dL, 95% CI -10.6, -2.0) decreased cholesterol in linear regression, but only MBzP was an important contributor with BKMR.

CONCLUSIONS: Overall, we observed positive associations of PBDEs with glucose and cholesterol levels during pregnancy, while negative associations were found between some phthalates and cholesterol. No relationship was noted for BPA or PFAS with cardiometabolic health during pregnancy.

Keywords: bisphenol A (BPA), polybrominated diphenyl ethers (PBDEs), per- and polyfluoroalkyl substances (PFAS), phthalates, blood pressure, glucose, lipids



ABSTRACT E-BOOK

P-701

Chemical exposures » Phthalates

Dietary Correlates of Urinary Phthalate Metabolite Concentrations in 6-19 Year Old Children and Adolescents from NHANES

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BACKGROUND AND AIM: Children are particularly vulnerable to phthalates, and food is one source of exposure. However, a comprehensive analysis that investigates exposure from food type and source has yet to be undertaken. We use reduced rank regression, a dimension reduction method, to identify dietary patterns associated with urinary phthalate metabolite concentrations in children in a large, US study with detailed data on dietary intake.

METHODS: We used data from 2,402 participants 6-19 years old from the 2005-2010 National Health and Nutrition Examination Survey who had urinary phthalate metabolites measured by mass spectrometry. Participants recalled their diet during the 24 hours before urine collection. We quantified dietary intake and source (i.e., home-prepared vs. prepared away from the home) of 135 food groups. We used reduced rank regression to identify dietary patterns explaining variation in overall urinary concentrations of Σ di-2-ethylhexyl phthalate (DEHP) and seven phthalate metabolites, adjusting for urinary creatinine and sociodemographics. We also examined pairwise associations between food groups and phthalate concentrations.

RESULTS: We identified eight dietary patterns that cumulatively explained 11.2% of variation in phthalates. The most variation was explained by a diet high in breakfast foods prepared away from home (e.g., bacon, low-sugar cereal, and reduced-fat milk). A one SD increment in adherence to the breakfast food dietary pattern was associated with an 11.3% higher monocarboxy-isononyl phthalate concentration (95% CI: 6.5, 15.9) and a 7.4% higher monobutyl phthalate concentration (95% CI: 3.0, 12.1). We observed some weak pairwise associations between food group intake and urinary phthalates (e.g., 0.1% [95% CI: 0.0, 0.2] higher DEHP per SD increment in milk intake).

CONCLUSIONS: We identified dietary factors that may be sources of phthalate exposure or reflect lifestyle correlates. Diet and preparation location explained a small percent variation in phthalate concentrations, suggesting the need for more detailed information on food processing and packaging.

Keywords: food/nutrition, phthalates, children's environmental health, biomarkers of exposure



ABSTRACT E-BOOK

P-703

Chemical exposures » Phthalates

Sociodemographic and dietary predictors of urinary concentrations of phthalates and their alternatives in children in the Project Viva cohort

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BACKGROUND AND AIM: Although phthalates are still widely used, phthalate alternatives are replacing their use in food packaging, toys, and personal care products. However, data on sociodemographic and dietary predictors of concentrations of phthalate alternatives in children are limited.

METHODS: We studied 830 children ages 6-10 years from 2007-2010 in Project Viva, a Boston-area cohort. We measured urinary phthalate metabolites and summed metabolites to calculate concentrations of ten parent phthalate diesters and alternatives. We determined average daily intake of 12 food groups over the prior month via a PrimeScreen questionnaire. We used linear regression to examine mutually adjusted associations of sociodemographics and diet with individual phthalates and alternatives, accounting for specific gravity. We used logistic regression to examine predictors of 1,2-cyclohexane dicarboxylic acid, diisononyl ester (DINCH) detectability.

RESULTS: Participants were mean (SD) 7.8 (0.8) years; 67% had college-educated mothers. We detected at least one DINCH metabolite in 35% of samples and at least one metabolite of all other phthalates in $\geq 94\%$ of samples. Sociodemographics and diet explained 25% (for di-isodecyl phthalate) to 48% (for di-n-butyl phthalate) of phthalate variability. The phthalate alternative di-2-ethylhexyl terephthalate was higher in girls (18.7% [95% CI: 0.7, 39.9]), children who consumed more meat and dairy (e.g. 36.9% higher [95% CI: 3.8, 80.6] for \geq daily vs < daily meat consumption), and samples from later years (e.g., 373.4% higher [95% CI: 220.9, 598.4] for 2010 vs. 2007). DINCH was more likely to be detectable in girls (odds ratio [OR] 2.1 [95% CI: 1.5, 3.0]) and samples from later years (e.g., OR 8.5 [95% CI: 3.6, 21.2] for 2010 vs. 2007).

CONCLUSIONS: Sociodemographics and diet explained moderate variability of phthalate and alternative concentrations in children. We found higher concentrations of phthalate alternatives in girls and in samples from later years. Future studies should continue to investigate health effects of phthalate alternatives.

Keywords: Phthalates, Children's environmental health, Endocrine disrupting chemicals



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P-705

Chemical exposures » PFAS

Prenatal exposure to per- and polyfluoroalkyl substances and child adiposity at age 5 years: a multipollutant analysis

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BACKGROUND AND AIM: Prenatal exposure to per- and polyfluoroalkyl substances (PFAS) is linked to lower birthweight and adiposity at birth. In some but not all previous studies, prenatal PFAS predict greater childhood BMI. However, few have directly measured child adiposity. We hypothesized that prenatal PFAS would be positively associated with child adiposity, evaluated using a precise method.

METHODS: Pregnant women enrolled in the Healthy Start study (2009-2014). Blood samples were collected at a median of 27 weeks of gestation. Eleven PFAS were quantified in maternal serum; five were detected in >75% of participants and analyzed here. Child body composition at age 5 years was assessed using air displacement plethysmography. Adiposity was calculated as fat mass/total body mass x 100%. Three statistical approaches estimated associations between prenatal PFAS and child adiposity: single pollutant linear regression models; multipollutant linear regression model; and Bayesian Kernel Machine Regression (BKMR). Multipollutant models included five PFAS and a common covariate set.

RESULTS: Among 340 participants, median child adiposity was 20.2% [interquartile range: 8.6%]. Pairwise Spearman correlations between PFAS were moderate to high (range: 0.32-0.78). In single pollutant models, each ln-unit increase in perfluorooctanoate (PFOA) was associated with 1.3% (95% CI 0.2, 2.5) greater child adiposity; no other PFAS was associated with adiposity. In the multipollutant model, PFOA was more strongly associated with adiposity than in the single pollutant model and there was an inverse association between perfluorodecanoate (PFDA) and adiposity; all variance inflation factors were <5. BKMR confirmed PFOA as the only PFAS with a posterior inclusion probability >0.3, but also showed a weak inverse association with PFDA. No pairwise interactions between exposures or strong non-linear trends were detected.

CONCLUSIONS: Prenatal exposure to PFOA was positively associated with child adiposity at age 5. Multipollutant linear regression and BKMR produced similar results in this relatively simple scenario.



