

#ISEE2021

33rd Annual Conference of the International Society for Environmental Epidemiology

Promoting Environmental
Health and Equity in
a Shifting Climate



August 23-26, 2021

Abstracts'
E-Book



Local Academic Host:
Columbia University
Mailman School of Public
Health, New York, US





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ABSTRACT E-BOOK

SESSION ABSTRACTS

Keynote Sessions
Traditional Oral Sessions
Pecha Kucha Session
Lightning Talk Sessions
Symposia



ABSTRACT E-BOOK

August 23, 2021 / 09:30 - 11:00 / Statue of Liberty Hall (Hall 1)

KEYNOTE SESSION 1

Chairs: Joan Casey, United States & Marianthi-Anna Kioumourtzoglou, United States

When epidemiology meets climate science: new paths to address current and future challenges in climate change research

Keynote Speaker: Ana Maria Vicedo-Cabrera, Head of Climate Change and Health Research Group, Institute of Social and Preventive Medicine (ISPM), Switzerland

Climate change is the defining public health challenge of the century. Its impacts are already visible, and current evidence agrees that these will amplify as warming progresses. The scientific community has come together to work against the clock and fight this global threat. As epidemiologists our contribution is crucial - not only to understand the mechanisms and the magnitude and extension of the health impacts but also to furnish policymakers with scientifically grounded evidence on solutions to protect the population. Despite years of tremendous advancements in climate change research, still important gaps remain, and new approaches to address them have been proposed. In this regard, interdisciplinary collaborations between experts in the field have been seen as the key element. This constitutes an excellent opportunity for epidemiologists to be at the forefront of the research experts in this field, learn from other disciplines and open new research lines on the health impacts of climate change. This keynote presentation will aim to provide an overview of how epidemiology has contributed so far to and what are the main challenges ahead and give examples of fruitful collaborations with experts from other fields in climate change research.



ABSTRACT E-BOOK

August 23, 2021 / 09:30 - 11:00 / Statue of Liberty Hall (Hall 1)

KEYNOTE SESSION 1

Chairs: Joan Casey, United States & Marianthi-Anna Kioumourtzoglou, United States

Advancing Environmental Epidemiology through Data Science Innovations: Current State and Future Challenges

Keynote Speaker: Kiros Berhane, PhD, Cynthia and Robert Citron-Roslyn and Leslie Goldstein
Professor Chair, Department of Biostatistics, Mailman School of Public Health, Columbia University,
New York, NY, United States

Research in environmental epidemiology has motivated ground-breaking and innovative work towards development of new biostatistical modeling and analytical techniques, and has been in-turn influenced by the new biostatistical innovations. We start with an overview of these synergistic developments by focusing on key concepts and notable examples - with focus on new developments around study design, analysis of data with complex multi-level structures, as well as recurrent issues such as exposure measurement error, health effects of exposure mixtures and dealing with multiple, potentially high-dimensional, health outcomes. This will be followed by discussion on new opportunities and challenges for both methods development and epidemiologic applications necessitated by the new era of big data and emerging environmental challenges (e.g., increasing importance of climate change on human health). Here, we will focus on recent innovations in data science techniques, the need for enhanced inter-disciplinary collaborations, key issues that need to be taken into consideration (including those related to ethics, equity and algorithmic fairness), as well as needs for training and capacity building. We conclude by outlining areas for future research in the development and application of data science in environmental epidemiology.



ABSTRACT E-BOOK

August 24, 2021 / 09:30 - 11:00 / Statue of Liberty Hall (Hall 1)

KEYNOTE SESSION 2

Chairs: Chang-Chuan Chan, Taiwan, Andrea Baccarelli, United States

COVID-19 Containment and Reform for Health and Development Resilience: Taiwan Experiences

Keynote Speaker: Chein-Jen Chen, Sc.D., Ph.D., Academician and Distinguished Research Fellow
Genomics Research Center, Academia Sinica, Taiwan

Emerging infectious diseases threaten human health and sustainable development significantly. The catastrophic COVID-19 pandemic originated from Wuhan, China in December 2019 is a good example. There are two phases in the containment of COVID-19 pandemic: the interruption of viral transmission and the mass immunization. Taiwan is one of few countries with lowest COVID-19 mortality and positive GDP growth in the first phase of COVID-19 containment (from December 2019 to November 2020). Taiwan's success was based on experiences of combating pandemics of SARS in 2002-2003, avian H5N1 influenza in 2006-2008, and new H1N1 influenza in 2009-2010. Key elements of Taiwan's epidemic prevention are prudent action, rapid response, early deployment, transparency, and public trust. The strategies for interrupting viral transmission include (1) stringent border control and quarantine, (2) complete reporting and testing of suspected cases, (3) mobilization of healthcare facilities for isolation and treatment of confirmed cases, (4) strengthening infection control in hospitals and nursing homes, (5) careful tracing and isolation of close contacts of confirmed cases and inbound passengers from epidemic areas, (6) mass production and name-based distribution of face masks and other PPEs, and (7) promotion of personal hygiene practice including hand washing, face mask wearing, social distancing, and avoidance of large gathering. In the second phase of COVID-19 containment (from December 2020 till now), Taiwan was severely affected by the vaccine unavailability and the highly infectious new variant B.1.1.7. The current outbreak resulted in over 10,000 confirmed cases and over 300 deaths after May 1, 2021. Level 3 alert was announced on May 15 and schools were closed, and daily confirmed cases reduced from 500-600 in May to 200-300 in June. One health is the theme of the reform for health and development resilience. The promotion of human, animal and environment health is the key to prevent and contain emerging infectious diseases and to reach the sustainable development goals in the future.



ABSTRACT E-BOOK

August 24, 2021 / 09:30 - 11:00 / Statue of Liberty Hall (Hall 1)

KEYNOTE SESSION 2

Chairs: Chang-Chuan Chan, Taiwan, Andrea Baccarelli, United States

Omics in Environmental Epidemiology

Keynote Speaker: Dr. Cavin Ward-Caviness, US Environmental Protection Agency, United States

The rapid advancement of high-throughput molecular assessment technologies has ushered in a new frontier in studying the links between the environment, molecular markers, and health. From metabolomics, to epigenetics, to high throughout genotyping/sequencing, virtually every molecular feature can be examined for a variety of interactions with environmental health. This explosion of data has ushered in the need for new statistical techniques, study designs, and means to interpret vast amounts of analytic results. These data also offer new opportunities to understand mechanisms, develop biomarkers of environmental exposures, uncover early-stage indicators of health risks, and foster deeper integration between human cohort studies and in vivo / in vitro experiments. This talk will explore the current states of utilizing 'omics data to power novel environmental health studies, the current needs and challenges brought on by this data, and novel studies that may allow 'omics to power the next stages of environmental health research. It will lay out some of the insights that 'omics has brought us into the early stage actions and long-term risks of environmental exposures. It will also touch on the potential for environmental 'omics to play a major role in the emerging field of precision/personalized medicine and what steps we might need to take to get there.