ABSTRACT E-BOOK

Keywords: PFAS, Obesity and metabolic disorders, Mixtures analysis, Children's Environmental Health

P-706

Chemical exposures » Phenols

Urinary phenols and parabens in relation to hearing loss: The National Health and Nutrition Examination Survey

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BACKGROUND AND AIM: The animal studies raise concerns about the possible ototoxicity of phenolic chemicals. Therefore, we conducted an epidemiologic study to examine the associations of phenols and parabens with hearing impairment.

METHODS: Bisphenol A (BPA), benzophenone-3 (BP-3), and triclosan (TCS) were measured in urine samples in the National Health and Nutrition Examination Survey (NHANES) 2003-06 and 2009-12. Methyl paraben (MPB) and propyl paraben (PPB) were measured in urine samples in NHANES 2005-06 and 2009-12. Hearing impairment was defined as a hearing threshold of more than 25dB at each hearing frequency in the worse ear. Tests for linear trend were conducted using the median concentrations of urinary phenols or parabens in each quartile as a continuous variable.

RESULTS: A total of 1809 participants (women=52.0%) aged 20 and above were included in the final analysis (For MPB and PPB, the sample size was 1188). After adjusting for potential confounders, we found positive associations between BPA and hearing impairment at 3K (p-trend = 0.04); between TCS and hearing impairment at 6K (p-trend = 0.03); However, the odds ratio (OR) for the highest compared with the lowest quartile of both BPA and TCS did not reach statistical significance. In contrast, we found unexpected negative associations between BP-3 and hearing impairment at 0.5K (p-trend = 0.04), 1K (p-trend = 0.02), 2K (p-trend < 0.01), 6K (p-trend = 0.03) and 8K Hz (p-trend = 0.02), respectively.

CONCLUSIONS: This study offers no strong evidence that background phenol and paraben exposures are ototoxicants for the United States adult population.

Keywords: phenols, parabens, hearing loss, endocrine disruptors, NHANES



ABSTRACT E-BOOK

P-707

Chemical exposures » PFAS

Prenatal Perfluoroalkyl Substances and Fetal Growth Trajectories Within the MADRES Pregnancy Cohort

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BACKGROUND AND AIM: Perfluoroalkyl Substances (PFAS) are synthetic chemicals found in household products with long half-lives and upon exposure can cross the placenta during pregnancy. We examined the influence of maternal PFAS levels on fetal growth trajectories within a cohort of predominately low-income, Hispanic mothers residing in urban Los Angeles.

METHODS: Blood serum concentrations of five PFAS (PFOS, PFHxS, PFNA, PFDA, and PFOA) were measured in 333 prenatal specimens (mean gestational age (GA): 20±9 weeks) in the ongoing Maternal And Developmental Risks from Environmental and Social Stressors (MADRES) pregnancy cohort. Fetal growth outcomes, including head circumference, abdominal circumference, biparietal diameter and femur length, were abstracted from ultrasound data recorded on prenatal visit medical records and were also measured during the 3rd trimester study visit by a certified sonographer (N=805 scans, GA range 3-42 weeks, mean 2.4 scans/participant). We estimated the association between each prenatal PFAS exposure and fetal growth trajectory by fitting a linear mixed model which allowed for a quadratic growth curve in GA, with adjustment for key covariates.

RESULTS: Participants (N=333) were on average 29±6 years old at study entry and were predominately Hispanic (76%). PFOS and PFHxS were detected in all samples, while PFNA, PFOA, and PFDA were detected in 71%, 66% and 56% of samples, respectively. Median concentrations were 1.34ng/mL for PFOS, 1.10 ng/mL for PFHxS, 0.07 ng/mL for PFNA, 0.12 ng/mL for PFOA and 0.04 ng/mL for PFDA. Levels were lower than comparable cohorts within California. Maternal serum PFNA was inversely associated with fetal head circumference (B= -6.70, 95% CI: -12.23, -1.22). We did not find significant associations between the remaining PFAS exposures and fetal growth parameters.

CONCLUSIONS: Higher maternal serum PFNA concentrations were associated with lower fetal head circumference which suggests that exposure to PFAS during critical periods in development may negatively impact children's health.

Keywords: PFAS, Fetal Growth, Pregnancy



ABSTRACT E-BOOK

P-709

Chemical exposures » Endocrine disrupting chemicals

Organophosphate and organohalogen flame retardant exposure and thyroid hormone disruption in women firefighters and office workers from San Francisco

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BACKGROUND AND AIM: Organophosphate flame retardants (OPFR) are suspected endocrine disrupting compounds and have been detected in fire station dust and firefighter gear. Studies have reported that exposure to FRs can disrupt thyroid hormone (TH) function; however, this relationship is not well characterized, especially for halogenated OPFRs. TH is important for thyroid mediated gene expression and may be relevant to adverse health effects such as cardiovascular disease and cancer. We describe OPFR exposure and its association with TH levels in a cohort of women firefighters and office workers from San Francisco.

METHODS: Using liquid chromatography-tandem mass spectrometry (LC MS/MS), we measured 8 urinary FR metabolites in female firefighters (N=86) and office workers (N=84) from San Francisco: bis(1,3-dichloro-2-propyl) phosphate (BDCPP), bis(2-chloroethyl) phosphate (BCEP), dibutyl phosphate (DBuP), dibenzyl phosphate (DBzP), di-p-cresyl phosphate (DpCP), di-o-cresyl phosphate (DoCP), 2,3,4,5-tetrabromobenzoic acid (TBBA), tetrabromobisphenol-A (TBBPA). We assessed potential predictors of exposure levels and the association between FR exposures and thyroxine (T4) and thyroid stimulating hormone (TSH) for 84 Firefighters and 81 office workers.

RESULTS: BDCPP, BCEP and DBuP had the highest concentrations among all study participants. However, firefighters had higher median exposure levels of BDCPP, BCEP and DBuP compared to office workers. When we assessed the association of each FR with TH we found that a doubling of BDCPP was associated with a 2.88% decrease (95%CI -5.28,-0.42) in T4 among firefighters. We did not observe significant associations between FR and T4 among office workers nor between FR and TSH in either firefighters or office workers.

CONCLUSIONS: Firefighters had significantly higher exposures to FR compared to office workers and their exposure to BDCPP was associated with TH disruption. Characterizing exposure to endocrine disrupting chemicals and assessing the association with biomarkers of early effect such as TH can inform prevention efforts without having to wait for adverse health outcomes to occur.

Keywords: occupational exposures, women firefighters, endocrine disruption



ABSTRACT E-BOOK

P-710

Chemical exposures » Endocrine disrupting chemicals

Maternal Exposure to Polycyclic Aromatic Hydrocarbons During the Second Trimester of Pregnancy and Gestational Age at Birth Among Term Births

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BACKGROUND AND AIM: Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous probable human carcinogens with suspected effects on gestational development. We examined associations between prenatal PAH exposure and gestational age at birth among spontaneous term births. Given the endocrine disrupting properties of PAHs, we additionally examined the extent to which infant sex modifies the relationship between PAH exposure and gestational age at birth.

METHODS: We included 1,452 non-smoking participants with singleton pregnancies from three cohort studies (CANDLE, TIDES, and GAPPS) in the ECHO PATHWAYS Consortium. Seven PAH metabolites (1-



ABSTRACT E-BOOK

hydroxynaphthalene, 2-hydroxynaphthalene, 2-hydroxyphenanthrene, 3-hydroxyphenanthrene, combined 1- and 9-hydroxyphenanthrene, combined 2-, 3-, and 9-hydroxyfluorene, and 1-hydroxypyrene) were measured in second trimester maternal urine. PAH values below the limit of detection were imputed using censored likelihood multiple imputation. We assessed our primary aim using linear regression models assessing individual log₁₀-transformed PAH metabolite associations with gestational age at birth, adjusted for specific gravity as well as demographic and behavioral characteristics. Effect modification by infant sex was assessed using interaction terms and comparison of marginal sex-specific estimates.

RESULTS: A ten-fold higher exposure to 2-hydroxynaphthalene was associated with a 1.13-day (95% CI: -0.13, -2.19) lower gestational age at birth. Associations for the remaining PAH metabolites were null. We observed shorter gestational age among females versus males in relation to all PAH metabolites, and the marginal estimate was significant for females exposed to 2-hydroxynaphthalene (-2.00 days, 95% CI: -3.25, -0.76).

CONCLUSIONS: In this large cohort study with urinary biomarker PAH assessment, we observed a shorter gestational age at birth associated with exposure to 2-hydroxynaphthalene as well as suggestive evidence that female fetuses may be more susceptible to exposure to 2-hydroxynaphthalene. This study is the first to assess sex-specific PAH toxicity in relation to gestational age among term births.

Keywords: Chemical exposures, Pregnancy outcomes, Endocrine disrupting chemicals, Biomarkers of exposure



ABSTRACT E-BOOK

P-711

Outcomes » Other (to be specified with keywords in the keywords section)

Mediation Effects of Oxidative and Nitrosative Stress Biomarkers in the Associations between Phthalate Exposure and Thyroid Function in Taiwanese Adults

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BACKGROUND AND AIM: Phthalate exposure was shown to alter thyroid function, however it is unclear, whether oxidative and nitrosative stress explains the intermediate biological mechanism. This study aimed to investigate the associations between phthalate exposure, oxidative/nitrosative stress, and thyroid function in adults, and to examine the mediating role of oxidative/nitrosative stress in the associations between phthalate exposure and thyroid function.

METHODS: Levels of eleven urinary phthalate metabolites, three urinary biomarkers of oxidative/nitrosative stress (malondialdehyde [MDA], 8-OHdG, and 8-NO₂Gua) and five serum thyroid hormones (thyroxine [T₄], free T₄, triiodothyronine, thyroid-stimulating hormone, and thyroxine-binding globulin) were measured in 266 Taiwanese adults. Cross-sectional associations between phthalate metabolites, biomarkers of oxidative/ nitrosative stress and thyroid hormones were analyzed using multivariate regression models. Mediation analysis was conducted to assess the role of oxidative/nitrosative stress in the associations between phthalate metabolites and thyroid hormone levels.

RESULTS: Sum of di-(2-ethylhexyl) phthalate (DEHP) metabolites was positively associated with MDA (p for trend = 0.005) and 8-NO₂Gua (p for trend = 0.045). Mono-n-butyl phthalate (MnBP) was positively associated with 8-NO₂Gua (p for trend = 0.018). T₄ was negatively associated with MDA (p for trend = 0.005) and 8-NO₂Gua (p for trend < 0.001). Free T₄ was positively associated with MDA (p for trend = 0.047) and with 8NO₂Gua (p for trend < 0.001). 8-NO₂Gua mediated 11% of the association between the sum of DEHP metabolites and T₄, and 17% of the association between MnBP and free T₄.

CONCLUSIONS: These results suggest that phthalate exposure may influence thyroid hormone levels through induced oxidative/nitrosative stress.

Keywords: Mediation analysis, Phthalates, Thyroid hormones, Oxidative stress, Nitrosative stress



ABSTRACT E-BOOK

P-712

Outcomes » Obesity and metabolic disorders

Phthalate Exposure Increased the Risk of Early Renal Impairment in Taiwanese without Type 2 Diabetes Mellitus

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BACKGROUND AND AIM: Studies have suggested that phthalates may be a risk factor for microalbuminuria, whereas little is known regarding their nephrotoxic effects on adults. We aimed to assess the relationship between phthalate exposure and renal function including serum level of BUN, and urinary levels of microalbumin, albumin, protein, and creatinine in Taiwanese.

METHODS: We enrolled 311 participants (≥ 18 y, N = 241; < 18 y, N = 70) who provided questionnaire information as well as blood and urine samples from a nationally cross-sectional study. Urinary phthalate metabolites were analyzed through liquid chromatography–tandem mass spectrometry. From the renal function index, we measured the serum level of blood urea nitrogen (BUN), and the urinary levels of microalbumin, albumin, protein and creatinine. We used multiple logistic regressions and a cumulative risk assessment of renal effect to evaluate the relationship between phthalate exposure and renal function in our participants.

RESULTS: The multiple logistic regression showed that the adjusted odds ratio of the highest tertile of estimated di-2-ethylhexyl phthalate (DEHP) daily intake in participants ≥ 18 y for early renal impairment (microalbumin > 1.9 mg/dL) was 9.40 times higher (95% confidence interval= 1.67–52.84) than the lowest tertile. The cumulative hazard index of phthalate-induced nephrotoxicity (HInephro) was significantly positively associated with microalbumin (β : 0.98, $P < 0.001$), BUN (β : 0.19, $P = 0.002$), and urine protein (β : 0.75, $P = 0.001$) in participants ≥ 18 y without type 2 diabetes mellitus after adjusting for confounding factors, but not in those < 18 y.

CONCLUSIONS: Our findings suggest that daily exposure to DEHP and its metabolites were significantly positively associated with an increased risk of higher microalbumin in Taiwanese ≥ 18 y. Comprehensive or mechanistic studies are required to elucidate these associations.

Keywords: Phthalate metabolites, Cumulative risk assessment, microalbumin, early renal impairment.



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ABSTRACT E-BOOK



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P-713

Chemical exposures » Endocrine disrupting chemicals

Knowledge, attitude and practice towards endocrine disrupting chemicals in related to the use of selected food contact materials among adolescents

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BACKGROUND AND AIM: The use of Plastic-Type Food Contact Materials (PTFCMs) is a common practice nowadays. However, PTFCMs contain chemicals that are grouped into Endocrine Disrupting Chemicals (EDCs), that can cause adverse health effects to human. The continuous use of plastic material in food packaging would increased the likelihood of hazard exposure. The main objective of this study was to assess the level of knowledge, attitude and practice (KAP) towards EDCs in related to the use of PTFCMs among university students in Kelantan.