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ABSTRACT E-BOOK

August 25, 2021 / 09:30 - 11:00 / Statue of Liberty Hall (Hall 1)

KEYNOTE SESSION 3

Slow Violence: Place, Race, and Local Environmental Inequity

Chairs: Devon Corcia Payne-Sturges, United States & Margaret Hicken, United States

In Pursuit of Environmental and Climate Justice

Keynote Speaker: Catherine Coleman Flowers, American environmental health researcher, writer and the founder of the Center for Rural Enterprise and Environmental Justice, Center For Rural Enterprise And Environmental Justice, United States

Sanitation inequity is found more commonly in marginalized communities, often part of systemic racism, ethnic or class discrimination. A northern and southern community will be presented as case studies about sanitation equity. Both communities are largely inhabited by people of color and each exemplify how climate change has made the inequities more glaring. It is also a warning about how not pursuing climate-friendly infrastructure for everyone will create even more health challenges through disease and preventable death for the nation and world.



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ABSTRACT E-BOOK

August 25, 2021 / 09:30 - 11:00 / Statue of Liberty Hall (Hall 1)

KEYNOTE SESSION 3

Slow Violence: Place, Race, and Local Environmental Inequity

Chairs: Devon Corcia Payne-Sturges, United States & Margaret Hicken, United States

Critical Infrastructures and the Fight for Environmental Justice

Keynote Speaker: Danielle Purifoy, JD, PHD, The University of North Carolina, Department of Geography, United States

Access to basic infrastructures has been a neglected facet of environmental racism scholarship and organizing in the United States, which has mostly centered around the siting of toxic industries and pollution, rather than the absence of basic services. However, the recent rise in attention to the the lack of basic sanitation and clean water in many communities of color and poor communities, which are also saddled with disproportionately degraded environments has made the connections more legible. This talk will make the case for why critical infrastructures are intimately linked to environmental racism, what political and legal practices recreate the problem, and how communities fight for access.



ABSTRACT E-BOOK

August 26, 2021 / 09:30 - 11:00 / Statue of Liberty Hall (Hall 1)

KEYNOTE SESSION 4

Chairs: Beate Ritz, United States & Joel Kaufman, United States

Breaking the impasse in pesticide and health research risk reduction effectiveness in Africa

Keynote Speaker: Hanna-Andrea Rother, Division of Environmental Health, School of Public Health and Family Medicine, University of Cape Town, South Africa

Over the past 30 years extensive research has highlighted that different pesticides cause, or potentially cause, acute and chronic health effects. This research has also shown the exposure risks and contextual challenges that need to be addressed to reduce and prevent health risks, particularly for vulnerable populations in Africa. Despite this, pesticide poisonings and pesticide-related illnesses continue. We are at an impasse and need to ask why. Why do African vulnerable populations – that is, farm workers, women, children, people who are health compromised, or people living in poverty – continue to be poisoned and made ill by pesticides? What can we as researchers do differently? How can we break this impasse as a collective of researchers and academics? The answer is multifaceted and complex. My lecture, however, will provide some food for thought on how we as a member of ISEE, members of various institutions and as individual researchers can collectively have an impact on reducing pesticide poisoning and pesticide-related illnesses in Africa, as well as in other countries. In my presentation, I share some of the key issues and challenges in Africa drawing on my research and policy work in South Africa, in the Southern African region and internationally. Furthermore, I highlight opportunities for making contributions to current global actions on managing, reducing and preventing pesticide related health risks. I have identified four areas that play a significant role, especially in Africa, in perpetuating pesticide poisonings and disease burden. These are, compromising pesticide use contexts, existing legislative quagmires (focusing on illegal pesticides and a lack of data transparency), corporate capture and the lack of end-users right-to-comprehend risk information being actioned. I will briefly touch on each of these and provide some of my thoughts on how we, as a community of researchers, can start to shift this current impasse in pesticide risk reduction and prevention effectiveness.

Keywords: pesticides, risk assessment, environmental disparities, environmental justice, occupational exposures



ABSTRACT E-BOOK

August 26, 2021 / 09:30 - 11:00 / Statue of Liberty Hall (Hall 1)

KEYNOTE SESSION 4

Chairs: Beate Ritz, United States & Joel Kaufman, United States

Impacts of Developmental Exposure to Environmental Chemicals on Human Health: The Hokkaido Birth Cohort Study with Global Perspectives

Keynote Speaker: Reiko Kishi, MD., PhD., MPH. (ISEE John Goldsmith Awardee), Hokkaido University, Center for Environmental and Health Sciences in Sapporo, Japan

The Hokkaido Study on Environment and Children's Health is an ongoing study consisting of two birth cohorts of different population sizes: the Sapporo cohort and the Hokkaido cohort. Our primary objectives are to (1) examine the effects that low-level environmental chemical exposures have on birth outcomes, including congenital malformation and growth retardation; (2) follow the development of allergies, infectious diseases, and neurobehavioral developmental disorders, as well as perform a longitudinal observation of child development; (3) identify high-risk groups based on genetic susceptibility to environmental chemicals; and (4) identify the additive effects of various chemicals, including tobacco. The purpose of my speech is to provide an update on the progress of the Hokkaido Study, summarize recent results, and suggest future directions.

The latest findings indicate different risk factors of parental characteristics on birth outcomes and the mediating effect between socioeconomic status and children that are small for the gestational age. Maternal serum folate was not associated with birth defects. Prenatal chemical exposure and smoking were associated with birth size and growth, as well as cord blood biomarkers, such as adiponectin, thyroid, and reproductive hormones. We also found significant associations between the chemical levels and neuro development, asthma, and allergies.

Longer follow-up for children is crucial in birth cohort studies to reinforce the Developmental Origins of the Health and Disease hypothesis. In contrast, considering shifts in the exposure levels due to regulation is also essential, which may also change the association to health outcomes. Our study found that individual susceptibility to adverse health effects depends on the genotype. Epigenome modification of DNA methylation was also discovered, indicating the necessity of examining molecular biology perspectives. International collaborations can add a new dimension to the current knowledge and provide novel discoveries in the future.

Keywords: Early life, Environmental chemicals, Development, Allergies and infections, Genetic polymorphisms, Epigenetics



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 1

Air Pollution and Cardiometabolic Health

Chairs: Barbara Hoffman, Germany & Laura Corlin, United States

O-TO-001

Outcomes » Cardiovascular diseases

Long-term air pollution exposure and sex-specific cardiometabolic health trajectories: the Framingham Offspring Study

Laura Corlin¹, Mengyuan Ruan², Vanessa Xanthakis³, Nikhil Nath², Helen Suh⁴, Ramachandran S Vasan⁵

¹Department of Public Health and Community Medicine, Tufts University School of Medicine, Boston, MA, USA; Department of Civil and Environmental Engineering, Tufts University School of Engineering, Medford, MA, USA

²Department of Public Health and Community Medicine, Tufts University School of Medicine, Boston, MA, USA

³Section of Preventive Medicine and Epidemiology, Department of Medicine, Boston University School of Medicine, Boston, MA, USA; National Heart, Lung, and Blood Institute, Framingham Heart Study, Framingham, MA, USA; Department of Biostatistics, Boston University School of Public Health, Boston, MA, USA

⁴Department of Civil and Environmental Engineering, Tufts University School of Engineering, Medford, MA, USA

⁵Section of Preventive Medicine and Epidemiology, Department of Medicine, Boston University School of Medicine, Boston, MA, USA; National Heart, Lung, and Blood Institute, Framingham Heart Study, Framingham, MA, USA; Department of Epidemiology, Boston University School of Public Health, Boston, MA, USA

BACKGROUND AND AIM: We assessed whether annual average particulate matter (PM_{2.5}) exposure modified sex-specific cardiometabolic health (CMH) trajectories.