METHODS: A cross-sectional study was conducted among 166 university students in Kelantan. Their knowledge, attitude and practice were assessed using the modified questionnaire adopted from previous study by Hui, Khairil, and Hayati (2017) with Cronbach's alpha of 0.877.

RESULTS: Most of the students had poor level of knowledge (50.6%), attitude (52.4%) and practice (51.8%). Majority of sciences students had poor knowledge level towards EDCs while only less than half (42.2%) of non-science students had poor knowledge level. There was a significant different of attitude score ($z = -2.338$, $p = 0.019$) between science and non-science students tested using Mann Whitney test. This study found that there was a significant, very strong, positive linear relationship between knowledge score and attitude score ($r = 0.273$, $p < 0.05$).

CONCLUSIONS: Improvement is needed to increase student knowledge, attitude and practices towards EDCs and the harmful usage of PTFCMs. Appropriate educational program regarding the harmful effects of EDCs and proper usage of PTFCMs should be given to students to increase their awareness.

Keywords: Awareness, Adolescents, University students, Endocrine disrupting chemicals, Food contact materials



ABSTRACT E-BOOK

P-715

Chemical exposures » Phthalates

Effects of mid-pregnancy exposure to phthalate acid esters and polycyclic aromatic hydrocarbons on offspring size at birth

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BACKGROUND AND AIM: Phthalate acid esters (PAEs) and polycyclic aromatic hydrocarbons (PAHs) are the environmental endocrine disruptors and threaten human health especially for pregnant women and fetuses. Evidence on how these contaminants affect fetal growth in newborns is lacking and inconsistent. We therefore conducted a prospective cohort study to assess the associations of prenatal PAEs and PAHs exposure with fetal growth.

METHODS: This study included 835 mother-infant pairs from the Tongji Birth Cohort in Wuhan, China. We detected the concentrations of 9 PAEs metabolites and 10 PAHs metabolites in urine samples collected during mid-pregnancy (13~28 weeks' gestation). The fetal biometric parameters for head circumference (HC), abdominal circumference (AC), femur length (FL), and estimated fetal weight (EFW) were collected during pregnancy (weeks 28~37). We measured birth size. The associations of urinary metabolites with fetal growth parameters were estimated by using linear regression models.

RESULTS: We observed each ln-unit increase in monoethyl phthalate (MEP) was associated with decrement in EFW (-128 g, 95% CI: -233, -23), birth weight (-44 g, 95% CI: -88, -1), birth weight z-scores (-0.10 SDs, 95% CI: -0.20, 0.00) among boys but not in girls. Elevated maternal 2-hydroxyfluorene concentrations were associated with the decline of birth length (-0.22 cm, 95% CI: -0.37, -0.07) and birth length z-scores (-0.12 SDs, 95% CI: -0.21, -0.04) in boys. However, we observed a positive association between 4-hydroxyphenanthrene and birth length z-scores in girls with a $\beta = 0.11$ SDs, (95% CI: 0.00, 0.21). Meanwhile, gestational levels of MEP, monoisobutyl phthalate, 1-hydroxyphenanthrene, 2-hydroxyphenanthrene, 9-hydroxyphenanthrene, and 9-hydroxyfluorene were also positively associated with HC and AC in girls.

CONCLUSIONS: This study suggested that the impact of mid-pregnancy PAEs and PAHs exposure on fetal and birth size maybe in a sex-specific manner and MEP was negatively associated with some fetal growth parameters among boys. More findings are required in future research.

Keywords: Phthalates, Multi-pollutant, Endocrine disrupting chemicals, Pregnancy outcomes



ABSTRACT E-BOOK

P-716

Chemical exposures » PFAS

Exposure to perfluoroalkyl substances (PFAS) and liver injury: a systematic review and meta-analysis

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BACKGROUND AND AIM: Experimental evidence indicates that exposure to pollutants is associated with liver damage and “toxicant-associated fatty liver disease” (TAFLD). Perfluoroalkyl substances (PFAS) are synthetic chemicals widely used in industry and consumer products that persist in the environment and bioaccumulate in food webs and human tissues. Our objective was to systematically review the literature evaluating PFAS exposure and evidence of liver injury from epidemiology and rodent studies.

METHODS: PubMed and Embase were searched through January 27, 2021 using keywords corresponding to PFAS exposure and liver injury. For data synthesis, results were limited to articles assessing two primary outcomes: serum alanine aminotransferase (ALT) and steatosis. Other measures of liver injury were included as secondary outcomes. For human studies, the evidence from at least three observational studies per PFAS were synthesized using a weighted z-score approach to determine the direction and significance of associations between PFAS and biomarkers of liver injury. For animal studies, data were synthesized to summarize direction and significance of effect of exposure and dose on hepatic enzyme abundance and activity.

RESULTS: Our search identified 23 epidemiological and 75 rodent studies. Studies focused primarily on four PFAS congeners: perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorononanoic acid (PFNA), and perfluorohexanesulphonic acid (PFHxS). Positive associations with ALT were found for PFOA (Z-score: 6.20, $p < 0.001$), PFOS (Z-score: 3.55, $p < 0.001$), and PFNA (Z-score: 2.27, $p = 0.023$) in humans. PFOA exposure was also associated with higher aspartate aminotransferase (AST) and gamma-glutamyl transferase (GGT) levels in humans. PFAS exposed rodents had increased ALT levels, steatosis, and liver weight compared to non-exposed rodents.



ABSTRACT E-BOOK

CONCLUSIONS: There is consistent evidence for PFAS hepatotoxicity from both human and rodent studies. Future research should evaluate PFAS mixtures to elucidate potential synergistic effects.

Keywords: PFAS, Chemical exposures, Systematic review, Meta-analysis, Obesity and metabolic disorders

P-717

Chemical exposures » Other (to be specified with keywords in the keywords section)

Intake of phosphate flame retardants from short and long-term accumulated housedust and asthma and allergies among children: Hokkaido Study

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BACKGROUND AND AIM: Phosphorus flame retardants and plasticizers (PFRs) are a class of chemicals predominantly used as additives in flame retardants and plasticizers in variety of consumer products, building materials, and furniture. Previous studies collected house dust using vacuum cleaners, however, there was no study collected long-term accumulated dust. In this study, we aim to calculate daily intake of PFR from short-term and long-term accumulated house dust and examined their associations with asthma and allergies.

METHODS: Study populations were children of the Hokkaido Study on Environment and Children's Health. We visited 91 homes of 94 children, who agreed to participate. Short-term dust samples were collected using vacuum cleaners from floor and multi-surface of each house. A box was set to collect long-term accumulated dust for six months. Fourteen PFRs were examined by LC-MSMS and daily intake of PFRs through ingestion, dermal absorption, and their sum were calculated. Child asthma and allergies were determined by ISAAC questionnaire.

RESULTS: All children were aged 7, and mean \pm SD of height and weight were 119.3 ± 5.44 cm and 22.78 ± 2.73 kg, respectively. The highest concentration detected was TBOEP in floor, multi-surface, and long-term dusts were 46.9, 6.56, and 7.09 $\mu\text{g/g}$ dust, followed by TCIPP of 1.96, 1.98, and 0.72 g/g dust, respectively. Median daily intake ingestion of TBOEP from floor dust was the highest with 0.3 $\mu\text{g/kg/day}$. The highest daily intake observed was 2.91 $\mu\text{g/kg/day}$ of TDCIPP. Total intake of TCsP from floor and long-term dusts were higher among those with asthma than without, and TNBP and TBOEP from multi-surface dust were higher among those with rhino-conjunctivitis than those without.

CONCLUSIONS: Association with TBOEP and multi-surface dust and rhino-conjunctivitis were in line with our previous findings. TCsP was first examined so that more detailed analysis is needed.

Keywords: Asthma, Allergies, Built environment, Exposure assessment, Risk assessment, Phosphate Flame Retardants



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

P-719

Air pollution » Particulate matter

Mortality burden attributable to long-term exposure to ambient PM_{2.5}: a systematic subnational analysis in 296 Chinese cities

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BACKGROUND AND AIM: BACKGROUND: Quantifying the spatial and socioeconomic variation of mortality burden attributable to particulate matters with aerodynamic diameter $\leq 2.5 \mu\text{m}$ (PM_{2.5}) has important implications for pollution control policy. This study aims to examine the regional and socioeconomic disparities in the mortality burden attributable to long-term exposure to ambient PM_{2.5} in China.

METHODS: METHODS: Using data of 296 cities across China from 2015 to 2019, we estimated all-cause mortality (people aged ≥ 30 years) attributable to the long-term exposure to ambient PM_{2.5} above the WHO air quality guideline (10 $\mu\text{g}/\text{m}^3$) with the AirQ+ software. Attributed fraction (AF), attributed deaths (AD), attributed mortality rate (AMR) and total value of statistical life lost (VSL) by regional and socioeconomic levels were reported.

RESULTS: RESULTS: Over the period of 2015-2019, 18.1% [95% confidence interval (CI): 12.3-23.1] of all-cause mortality for adults ≥ 30 years were attributable to long-term exposure to ambient PM_{2.5}, corresponding to 1540.8 thousand deaths (95% CI: 1050.1-1961.5), 180.5/105 (95% CI: 122.7-230.4) AMR, and 20.0 billion USD (95% CI: 15.8-24.3) total VSL per year. The highest mortality burden was observed in the central region (annual average AF = 24.5%, 95% CI: 16.8-30.9; annual average AMR = 236.1/105, 95% CI: 161.9-298.8). The highest AD and economic loss were observed in the east region (annual average AD = 416.0 thousand persons, 95% CI: 282.6-531.1; annual total VSL = 27.4 billion USD, 95% CI: 21.6-33.2). Highest AMR was in the cities with middle level of GDP per capita (PGDP)/urbanization. The majority of the top ten cities of AF and AMR were in low and middle PGDP/urbanization regions while top ten VSL in high PGDP/urbanization regions.

CONCLUSIONS: CONCLUSION: There were significant regional and socioeconomic disparities in PM_{2.5} attributed mortality burden among Chinese cities, suggesting differential mitigation policies should be needed for different regions in China.

Keywords: mortality burden, ambient PM_{2.5}, socioeconomic disparity, economic loss



ABSTRACT E-BOOK

P-720

Air pollution » Long-term exposure

Long-term air pollution exposure and metabolic syndrome prevalence: A longitudinal cohort study from the electricity generating authority of Thailand study

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BACKGROUND AND AIM: It has been reported that long-term exposure to air pollution is linked to metabolic syndrome (MetS), which is an important risk factor for cardiovascular diseases. However, no study has investigated the epidemiological association between long-term air pollution exposure and MetS in Southeast Asia. We examined the association between long-term exposure to air pollution and prevalence of MetS in workers of Electricity Generating Authority of Thailand (EGAT) in Bangkok metropolitan region, Thailand.

METHODS: The diagnosis of MetS was made based on the criteria defined by the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) that modified waist circumference cut-points for Asians. This study was based on 1,839 subjects of EGAT1 cohort study (2002-2012; mean age 58.3 years at the baseline). Blood tests were measured in 2002, 2007, and 2012. One-year average air pollution concentrations of particulate matter $\leq 10 \mu\text{m}$ in diameter (PM₁₀), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃), and carbon monoxide (CO) prior to the laboratory test was estimated using ordinary kriging method. We applied the logistic mixed effects models to calculate odds ratios (ORs) of the MetS prevalence per an interquartile range increase in air pollution.

RESULTS: After controlling for potential confounders, higher prevalence of MetS was significantly associated with increased PM₁₀ (ORs = 1.31, 95%CI: 1.1, 1.56) and CO (ORs = 1.2, 95%CI: 1.04, 1.38). Although not statistically significant, we also found the positive association between SO₂ and prevalent MetS (ORs = 1.26, 95%CI: 0.97, 1.64). In contrast, O₃ was inversely associated with prevalence of MetS (ORs = 0.59, 95%CI: 0.46, 0.76).

CONCLUSIONS: Long-term exposure to air pollutants, especially for PM₁₀ and CO were positively associated with prevalence of MetS in subjects of EGAT cohort study.



ABSTRACT E-BOOK

Keywords: Air pollution, long-term exposure, particulate matter, ozone, cardiovascular diseases

P-721

Air pollution » Particle components

Fetoplacental weight ratio in relation to PM2.5 exposure during the gestation in Tokyo, Japan

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BACKGROUND AND AIM: Some studies reported the association between particulate matter exposure during the gestation and placental weight. Because there is well correlation between placental weight and birth weight, it is no wonder that PM2.5 exposure was associated with placental weight as well as birth weight. However, we have little evidence whether PM2.5 exposure alters placental weight as a result of the disturbance of placental function. In this study, we examined the association of maternal exposure to PM2.5 and its components with placental weight and fetoplacental weight ratio that reflects placental function.

METHODS: We collected birth records from the Japan Perinatal Registry Network database, and included all women without missing information, who delivered singleton term births in 23 Tokyo wards from 2013 to 2015. Using fine particles that collected everyday at one monitoring station according to the Federal Reference Methods, we analysed the chemical constituents of PM2.5, including organic carbon, elemental carbon, and ions (nitrate, sulphate, ammonium, chloride, sodium, potassium, and calcium). We estimated exposure to each pollutant over the first (0-13 gestational weeks), second (14-27 weeks), and third (28-36 weeks) trimesters, and examined the exposure-outcome association using multilevel linear regression models.

RESULTS: We analysed 63,990 women (births) in this study. Total PM2.5 over the third trimester (mean concentration = 16.9 µg/m³) was not associated with placental weight, but the inverse association was observed for sulphate. Compared with the lowest quintile of sulphate concentrations, the adjusted differences of placental weight in the highest was -6.7g (95% CI = -12.5 to -0.9). No meaningful association was observed between PM2.5 and its components, and fetoplacental weight ratio.

CONCLUSIONS: In this study, exposure to sulphate, one of major PM2.5 components, over the third trimester reduced placental weight. Further studies are needed to elucidate whether PM2.5 exposure leads to placenta functional disturbance.