METHODS: We evaluated 3113 Framingham Offspring Study participants by classifying their CMH at each of nine examination cycles (1971-2014) into six categories: (1) cardiometabolically healthy and no cardiometabolic medications, (2) 1-2 sub-clinical risk factors (body mass index ≥ 25 kg/m², waist circumference ≥ 102 cm in men/ ≥ 88 in women, total cholesterol ≥ 200 mg/dL, low-density lipoprotein ≥ 130 mg/dL, high-density lipoprotein < 40 mg/dL in men/ < 50 in women, triglycerides ≥ 150 mg/dL, systolic blood pressure ≥ 120 mmHg, diastolic blood pressure ≥ 80 mmHg, fasting plasma glucose ≥ 100 mg/dL), (3) 3-4 sub-clinical risk factors, (4) one of hypertension, diabetes, or chronic kidney disease, (5) clinical cardiovascular disease or ≥ 2 cardiometabolic diagnoses from category four, and (6) cardiovascular-related mortality. Each participants' annual average PM_{2.5} exposure (in 2000) was previously assessed using a validated model. We calculated sex-specific CMH trajectories with age as the time scale. We determined the number and polynomial order of trajectory groups based on the Bayesian information criterion and an average posterior probability > 0.8 for each group. We identified trajectories based on average CMH status at age 35 years (good < 2 ; intermediate = 2-3; poor > 3) and trajectory slope through age 70 years (fast aging ≥ 2 average increase in group classification; medium = 1-2 average increase; slow ≤ 1 average increase).



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RESULTS: Men were more likely to have intermediate or poor CMH at age 35 years, but women were more likely to experience intermediate or fast aging between 35-70 years of age. PM_{2.5} exposure did not modify average CMH status at 35 years or trajectory slope for either men or women. Higher PM_{2.5} exposure was significantly associated with decreased likelihood of membership in the healthiest CMH trajectory group for both men and women.

CONCLUSIONS: Long-term PM_{2.5} exposure is associated with CMH trajectories throughout middle age.

Keywords: Cardiovascular diseases, Obesity and metabolic disorders, Particulate matter, Female



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 1

Air Pollution and Cardiometabolic Health

Chairs: Barbara Hoffman, Germany & Laura Corlin, United States

O-TO-002

Outcomes » Cardiovascular diseases

Association Between Long-Term Exposure to Ambient Air Pollution and Lesion Ischemia in Atherosclerotic Patients

Nadia Koyratty¹, Zhihui Hou², Conghong Huang¹, Bin Lu², Meng Wang¹

¹Department of Epidemiology and Environmental Health, University at Buffalo, Buffalo, NY, USA

²Department of Radiology, Fuwai Hospital, Chinese Academy of Medical Sciences, Beijing, China

BACKGROUND AND AIM: Air pollution has been associated with coronary artery diseases (CAD) worldwide. The underlying mechanisms are understudied, especially through the coronary stenosis pathway to induce myocardial ischemia. The advances of computed tomography (CT) allows novel quantifications on lesion ischemia. We aim to investigate associations between long-term exposure to air pollution and fractional flow reserve on CT (CT-FFR), a subclinical measure of blood flow limitation to gain insight into potential mechanism.

METHODS: CT-FFR, which defines a ratio of maximal myocardial blood flow compared to its normal value (range: 0-100%), was characterized in 1897 patients with atherosclerosis between 2015-2017 from a cohort study. Annual average exposure to air pollutants, including ozone (O₃), nitrogen dioxide (NO₂), and fine particulate matter (PM_{2.5}), was estimated by high-resolution spatiotemporal exposure model for individual participants. Linear regression models, controlling for potential confounders, were used to assess the association of each air pollutant with CT-FFR. Adjusted logistic regression models were used to estimate associations with prevalence of myocardial ischemia (CT-FFR <80%).

RESULTS: Participants were on average 60 years old with 62% males. Annual average O₃, NO₂, PM_{2.5} were 61, 47 and 60 µg/m³, respectively. Mean CT-FFR value was 77%. In the main analysis, higher level of O₃ exposure is associated with smaller CT-FFR value (-1.28%, 95% CI: -2.36, -0.19 per 8 µg/m³), adjusting for risk factors and plaque phenotypes, independent from the effects of exposure to NO₂ and PM_{2.5}. No associations were observed for PM_{2.5} nor for NO₂ with CT-FFR or for any exposure metrics with prevalence of myocardial ischemia.

CONCLUSIONS: Long-term exposure to O₃ is associated with lower CT-FFR value in atherosclerotic patient, indicating higher risk of lesion ischemia. The novel finding needs to be examined broadly among larger population at risk of CAD.

Keywords: Air pollution, Cardiovascular diseases, Environmental epidemiology, Outcomes



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 1

Air Pollution and Cardiometabolic Health

Chairs: Barbara Hoffman, Germany & Laura Corlin, United States

O-TO-003

Outcomes » Cardiovascular diseases

Habitual Physical Activity Is Associated with Reduced Risk of Cardiovascular Mortality Regardless of Ambient PM_{2.5} Exposure

Xiang Qian Lao, Yacong Bo, Cui Guo, Yiqian Zeng, Teresa Chan

Jockey Club School of Public Health and Primary Care, the Chinese University of Hong Kong, Hong Kong

BACKGROUND AND AIM: Increased inhalation and deposition of air pollutants during physical activity (PA) may attenuate the beneficial effects PA on cardiovascular disease. We thus examined the interaction between chronic exposure to fine particle matter (PM_{2.5}) and habitual PA in the association with Cardiovascular (CVD) mortality in Taiwan.

METHODS: We included a total of 384,128 adults (aged 18 years old or above) with 842,384 medical examinations from 2001 to 2016. All participants were followed up until May 31, 2019. The vital status were retrieved from the National Death Registry of Taiwan. The satellite-based spatiotemporal model was selected to estimate ambient PM_{2.5}. A standard self-administered questionnaire was used to evaluate the information of habitual PA. The Cox regression with time-dependent covariates was adopted to evaluate the interaction between chronic exposure to PM_{2.5} and habitual PA on CVD mortality.

RESULTS: The CVD mortality risk was positively associated with chronic exposure to PM_{2.5} and inversely associated with habitual PA. The inverse associations of habitual PA with CVD mortality were not modified by chronic exposure to PM_{2.5}. Compared to individuals with inactive-low-PA and high-PM_{2.5}, those with high-PA and low-PM_{2.5} exhibited a 60% lower risk of cardiovascular mortality [95% confidence interval (CI): 52%-67%].

CONCLUSIONS: Increased PA and reduced PM_{2.5} exposure are associated with lower risk of CVD mortality. Exposure to high levels of PM_{2.5} did not modify the benefits of habitual PA on CVD mortality.