ABSTRACT E-BOOK

Keywords: Air pollution, Particulate matter, Particle components, Birth outcomes, Environmental epidemiology

P-722

Air pollution » Long-term exposure

Chronic PM_{2.5} Exposure, Habitual Exercise, and Dyslipidaemia: A Longitudinal Cohort Study

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BACKGROUND AND AIM: Physical activity may increase the intake of air pollutants due to higher ventilation, which may enhance the adverse health effects. This study investigated the combined effects of habitual exercise and long-term exposure to PM_{2.5} on the incidence of dyslipidaemia in a large longitudinal cohort in Taiwan.

METHODS: A total of 121,948 adults (≥18 years) with 407,821 medical examination records were recruited between 2001 and 2016. All participants received at least two medical examinations. Satellite-based spatiotemporal model was used to estimate 2-year average PM_{2.5} concentration at each participant's address. Information on habitual exercise was collected using a standard self-administered questionnaire. Cox regression model with time-dependent covariates was used to investigate the combined effects.

RESULTS: Compared to inactive exercise, moderate and high exercise were associated with a lower risk of dyslipidaemia [hazard ratios (HRs) (95% confidence intervals, CI) were 0.91 (0.88, 0.94) and 0.73 (0.71, 0.75), respectively]. In contrast, participants with moderate-/high-PM_{2.5} were associated with a higher risk of incident dyslipidaemia than those with low-PM_{2.5} [HR (95%CI) were 1.36 (1.32, 1.40) and 1.90 (1.81, 1.99)]. A minor interaction effect was observed [HR (95%CI) was 1.08 (1.05, 1.10)].

CONCLUSIONS: Increased levels of exercise and reduced PM_{2.5} exposures are associated with lower risks of incident dyslipidaemia. A minor interaction effect between exercise and PM_{2.5} was found in our study, but the beneficial effects of exercise remain in all levels of PM_{2.5} exposure. Our study suggests that habitual exercise is a safe approach for dyslipidaemia prevention even for people residing in relatively polluted areas.



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ABSTRACT E-BOOK

Keywords: Ambient PM2.5, habitual exercise, dyslipidaemia, longitudinal cohort, Taiwan



ABSTRACT E-BOOK

P-724

Air pollution » General

The association between Air Pollution and Kidney Function: results from the Korea National Health and Nutrition Examination Survey

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BACKGROUND AND AIM: The incidence and prevalence of CKD are increasing worldwide. Recent epidemiological studies have shown that air pollution also contributes the renal health, however few studies have demonstrated the differential effects of different types of air pollutants on renal function. In this study, we evaluated the association between air pollution exposure, deterioration of kidney function and CKD prevalence using the 7th Korean National Health and Nutrition Examination Survey (KNHANES) data.

METHODS: The KNHANES data (2016–2018) were used to estimate estimated glomerular filtration rate (eGFR) by the CKD–EPI equation and the CKD was defined as an eGFR of <60 mL/min/1.73 m². Air pollutants (PM_{2.5}, PM₁₀, SO₂, NO₂, CO, and O₃) were obtained from the AirKorea. Given the characteristic of this data (stratified, multistage, and cluster sampling design), all analyses were performed in a complex survey design. We conducted multivariate linear regression and logistic regression analysis to assess the association between air pollution exposure and kidney function after adjusting the covariates including gender, body mass index, education level, household income, smoking status, frequency of drinking, underlying diseases, and serum triglyceride.

RESULTS: A total of 15,308 adults aged 20 or older were included in the analyses. The exposure to PM_{2.5}, PM₁₀, NO₂ and CO was associated with lower eGFR (PM_{2.5}: -4.67, 95% CI: -6.16, -3.18; PM₁₀: -2.19, 95% CI: -2.84, -1.54; NO₂: -1.56, 95% CI: -2.16, -0.97; CO: -1.34, 95% CI: -1.96, -0.71). The prevalence of CKD was related to PM_{2.5} (OR: 1.97, 95% CI: 1.14, 3.42) and PM₁₀ (OR: 1.45, 95% CI: 1.10, 1.91). association.

CONCLUSIONS: Annual exposure to PM_{2.5}, PM₁₀, NO₂, and CO was associated with a higher risk of lower eGFR and prevalent CKD. A significant exposure-response association was observed between PM_{2.5}, PM₁₀, and CO exposure and low eGFR.

Keywords: Air pollution, Chronic kidney disease, Glomerular filtration rate, Republic of Korea



ABSTRACT E-BOOK

P-725

Air pollution » Long-term exposure

Association of long-term exposure to PM_{2.5} with cause-specific mortality in elderly patients with the previous history of ischemic heart disease

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BACKGROUND AND AIM: Numerous studies have reported an association between fine particulate matter (PM_{2.5}) and cardiovascular disease (CVD) morbidity and mortality. However, the association between PM_{2.5} and mortality among those with a previous history of ischemic heart disease (IHD) is less understood. We aimed to evaluate whether long-term exposure to PM_{2.5} is related to mortality after hospital discharge in elderly patients with IHD.

METHODS: We followed-up 306,418 IHD elderly patients residing in seven major cities between 2008 and 2016 using the Korean National Health Insurance Database and identified cause-specific mortality after the hospital admission. We linked the modelled PM_{2.5} data corresponding to each patient's administrative districts. We used time-varying Cox hazard models after adjusting for the individual- and area-level confounders. Subgroup analyses were conducted by age group (65–74 vs ≥ 75), sex, and income- and wealth-based insurance premiums.

RESULTS: Of a total of 306,418 IHD elderly patients, 43.1 (%) were male, mean age was 76.8 years, and 105,913 died during a mean follow-up of 21.4 years. The adjusted hazard ratio (HR) of all-cause mortality was 1.10 [95% confidence intervals (CI): 1.07, 1.14] per 10 µg/m³ increase in a 12-month moving average PM_{2.5}. The HRs were greater for cause-specific mortality: 1.17 (95% CI: 1.11, 1.24), 1.17 (95% CI: 1.06, 1.30), and 1.25 (95% CI: 1.15, 1.35) for CVD, stroke, and IHD, respectively. The subgroup analyses showed that for all-cause mortality, 65–74 age group, men, and low wealth-based insurance premiums were more susceptible to PM_{2.5} exposure.

CONCLUSIONS: We found an association between long-term exposure to PM_{2.5} and mortality among elderly IHD patients, particularly for CVD-related mortality. Our results suggest that those with a previous history of IHD were more susceptible to PM_{2.5} exposure.

Keywords: Cohort Studies, Ischemic heart disease, Mortality, Particulate matter, Republic of Korea



ABSTRACT E-BOOK

P-728

Air pollution » Long-term exposure

Mediation Effect of Folate on the Effect of Particulate matter and Anemia Indicators: KoCHENS-MOM study

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BACKGROUND AND AIM: Housewives do a lot of house chores such as cleaning and laundry, so they are directly exposed to indoor particulate matter (PM). Indoor PM exposure is a potential factor that increases systemic inflammation and affects erythropoiesis. This study aimed to investigate the association between indoor PM exposure and anemia indicators (hemoglobin, MCV, MCH, MCHC) in housewives. We also examined the indirect effect of indoor PM exposure on indicators of anemia mediated by folate.