Keywords: Particulate matter, Long-term exposure, cardiovascular mortality



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August 23, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 1

Air Pollution and Cardiometabolic Health

Chairs: Barbara Hoffman, Germany & Laura Corlin, United States

O-TO-004

Outcomes » Obesity and metabolic disorders

Long-term exposure to ambient PM_{2.5} leads to increased risk of Type 2 diabetes in urban Delhi and Chennai, India

Siddhartha Mandal¹, Suganthi Jaganathan², Dimple Kondal², Joel D Schwartz³, Nikhil Tandon⁴,
Viswanathan Mohan⁵, Dorairaj Prabhakaran¹, Km Venkat Narayan⁶

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⁵Madras Diabetes Research Foundation (MDRF), Chennai, India

⁶Rollins School of Public Health, Emory University, Atlanta, USA

BACKGROUND AND AIM: India has high levels of ambient air pollution and a high burden of cardiometabolic disease. However, there is a lack of detailed exposure assessment and longitudinal studies on health impacts of ambient PM_{2.5}. We studied the association between ambient PM_{2.5} with fasting plasma glucose (FPG), glycosylated haemoglobin (HbA1c) and incident Type 2 diabetes mellitus (T2DM) in the CARRS cohort (n=12066) in Delhi and Chennai, India, over 7 years of follow-up (median years of follow-up = 4.84 years).

METHODS: Long-term exposure to PM_{2.5} was measured using daily predictions from a hybrid ensemble averaging based model. FPG and HbA1c were assessed at three time points, and T2DM was defined as FPG≥126mg/dl, or HbA1c≥6.5%, or self reported physician diagnosed diabetes, or being on medication for diabetes. Associations between PM_{2.5} and glycemic markers were assessed using longitudinal mixed effects models while incident T2DM was analyzed using Cox proportional hazard models.

RESULTS: Median annual exposure at baseline was 41.14 µg/m³ (interquartile range, 38.70-43.35) and 92.08 µg/m³ (interquartile range, 87.60-95.74), in Chennai and Delhi respectively. For interquartile range(IQR) increase in annual exposures, we observed 2.54 mg/dL(95% CI:1.36-3.72) and 3.56 mg/dL(95% CI:1.16-5.96) increase in FPG at Chennai and Delhi respectively, after adjusting for covariates. The IQR differences in 2 years of exposure increased the risk of incident T2DM by 1.11(95% CI:1.03-1.19) times in Delhi and by 1.24(95% CI: 1.02-1.50) times in Chennai. Using a propensity score analysis, marginal hazard ratios for IQR change in 1 year, 1.5 years and 2 years of exposure were 4.1(95% CI:1.5-11.2), 5.6(95% CI:2.5-12.5) and 6.1(95% CI:2.5-14.8), indicating a dose-response rise in risk with continued long-term exposure.

CONCLUSIONS: Our findings demonstrated the effect of a wide range of PM_{2.5} exposure on the risk of Type 2 diabetes, thus emphasizing the need to mitigate ambient air pollution for health benefits.

Keywords: Particulate matter, Long-term exposure, Obesity and metabolic disorders, Environmental epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 1

Air Pollution and Cardiometabolic Health

Chairs: Barbara Hoffman, Germany & Laura Corlin, United States

O-TO-005

Air pollution » Short-term exposure

Short-term joint effects of multiple air pollutants on cardio-respiratory disease hospital admissions in Cape Town, 2011 – 2016

Temitope Christina Adebayo Ojo¹, Janine Wichmann³, Oluwaseyi Olalekan Arowosegbe², Nicole Probst Hensch¹, Christian Schindler¹, Nino Kuenzli¹

¹Swiss Tropical and Public Health Institute, Basel, Switzerland

²University of Basel, Basel, Switzerland

³University of Pretoria, Pretoria, South Africa

BACKGROUND AND AIM: There is limited understanding on the short-term association between hospital admissions and ambient air pollution in sub-Saharan African countries. Therefore, this study investigated the short-term association of air pollution with daily counts of hospital admissions due to respiratory and cardiovascular diseases in Cape Town, South Africa.

METHODS: Generalized additive quasi-Poisson models were used within a distributed lag linear modelling framework to estimate the cumulative effects of PM₁₀, NO₂ and SO₂ up to a lag of 14 days. We further conducted multi-pollutant models and stratified our analysis by age group, sex and season.

RESULTS: The relative risk (95% confidence interval (CI)) for PM₁₀, NO₂ and SO₂ for all ages, both sexes, and seasons, at lag 0 – 1 for hospital admissions due to respiratory disease (RD) were 3.5% (1.8 – 5.2%), 3.2% (1.0 – 5.5%), 1.8% (0 – 3.6%), respectively. In cardiovascular disease (CVD), 2.2% (0.3% – 4%), 1.8% (-0.6% – 4.3%) and -0.5% (-2.3% – 1.3%), respectively, per inter-quartile range increase of 12 µg/m³ for PM₁₀, 7.3 µg/m³ for NO₂ and 3.6 µg/m³ for SO₂. In multi-pollutant models, PM₁₀ for associations RD remained significant despite some attenuation. The overall cumulative risk per IQR increase in PM₁₀ for females of all ages was 2.7% (-0.2% – 5.6%), 2.9% (0.1% – 5.9%) for males and 6.8% (2.6% – 11.2%) for aged ≥ 65. However, in CVD the association were not significant for all the pollutants, the overall effect estimate for all ages and sexes were 1.4% (-0.8% – 3.7%), 1.4% (-1.4% – 4.3%) and -1% (-2.9% – 1%) for PM₁₀, NO₂ and SO₂ in three-pollutant models.

CONCLUSIONS: We found robust associations of daily respiratory disease hospital admissions with daily PM₁₀ concentrations. Associations were strongest during the warm season and people aged ≥ 65.

Keywords: cardiovascular disease, respiratory disease, multi pollutant, short-term association, DLNM, South Africa



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August 23, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 1

Air Pollution and Cardiometabolic Health

Chairs: Barbara Hoffman, Germany & Laura Corlin, United States

O-TO-006

Outcomes » Obesity and metabolic disorders

Associations between air pollution and temperature on glycated hemoglobin levels in women of child bearing age

Mike Z. He¹, Itai Kloog², Allan C. Just¹, Iván Gutiérrez Avila¹, Elena Colicino¹, Martha M. Téllez Rojo³, María Luisa Pizano Zárate⁴, Marcela Tamayo Ortiz⁵, Andrea A. Baccarelli⁶, Robert O. Wright¹, Maayan Yitshak Sade¹

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⁵Center for Nutrition and Health Research, Instituto Nacional de Salud Pública, Cuernavaca, Morelos, Mexico; Occupational Health Research Unit, Mexican Social Security Institute, Mexico City, Mexico

⁶Department of Environmental Health Sciences, Columbia University Mailman School of Public Health, New York, United States

BACKGROUND AND AIM: Fine particulate matter (PM_{2.5}) is associated with cardiovascular disease possibly through impaired glucose metabolism. Higher temperature has been linked to lower blood glucose levels in clinical settings as well. We examined the association between intermediate-term exposure to PM_{2.5} and temperature and glycated hemoglobin (HbA1c), a longer-term marker of glucose control.

METHODS: We assessed air pollution and temperature at 1-km² spatial resolution via satellite-based models, and HbA1c four years postpartum in women enrolled in the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) cohort in Mexico City (2013–2019). PM_{2.5} and temperature were matched to participants' addresses and confirmed by GPS tracker. Using linear mixed-effects models, we examined the association between 3-month and 6-month average PM_{2.5} and temperature with log-transformed HbA1c values. Both models included a random intercept per woman and were adjusted for calendar year, season, and individual-level confounders (age, marital status, smoking status, alcohol consumption level, and education level).

RESULTS: We analyzed 1,257 tests of 490 women. PM_{2.5} ranged from 3.2µg/m³ to 76.7µg/m³, average temperature ranged from 6.4°C to 22.9°C, and HbA1c values ranged from 3.0% to 12.8%. Results were antilog transformed and are presented as percent increases in HbA1c levels. Per interquartile increase in 3-month and 6-month average PM_{2.5}, HbA1c levels increased by 1.85% (95%CI: 0.92, 2.80) and 1.08% (95%CI: 0.10%, 2.08%) respectively. Per one-degree Celsius increase in temperature, HbA1c levels decreased by 0.64% (95%CI: -1.05%, -0.23%) and 0.58% (95%CI: -1.04%, -0.12%) respectively.



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CONCLUSIONS: Intermediate-term exposure to PM_{2.5} and temperature are associated with opposing changes in HbA1c levels, in this region of high PM_{2.5} and moderate temperature fluctuation. These effects, measurable in mid-adult life, may portend future risk of heart disease and type 2 diabetes. Additional research is necessary to elucidate whether the observed associations with HbA1c mediate early indicators of cardiovascular disease as the cohort ages.

Keywords: air pollution, particulate matter, temperature, diabetes, glycated hemoglobin, HbA1c



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 2

Climate and Health: Co-benefits

Chairs: Kristie Ebi & Lara Cushing, United States

O-TO-007

Climate » Temperature

Heat alerts associated with higher rates of cause-specific hospital admissions but not lower mortality among older adults in the US

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BACKGROUND AND AIM: Heat alerts are issued in advance of forecast periods of extreme heat in order to protect the public's health, yet little evidence is available regarding their effectiveness in reducing heat-related illness and death. We estimated the association of heat alerts with all-cause mortality and cause-specific hospital admissions among Medicare beneficiaries aged 65 years and older living in counties in the contiguous United States, 2006-2016.

METHODS: In each county, we compared days with heat alerts to days without heat alerts, matched on daily maximum heat index (plus or minus 2 degrees Fahrenheit) and month. We used conditional Poisson regression models stratified on county to estimate the association between heat alerts and each health outcome, adjusting for year, day of week, federal holidays, and lagged daily maximum heat index. In sensitivity analyses, we additionally adjusted for ozone, PM2.5, and same-day daily maximum heat index.

RESULTS: We were able to identify a matched non-heat alert day for 92,029 heat alert days in 2,817 counties. We did not observe evidence of a protective association between heat alerts and mortality (RR: 1.005 [95% CI: 0.997, 1.013]). However, heat alerts were associated with a higher risk of hospitalization for fluid and electrolyte disorders (RR: 1.040 [95% CI: 1.015, 1.065]) and heat stroke (RR: 1.094 [95% CI: 1.038, 1.152]). Results were similar in sensitivity analyses adjusting for air pollution and same-day heat index.

CONCLUSIONS: We found that heat alerts were not associated with lower mortality on the days and counties included in this study. However, this study does provide initial evidence that heat alerts may be associated with higher rates of healthcare utilization for fluid and electrolyte disorders and heat stroke, potentially suggesting that heat alerts lead more individuals to seek or access needed care.

Keywords: Temperature, Climate, Environmental epidemiology, Short-term exposure



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 2

Climate and Health: Co-benefits

Chairs: Kristie Ebi & Lara Cushing, United States

O-TO-008

Climate » Health co-benefits

Impacts of climate change mitigation and clean cooking access on future childhood stunting in India

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BACKGROUND AND AIM: Many children in India face the double health burden of high exposure to ambient (AAP) and household air pollution. Although climate change mitigation is expected to decrease AAP, climate policies could increase the cost of clean fuels. We aimed to quantify the impacts of climate change mitigation and clean cooking access on future childhood stunting in India.

METHODS: We linked 2015-2016 Demographic Health Survey data with satellite-based particulate matter (PM_{2.5}) data to estimate the association between in-utero exposure to ambient PM_{2.5}, cooking fuel type, and stunting among children < 5 years. Ambient PM_{2.5} and clean cooking access were projected under global climate change mitigation scenarios in line with the 2°C Paris Agreement target and a range of national energy access scenarios with an integrated assessment model. We used a modified substitution estimator approach to estimate the number of children with stunted growth under each scenario in 2030 and 2050 according to state and urbanicity and accounting for demographic change.

RESULTS: In-utero exposure to ambient PM_{2.5} significantly increased the odds of child stunting (OR: 1.04, 95%CI: 1.05-1.03 per 10 µg/m³ increase in PM_{2.5}) and clean compared to polluting cooking fuel decreased the odds of stunting (OR: 0.86, 95%CI: 0.88-0.84) in confounder-adjusted models. Under the 2°C target and a range of policies to support clean energy access, national average exposure to ambient PM_{2.5} was 45.9 µg/m³ and clean cooking access was 74% -97% in 2050 compared to 57.4 µg/m³ and 91%-99% under business-as-usual. Reductions in AAP under the 2°C Paris Agreement target prevented stunting in 1 million children in rural and 0.8 million in urban areas in India in 2050 compared to business-as-usual.

CONCLUSIONS: Air pollution reductions achieved by meeting the Paris Agreement target combined with policies to offset increased costs of clean cooking could contribute to improved linear growth in young children in India.

Keywords: co-benefits, clean cooking access, childhood stunting



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 2

Climate and Health: Co-benefits

Chairs: Kristie Ebi & Lara Cushing, United States

O-TO-009

Climate » Health co-benefits

Climate action for health and wellbeing in cities: systematic development of a database of peer-reviewed studies using machine learning methods

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BACKGROUND AND AIM: Cities produce more than 70% of global greenhouse gas emissions. Action by cities is therefore crucial for climate change mitigation as well as for safeguarding the health and wellbeing of their populations under climate change. Many city governments have made ambitious commitments to climate change mitigation and adaptation and implemented a range of actions to address them. However, a systematic record and synthesis of the findings of evaluations of the effect of such actions on human health and wellbeing is currently lacking. We are reporting an innovative approach for the systematic development of a database of studies of climate change mitigation and adaptation actions implemented in cities, and their benefits (or disbenefits) for human health and wellbeing, derived from peer-reviewed academic literature.

METHODS: Our approach draws on extensive tailored search strategies and machine learning methods for article classification and tagging to generate a database for subsequent systematic reviews addressing questions of importance to urban decision-makers on climate actions in cities for human health and wellbeing.

RESULTS: Our searches retrieved >650,000 records across the Web of Science Core Collections, Scopus, and Medline databases. Samples of these records are currently being screened for inclusion into the database by human reviewers to train the machine learning algorithms to assist further screening.

CONCLUSIONS: The database is intended to serve as a source for subsequent systematic reviews addressing specific research questions of relevance to stakeholders in urban climate action and health. The outputs of the systematic reviews will be of value to the scientific community, international networks on city climate action and leadership, such as C40 cities network, urban policy makers, and other stakeholders.

Keywords: climate change, cities, urban health, mitigation, adaptation, wellbeing



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 2

Climate and Health: Co-benefits

Chairs: Kristie Ebi & Lara Cushing, United States

O-TO-010

Climate » Health co-benefits

Air quality-related health co-benefits from Pennsylvania's entry into the Regional Greenhouse Gas Initiative (RGGI)

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BACKGROUND AND AIM: Climate policies can provide local health co-benefits by simultaneously reducing local and regional air pollutants co-released with greenhouse gas emissions. The Regional Greenhouse Gas Initiative (RGGI) is a regional cap and trade system that seeks to reduce CO₂ emissions from the electric power sector in eleven northeastern and mid-Atlantic states in the United States. Here we focus on Pennsylvania's anticipated entry into RGGI in 2022. As a major power producer and carbon-emitter in the PJM interconnection (i.e., the Regional Transmission Organization that manages the wholesale electricity market in Pennsylvania and twelve other states), Pennsylvania's participation affects both the PJM electricity market and the RGGI carbon market.