METHODS: In our housewife cohort study, we recruited a total of 284 housewives (from 2017 to 2021) in Seoul and Ulsan, Republic of Korea. We used indoor PM_{2.5} and PM₁₀ data measured by the gravimetric and sensor method, as well as blood test results, including folate and anemia indicators such as hemoglobin, MCV, MCH, and MCHC. Multiple linear regression was performed to evaluate the association between indoor PM exposure and anemia indicators. Mediation analysis was used to examine the indirect effect of indoor PM exposure on indicators of anemia mediated by folate.

RESULTS: The increase in the level of indoor PM_{2.5} was associated with a decrease in Hemoglobin (B: -0.029, SE: 0.012, P<0.001), Hematocrit (B: -0.089, SE: 0.038, P<0.001), MCV (B: -0.14, SE: 0.047, P<0.001) and MCH (B: -0.047, SE: 0.016, P<0.001). Mediation analysis confirmed protective mediating effect of folate (p>0.001) on indoor PM affecting anemia indicators.

CONCLUSIONS: The indoor PM exposure was significantly associated with the decrease of hemoglobin, MCV, MCH, and MCHC in housewives. These associations suggest that exposure to indoor PM is a risk factor of anemia in housewives. Therefore, indoor PM exposure should be managed to prevent anemia in the housewives. In addition, this study shows that folate can be used for prevention at the individual level to control and complement the potential pathways of PM_{2.5}-induced oxidative stress.

Keywords: Mediation Effect, Folate, PM_{2.5}, Anemia, Housewives, KoCHENS



ABSTRACT E-BOOK

P-729

Air pollution » Long-term exposure

Associations of long-term PM₁₀ exposure with cardiovascular mortality and morbidity in South Korea: investigating the regional heterogeneity

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BACKGROUND AND AIM: Long-term exposure to ambient PM has long been linked to cardiovascular diseases. However, fewer studies have investigated non-fatal outcomes, especially in Asian regions, and little is known whether long-term health effects of PM are identical across the country. This study aimed to estimate the effects of long-term PM₁₀ exposure on cardiovascular disease incidence and death in South Korea. We further examined effect modification by regional characteristics.

METHODS: The study population comprised 317,204 subjects from the National Health Insurance Service-National Sample Cohort (2006-2015) residing in 120 districts where urban air monitoring stations are located. Incidence of cardiovascular disease was defined as the first occurrence of a hospital visit or admission among those with no previous history of cardiovascular disease. For each year of follow-up, we estimated a five-year moving window of past exposure to PM₁₀ for each subject at the district-level. Time-varying Cox proportional hazards models were used to assessing the relationship between PM₁₀ and cardiovascular events. We conducted stratification analyses to explore effect modifications by metropolitan city indicator, district-level socioeconomic status indicators, and medical index.

RESULTS: Each 10 µg/m³ increase in PM₁₀ was associated with increased risk of both cardiovascular morbidity (hazard ratio, HR, 1.04; 95% CI, 1.02-1.07) and mortality (HR, 1.14; 95% CI, 1.03, 1.26). Subgroup analyses yielded competing results between cardiovascular mortality and morbidity. Effect estimate for cardiovascular morbidity was higher in the non-metropolitan area while the association with cardiovascular morbidity was higher in the metropolitan area. Districts with lower socioeconomic status had a larger increase in the risk of morbidity and had a lower increase in the risk of mortality

CONCLUSIONS: This study supports the evidence that PM₁₀ has long-term effects on cardiovascular health in South Korea. Regional vulnerability to PM₁₀ might differ by the severity of the health outcome.

Keywords: Particulate matter, Long-term exposure, Cardiovascular diseases, Environmental justice, Environmental epidemiology



ABSTRACT E-BOOK

P-730

Air pollution » Particle components

Associations of PM_{2.5} components with urban characteristics and mortality in South Korea

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BACKGROUND AND AIM: Fine particulate matter (PM_{2.5}) is a mixture of many chemical materials including carbon, ions, and trace elements. Although information on which components of PM_{2.5} is most harmful and associated with certain disease has gained increasing attention, few studies have investigated the association of the components with health in South Korea because of the limited access to components data. Therefore, we aim to investigate the associations of PM_{2.5} components with district level urban characteristics and non-external, respiratory, and cardiovascular mortality rate.

METHODS: Air pollution data from the National Institute of Environmental Research for the year 2019 was consisted of annual mean concentration of PM_{2.5}, cation, anion, organic carbon (OC), elemental carbon (EC), crust metal, and trace metal and measured at 38 monitor stations nationwide. The study area was selected in accordance with the regions where monitor stations are located. We used multivariable linear regression to evaluate association of the components ratio with district level variables including population density, park/city area ratio, basic livelihood security recipient ratio, smoking, and walking. Further, the associations of the components concentration with age-standardized non-external, respiratory, and cardiovascular mortality were analyzed using overdispersed-poisson regression analysis. Adjustments were made for sex and urban characteristics.

RESULTS: The 1 person/km² increase in population density was associated with 0.2% increase in anion ratio (p-value = 0.02). Basic livelihood security recipient had positive but statistically non-significant association with increase in OC ratio. Park/city area ratio had adverse association with increase in cation and anion ratio but it was also statistically non-significant. In addition, increased OC concentration and cation had positive association with respiratory mortality. We did not observe significant associations with non-external and cardiovascular mortality.

CONCLUSIONS: To our knowledge, this is first study using nationwide components data of PM_{2.5}. Further studies with larger data are required to provide robust evidence.

Keywords: Particle components, Mixtures, respiratory outcomes, Environmental epidemiology.



ABSTRACT E-BOOK

P-732

Air pollution » Oxides of nitrogen

Long-term exposure to nitrogen dioxide and mortality: A prospective cohort study in urban and rural regions of China

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BACKGROUND AND AIM: Several epidemiology studies found nitrogen dioxide (NO₂) to be linked to increased mortality. We aim to better understand the concentration-response relationship between NO₂ and mortality in China.

METHODS: We used Chinese Longitudinal Healthy Longevity Study (CLHLS) data. The participants were enrolled in 2008 or 2009 and followed up to 2019 roughly every two years. We obtained annual nitrogen dioxide (NO₂) concentration at 1km spatial resolution using a previously validated model. We used Cox proportional hazards model to examine the association between one-five years average NO₂ exposure and all-cause mortality, adjusted for demographics and lifestyle factors. We used the restricted cubic spline to describe the concentration-response relationship. Possible effect modifiers were tested.

RESULTS: Our study included 13,398 individuals. We had 62,524 person-year follow-ups and 9309 mortality events. The average exposure of NO₂ in the mortality year was 9.81 ppb (SD:7.29), which was higher in urban, northern and eastern regions of China. Higher NO₂ was associated with higher risk for mortality, and HR (95% CI) for per ppb increase were 1.012 (1.009, 1.015), 1.008 (1.005, 1.011), 1.004 (1.001, 1.007), 1.004 (1, 1.007), and 1.004 (1.001, 1.008) for one to five years average NO₂ respectively. Compared to the lowest quartile of mortality year average NO₂, higher quartiles had higher risk for mortality [HR (95% CI): 1.03 (0.971, 1.093) for quartile 2; 1.223 (1.155, 1.296) for quartile 3; 1.319 (1.24, 1.404) for quartile 4]. The spline fit for NO₂ was supralinear, which indicated that marginal changes in risk was larger for low concentrations compared with higher values. We also found the effect of NO₂ was stronger in rural areas, younger participants, and those with less education.

CONCLUSIONS: We found an association that higher NO₂ exposure is associated with higher mortality. The association was stronger within lower range concentrations and rural areas.

Keywords: NO₂, nitric oxide, traffic, mortality, longevity, China



ABSTRACT E-BOOK

P-733

Air pollution » Ozone

The effect of ambient ozone on glucose-homeostasis: A prospective study of non-diabetic older adults in Beijing

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BACKGROUND AND AIM: Limited evidence on O₃ and glucose association among older, non-diabetic adults. To investigate potential effects of short- and medium-term exposure to low levels of ozone (O₃) on glucose-homeostasis in non-diabetic older adults.

METHODS: 166 non-diabetic, older participants in Beijing were deemed eligible to partake in this longitudinal population-based study. Observations were recorded on three separate occasions from November 2016 up until January 2018. Concentrations of outdoor O₃ were monitored throughout the study period. Biomarkers indicative of glucose-homeostasis, including fasting blood glucose, insulin, HbA_{1c}, glycated albumin percentage (glycated albumin/albumin), HOMA-IR and HOMA-B were measured at 3 sessions. A linear mixed effects model with random effects was adopted to quantify the effect of O₃ across a comprehensive set of glucose-homeostasis markers.

RESULTS: Short-term O₃ exposure positively associated with increased fasting blood glucose, insulin, HOMA-IR and HOMA-B. The effect on glucose occurred at 3-, 5-, 6- and 7-days, although the largest effect manifested on 6-days (5.6%, 95%CI: 1.4, 9.9). Significant associations with both insulin and HOMA-IR were observed on the 3- and 4-days. For HOMA-B, positive associations were identified from 3- to 7-days with estimates ranging from 40.0% (95%CI: 2.3, 91.5) to 83.1% (95%CI: 25.3, 167.5). Stratification suggests that women may be more susceptible to short-term O₃ exposure. There does not appear to be a significant association between O₃ and glucose-homeostasis in medium-term exposures.

CONCLUSIONS: In this study, we found that O₃ exposure is at least partially associated with type II diabetes in older adults with no prior history of this condition. O₃ therefore appears to be a potential risk factor, which is a particular concern when we consider the rise in global concentrations. Evidence also suggests that women may be more susceptible to short-term O₃ exposure although we are not quite sure why. Future research may look to investigate this phenomenon further.

Keywords: Glucose homeostasis, Glucose metabolism disorder, Longitudinal study, O₃



ABSTRACT E-BOOK

P-734

Air pollution » Particulate matter

Mortality burden due to long-term exposure to PM2.5 in Hanoi, Vietnam

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BACKGROUND AND AIM: Particulate matter with diameter less than 2.5µm (PM2.5) ranks the fourth in top main factors of Vietnam Burden of diseases This study quantifies the mortality burden due to PM2.5 for residents of Hanoi, Vietnam in 2017 using local air pollution, population and mortality incidence data and the Global Exposure Mortality Model (GEMM) risk function

METHODS: PM2.5 concentrations at 3X3 km grid resolution were estimated using measured and modelled data sources. We estimated the annual premature mortality burden due to PM2.5 exposure above background concentration (defined as 22µg/m³, which was the lowest value measured in a Hanoi district in 2017), the WHO recommended values (10µg/m³) and Vietnam National Standard (25µg/m³).

RESULTS: The PM2.5 value in Hanoi ranged from 22.1 µg/m³ to 37.2 µg/m³. The annual PM2.5 concentrations were lower in suburban districts. PM2.5 above the lowest measured background concentration results in 3,205 (95%CI: 2,649-3,748) premature death per year in Hanoi. There was substantial variability in the mortality burden between districts in Hanoi; ranging from 25.6 to 66.0 per 100,000 population. Using the WHO air pollution guideline as the reference value led to an estimate of 4760 additional deaths (95%CI: 3,958-5,534) per year. When measured above with the Vietnam Ambient National Standard as a reference, of PM2.5 led to an estimate of 2,696 additional deaths per year (95%CI: 2,225-3,158) attributable to excess

CONCLUSIONS: A substantial number of premature deaths in Hanoi could be avoided by reducing air pollution concentrations in the city. The variation of mortality burden by district within the city indicates the importance of local authorities in the air quality control in Hanoi. The study also suggests control strategies urgently need to be implemented to reduce air pollution to achieve the Capital cities title of “sustainable and liveable”

Keywords: Particulate matter, mortality, Long-term exposure



ABSTRACT E-BOOK

P-735

Air pollution » Oxides of nitroge

High spatial-temporal resolution land use regression models for ambient NO and NO₂ concentrations in Accra Metropolis, Ghana

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BACKGROUND AND AIM: Increasing urban expansion and economic growth along with downward trend in household biomass use in sub-Saharan Africa (SSA) is shifting the dominant air pollution sources in cities from biomass to road traffic, with nitrogen oxides (NO_x = NO + NO₂) concentrations expected to be doubled by 2030 compared to 2012. Yet, there is scarcity of data on the spatial patterns and community distribution of NO_x pollution in growing SSA cities.

METHODS: In a measurement campaign between April 2019 to June 2020, we collected weekly integrated NO_x and NO₂ samples at 134 locations, consisting of yearlong and weeklong measurement sites across the Greater Accra Metropolitan Area (GAMA). The data were combined with land use and meteorological variables, providing both spatial and temporal information, to develop mixed-effect land use regression models (LUR) to predict NO and NO₂ concentrations at 50m × 50 m resolution across the GAMA. Stepwise forward approach was used to select the final models for the prediction.

RESULTS: Our final models explained 80% and 88% of the variances (R²) in NO and NO₂, respectively. The root-mean-square error (RMSE) and mean absolute error (MAE) following a 10-fold cross validation was 20.1 and 15.1 µg/m³ for NO, and 14.1 and 10.6 µg/m³ for NO₂. Road traffic and meteorological variables were the most dominant predictors for both NO and NO₂ models.

CONCLUSIONS: Most of previous LUR models used solely spatial predictors and could only model annual concentrations for air pollutants. Our spatial-temporal integrated LUR models have really good performance for weekly NO and NO_x concentrations with high spatial resolution. These models could provide high-resolution population exposure estimates of NO and NO₂ for future study.

Keywords: nitrogen oxides, sub-Saharan Africa, traffic pollution, population exposure



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