METHODS: By combining a power system model of PJM with a reduced form model of CO₂ emissions abatement from RGGI states that are not in PJM, we first simulate the effects of Pennsylvania's participation in RGGI on electricity market outcomes, CO₂ emissions, and other local and regional air pollutants. We then use a range of marginal damage estimates derived from reduced-form air pollution models to monetize air quality-related health impacts.

RESULTS: Comparing the scenarios with and without Pennsylvania's participation in RGGI, we find the annual average power sector CO₂ emissions in Pennsylvania to be 40% lower from 2022 to 2030. During the same time period, the annual emissions are 79%, 68% and 76% lower for SO₂, NO_x and PM_{2.5} emissions, respectively. Such a reduction in co-emitted air pollutants leads to cumulative health co-benefits of \$17.7 billion to \$40.8 billion. However, the reduced emissions and health damages in Pennsylvania are slightly offset by increases in the other states in PJM that do not participate in RGGI.

CONCLUSIONS: Our study highlights the large potential for health co-benefits from Pennsylvania's entry into RGGI, though the cross-state leakage issue requires careful consideration in the policy design and implementation process.

Keywords: Air pollution, climate, health co-benefits, policy



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 2

Climate and Health: Co-benefits

Chairs: Kristie Ebi & Lara Cushing, United States

O-TO-011

Climate » General

Urban resilience: assessing climate vulnerabilities and risk perceptions in the city of Haifa, Israel

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University of Haifa

BACKGROUND AND AIM: Extreme climate events (wildfires, floods, heatwaves, cold spells) are becoming more frequent in the Mediterranean, but adaptation levels remain low. The city of Haifa in northern Israel is prone to extreme climate events. Focusing on Haifa, we aim to 1) conduct a spatial analysis of climate and health vulnerabilities, 2) examine local officials' risk perceptions of different extreme events, and 3) assess the public's perceived risk and resilience

METHODS: Mixed-METHODS: 1) spatial mapping of vulnerability indicators including socio-economic status, recipients of welfare allowances, temperature, sensitivity to floods and wildfires, proximity to hospitals. 2) qualitative analysis of 30 in-depth interviews with local government health and welfare officials, and 3) a survey of climate risk perceptions and resilience among a representative sample of 550 residents.

RESULTS: Social and climatic vulnerabilities are correlated, so that downtown neighborhoods are characterized by poorer socio-economic, health and welfare conditions, and higher summer temperatures. Hospitals are prepared for emergencies, but not for extreme climate events, and there are no national budget or guidelines for climate adaptation at the city level or in hospitals. Correspondingly, risk perceptions of climate change among health and welfare officials remain low. Public perceptions of danger (2.64 ± 0.82), community resilience (2.96 ± 0.76) and national resilience (3.28 ± 0.84) are moderate (1-5 scale), and correlated with ethnicity and age. Residents of neighborhoods with poorer socio-economic conditions report higher community resilience compared to others.

CONCLUSIONS: Haifa is a geographically and socially diverse city, with multiple vulnerabilities to climate change. However, climate risk perceptions remain low among health and welfare officials and among residents. Good preparedness for events that had been experienced in the past including war and wildfire, provides a good infrastructure for climate change awareness and adaptation. The city should develop and implement an adaptation plan that will address the vulnerabilities of different populations and neighborhoods, and enhance urban resilience.

Keywords: Adaptation, climate change, public policy, risk perceptions, urban resilience, vulnerability assessment.



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 3

Air Pollution and Neurodegeneration

Chairs: Sara Adar & Aisha Dickerson, United States

O-TO-012

Air pollution » Long-term exposure

Long-term exposure to ambient air pollution is associated with neuropathologic change of Alzheimer's Disease at Autopsy

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BACKGROUND AND AIM: There is a growing body of evidence linking exposure to air pollution with dementia and Alzheimer's disease (AD). However, the detailed molecular mechanisms explaining how air pollution exposures may affect the human brain are still largely unknown. Investigating the impact of air pollution on markers of AD neuropathology might provide mechanistic insights. We evaluated associations of long-term exposure to air pollution prior to death with three different measures of AD neuropathology: Braak stage; Consortium to Establish a Registry for AD (CERAD) neuritic plaque score; and combined AD neuropathologic change (ABC score).

METHODS: We obtained data on the neuropathology markers from autopsy samples collected after 2008 from the Emory University Goizueta Alzheimer's Disease Research Center Neuropathology Core Brain Bank (N=145 donors from Metro Atlanta, Georgia, USA). Long-term exposures to PM_{2.5}, CO, and NO_x were estimated at the deceased's last address for a fixed 7-year period (2002-2008) via the Research LINE source model (resolution: 250m). We performed ordinal logistic regression for each marker adjusting for age at death, race, gender, educational attainment, and APOE genotype.

RESULTS: The average age at death was 76 years (SD=9.5). The medians of exposure to PM_{2.5}, CO, and NO_x were 0.32µg/m³, 157.9ppb, 12.9ppb, respectively. After adjustment, one unit increase in 7-year average PM_{2.5} was associated with higher Braak stage [OR = 5.40 (1.30, 28.25)]. Associations with CERAD [0.83 (0.12, 5.61)] and ABC [2.41 (0.42, 13.95)] scores were not significant and no significant associations were found for CO and NO_x (Braak stage: 1.00 (0.99, 1.01) and 1.04 (0.99, 1.10), respectively).

CONCLUSIONS: PM_{2.5} was associated with neuropathologic changes assessed by Braak stage, which characterizes the abundance of neurofibrillary tangles. As Braak staging is the neuropathology marker showing the strongest association with cognitive performance and decline, these findings could have implication for both AD and AD-related dementias.

Keywords: Air pollution, Neurodegenerative outcomes.



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 3

Air Pollution and Neurodegeneration

Chairs: Sara Adar & Aisha Dickerson, United States

O-TO-013

Air pollution » Long-term exposure

Air pollution and plasma amyloid beta: Evidence from the Ginkgo Evaluation of Memory Study

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BACKGROUND AND AIM: Accumulation of amyloid beta (A β) proteins are central to the development of Alzheimer's disease (AD). Air pollution has also been implicated in AD through its potential to cause neuroinflammation, microglia activation and white matter abnormalities. To date, few epidemiologic studies have examined the association between air pollution and A β .

METHODS: The Ginkgo Evaluation of Memory Study (GEMS) is a longitudinal study of adults age 75 and older recruited from four US sites. Fine particulate matter (PM_{2.5}), coarse particles (PM₁₀) and nitrogen dioxide (NO₂) were predicted from a national universal kriging model which estimated annual average pollutant levels at participant's address one, five, 10 and 20 years prior to baseline visit. Both A β 1-40 and A β 1-42 were measured at baseline (years 2000-2002) and then again in 2008 in plasma blood samples using ELISA. After using multiple imputation by chained equations to impute missing covariates, we modelled baseline A β 1-40 and A β 1-42 separately using linear regression models and repeat measures (i.e., pooled) data using multilevel models with random intercepts. Final models were adjusted for several socio-demographic and behavioral covariates as well as cystatin C and apolipoprotein E ϵ 4 carrier status.

RESULTS: Pooled analyses included 4650 observations on 3004 participants. An interquartile range (IQR, 2- μ g/m³) higher 5-year average PM_{2.5} was associated with a 4.9% higher A β 1-40 (95% CI: 3.6%, 6.3%) and a 10.9% higher A β 1-42 level (95% CI: 6.7%, 15.2%). A 7 ppb (one IQR) higher 5-year averaged NO₂ was associated with a 10% higher A β 1-40 (95% CI: 7.7%, 12.4%) and 17.8% higher A β 1-42 level (95% CI: 10.4%, 25.7%). Similar results were seen for other pollutant-biomarker associations, although analysis of baseline A β data found attenuated results.

CONCLUSIONS: Findings suggest a robust association between PM_{2.5}, PM₁₀ and NO₂ and both plasma A β 1-40 and A β 1-42.

Keywords: air pollution, fine particulate matter, dementia, amyloid beta, Alzheimer's Disease



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 3

Air Pollution and Neurodegeneration

Chairs: Sara Adar & Aisha Dickerson, United States

O-TO-014

Air pollution » Particle components

The Effect of Ultrafine Particles (PM_{0.1}) on Neurological Disorders in New York State

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BACKGROUND AND AIM: Ultrafine particles (UFPs) are a significant air pollutant, yet related health research is rare. Among these studies, respiratory and cardiovascular outcomes have been analyzed far more than other health outcomes. This study evaluated the effects of UFP exposure on overall and various neurological disorders; and we examined if these associations differed by or interacted with social-demographics and meteorological factors.

METHODS: We gathered emergency department (ED) visit data from New York State (NYS) Department of Health with a primary diagnosis of several neurological disorders in NYS from 2013-2018. The concentrations of UFPs and other air pollutants (as confounders) were obtained from high resolution simulations using a validated chemical transport model with size-resolved particle microphysics. We used a case-crossover design and conditional logistic regression to estimate the excess risk of ED admission for all neurological disorders and the sub-types of dementia, Parkinson's disease, multiple sclerosis (MS), Amyotrophic Lateral Sclerosis (ALS), and stroke. We also analyzed interactions between UFP and gender, race, ethnicity, age, relative humidity (RH), temperature, and season.

RESULTS: An inter-quartile range (IQR) increase in UFP number concentration increased general neurological disorders on individual lags (Lag 0 & 1: 0.7%, 95% CI: 0.1-1.2%) and all cumulative lags (Excessive Risk ranged from 0.7-1.4, all $p < 0.05$). UFP exposure also increased ED visits for dementia (1.4%; 95% CI: 0.1-1.2%), Parkinson's disease (1.7%; 95% CI: 0.2-3.2%), and ALS (5.5%, 95% CI: 0.5-10.7%). Gender and age interacted with these health effects, with females and adults being more susceptible. Finally, mild temperatures (<90th percentile) made individuals more vulnerable to UFP's effects.

CONCLUSIONS: Exposure to UFPs significantly increased the risk of ED visits for general neurological disorders across all lag days, especially for dementia Parkinson's disease, and ALS. The associations varied by demographics and weather factors. More epidemiological research is needed to examine the relationships between UFPs and neurological health outcomes.

Keywords: Air pollution, neurological disorders, ultrafine particles



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 3

Air Pollution and Neurodegeneration

Chairs: Sara Adar & Aisha Dickerson, United States

O-TO-015

Air pollution » Long-term exposure

Associations of Long-Term Air Pollution Exposure with Incident Dementia among Older U.S. Adults: The Health and Retirement Study

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BACKGROUND AND AIM: Evidence suggests that long-term exposures to some air pollutants are detrimental for late-life cognition yet associations with incident dementia are less consistent. This may be partially due to the common use of administrative records to identify dementia, which can lead to inaccurate diagnoses and diagnosis patterns that vary by place. This study investigates associations between long-term air pollution exposures and incident dementia in a cohort in which all participants underwent standardized assessments of dementia.

METHODS: We used biennial data between 2000 and 2016 from participants >65 years in the nationally representative Health and Retirement Study. Using a validated algorithm based on cognitive testing and proxy information, we classified each participant's dementia status at each interview. We predicted 10-year average PM_{2.5}, PM_{10-2.5}, NO₂, and O₃ concentrations at participant addresses before each interview using spatiotemporal models. Associations between air pollution and incident dementia were estimated with time-varying Cox models, adjusting for individual demographics, area-level characteristics, as well as temporal and spatial trends. We fitted both single- and two-pollutant models.

RESULTS: Our study population of 16,262 adults (70+6.4 years) was predominantly Non-Hispanic White (77%), Non-Hispanic Black (13%), and Hispanic White (8%). Twenty-one percent of participants developed dementia during follow-up.



ABSTRACT E-BOOK

Overall, we found little evidence that air pollution exposure is associated with incident dementia in our single or multi-pollutant models, especially after adjustment for place. Following detailed individual and area-level adjustments, we observed hazard ratios (HR) ranging from 0.96 to 1.03 per interquartile range (IQR) for the various pollutants. The largest HR of 1.03 (95% CI: 0.94 – 1.12) was found for an IQR difference in PM_{10-2.5} (5.03 $\mu\text{g}/\text{cm}^3$).

CONCLUSIONS: This prospective study of older U.S. adults found no consistent evidence that air pollution exposure is associated with increased risk of incident dementia. Associations with pollution may be more apparent with more sensitive measures of cognitive function.

Keywords: Air Pollution, Long-Term Exposure, Incident Dementia



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 3

Air Pollution and Neurodegeneration

Chairs: Sara Adar & Aisha Dickerson, United States

O-TO-016

Air pollution » Traffic-related

Multi-air pollutant exposure and amyotrophic lateral sclerosis (ALS) diagnosis in Denmark

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BACKGROUND AND AIM: Amyotrophic lateral sclerosis (ALS) is a devastating and fatal neurodegenerative disease, with approximately half of patients dying within three years of symptom onset. Its aetiology remains elusive and known inherited mutated genes only account for 5–10% of the cases. There is some limited evidence to suggest ALS onset is associated with exposure to air pollution, and specifically to traffic-related pollution. However, previous smaller studies have only examined the association with relevant pollutants in separate models.

METHODS: In the present study, we used prospectively collected data from the Danish National Registers system from 2,188 ALS cases diagnosed between 1989 – 2013 and matched on age, sex, and vital status to 6,766 controls. We used predictions from a validated spatio-temporal model to assign 5-year average exposures prior to diagnosis to nitrogen oxides (NO_x), carbon monoxide (CO), elemental carbon (EC), fine particles (PM_{2.5}), and ozone at residential addresses of study participants. We used a Bayesian hierarchical conditional logistic model to assess whether exposure to traffic- and non-traffic-related pollution is associated with ALS diagnosis, adjusting for potential confounders.

RESULTS: We found that for an inter-quartile range (IQR) increase in 5-year average concentrations, the joint effect of included traffic-related pollutants (NO_x, CO, EC) was associated with an increase in odds of ALS diagnosis (8.4%; 95% credible interval [CrI]: -1.4, 18.9%). Increases in non-traffic related pollution resulted in an increase in odds for ozone (IQR=7.9 µg/m³) (6.6%; 95%CrI: -8.5%, 21.9%), and a decrease for PM_{2.5} (IQR=4.0 µg/m³) (-13.1%; 95%CrI: -35.8%, 10.7%). Overall, there was a 95% posterior probability of a positive association between the joint effect of included traffic-related pollutants and ALS diagnosis.



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ABSTRACT E-BOOK

CONCLUSIONS: Our results indicate a potential positive association between ALS diagnosis and traffic-related pollution. Further work is needed to understand the role of air pollution on ALS pathogenesis and timing of onset.

Keywords: Air Pollution, ALS, Traffic-Related Pollution, Denmark, Motor Neuron Disease, NOx



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 3

Air Pollution and Neurodegeneration

Chairs: Sara Adar & Aisha Dickerson, United States

O-TO-017

Policy » Research translation to affect policy and practice

Annual dementia incidence and socioeconomic costs attributable to fine particulate matter (PM_{2.5}) exposure in Sweden

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BACKGROUND AND AIM: Alzheimer's disease (AD) and other dementias currently represent the fifth most common cause of death in the world, according to the World Health Organization, with a projected future increase as the proportion of the elderly in the population is growing. Air pollution has emerged as a plausible risk factor for AD, but studies estimating dementia cases attributable to exposure to fine particulate matter (PM_{2.5}) air pollution and resulting socioeconomic costs are lacking.

METHODS: We used data on average population-weighted exposure to ambient PM_{2.5} for the entire population of Sweden above 30 years of age. To estimate the annual number of dementia cases in Sweden attributable to air pollution we used the latest concentration response functions (CRF) between PM_{2.5} exposure and dementia incidence, based on ten longitudinal cohort studies. To estimate the socioeconomic costs of dementia, we calculated average life-time costs related to dementia, including formal health care costs, informal care, indirect costs, and intangible costs by including quality-adjusted life years (QALYs) lost. Two applied monetary valuations of QALYs in Sweden decision-making process was used to estimate the monetary value of reduced quality-of-life.

RESULTS: The annual number of dementia cases attributable to PM_{2.5} exposure was estimated to be 820, which represents 5% of the annual dementia cases in Sweden. Formal life-time average cost per incidence of dementia was calculated to correspond € 213,000. From a societal perspective, this corresponds to monetarized annual dementia burden of €215 per individual at risk. Reducing PM_{2.5} by 1 µg/m³ would correspond to 0.6% of Swedish GDP in opportunity costs due to reduced incident of dementia.

CONCLUSIONS: This study estimated that 5% of annual dementia cases could be attributed to PM_{2.5} exposure, and that the resulting socioeconomic costs were substantial. These findings suggest the need to consider airborne toxic pollutants associated with dementia incidence in public health policy decisions.

Keywords: Air pollution, Policy, particulate matter,



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 4

Causal Inference, Novel Analysis Approaches, and Their Potential Role in Evidence Syntheses
in Environmental Epidemiology

Chairs: Andreas Neophytou, United States & Mary Willis, United States

O-TO-018

Birth and Pregnancy Outcomes » Birth outcomes

Maternal exposure to traffic-related pollutants during pregnancy and birth weight: using machine-learning methods to achieve balance in inverse-probability weights

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BACKGROUND AND AIM: Low birth weight (LBW) is associated with increased risks of health problems in infancy and later life. Among the current epidemiological analyses suggesting the association between air pollution and birth weight, few have specifically estimated the effects of traffic-related pollutants or used causal modelling. We aimed to investigate the causal association between prenatal exposure to black carbon (BC) and nitrogen dioxide (NO₂) and birth weight using machine learning methods to achieve balance in inverse-probability weights.

METHODS: We examined 1,119,011 birth records between January 1, 2001 and December 31, 2015 from the Massachusetts Birth Registry. Mean residential BC and NO₂ exposure 0-30, 31-90, 91-280 days prior to birth were calculated using estimates from validated spatial-temporal models. We fit generalized propensity score models with gradient boosting tuned by a new algorithm to achieve covariate balance, then fit marginal structural models with stabilized inverse-probability weights calculated from those models.

RESULTS: Over the entire pregnancy, average birth weight would drop by -31.2 g (95% CI: -35.5, -26.9) for an IQR increase of 0.145 µg/m³ in BC and would drop by -25.9 g (95% CI: -30.1, -21.7) for an IQR increase of 9.8 ppb in NO₂. The effect sizes are similar in the three averaging periods for BC but the effect in the 91-280 prior period for NO₂ is larger than the other two exposure windows. The estimated odds ratio of LBW (defined as birth weight less than 2,500 g) for every IQR increase during the entire pregnancy was 1.21 (95% CI: 1.13, 1.28) for BC and was 1.11 (95% CI: 1.05, 1.18) for NO₂.

CONCLUSIONS: In full-term singleton live births in Massachusetts between 2001 and 2015, higher maternal exposure to traffic-related air pollution (BC and NO₂) during pregnancy resulted in lowering birth weight and increasing the odds of LBW.

Keywords: Air pollution, Traffic-related, Big data, Birth outcomes, Causal inference, Epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 4

Causal Inference, Novel Analysis Approaches, and Their Potential Role in Evidence Syntheses
in Environmental Epidemiology

Chairs: Andreas Neophytou, United States & Mary Willis, United States

O-TO-019

Methods » Environmental epidemiology

Long-term Exposure to Fine Particulate Matter is Causally Linked to Mortality Among the Elderly

Francesca Dominici

Harvard T H Chan School of Public Health

BACKGROUND AND AIM: Many studies link long-term fine particle (PM_{2.5}) exposure to mortality, even at levels below current US air quality standards (12 µg/m³). These findings have been disputed citing traditional approaches do not guarantee evidence of causality.

METHODS: Leveraging 16 years of data—68.5 million Medicare enrollees and 570 million observations—we estimated the causal effect of annual PM_{2.5} exposure on mortality. We implemented five statistical approaches to estimate the effect of PM_{2.5} exposure on mortality, accounting for potential confounders. The two traditional approaches rely on regression modeling for confounding adjustment: 1) Cox proportional hazards model, and 2) Poisson regression. We also considered three approaches for causal inference that rely on the potential outcomes framework and generalized propensity scores (GPS).

RESULTS: We found that an increase of 10 µg/m³ PM_{2.5} leads to a statistically significant mortality risk increase, 6 to 8%. Lowering the standards to 10 µg/m³ would save 143,257 lives (95% confidence interval: 115,581–170,645) in one decade.

CONCLUSIONS: Our study provides the most robust and reproducible evidence to date of the causal link between long-term PM_{2.5} exposure and mortality even at levels below the standards

Keywords: air pollution, methods



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 4

Causal Inference, Novel Analysis Approaches, and Their Potential Role in Evidence Syntheses in Environmental Epidemiology

Chairs: Andreas Neophytou, United States & Mary Willis, United States

O-TO-020

Birth and Pregnancy Outcomes » Birth outcomes

Perinatal health impacts of air pollution mitigation policies: applying g formula to preterm birth in Temuco/Padre Las Casas, Chile

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BACKGROUND AND AIM: Wood burning is a primary energy source for heating but constitutes a significant source of PM_{2.5} emissions and is linked to adverse health outcomes, including preterm birth (PTB). There is little evidence on the expected benefits from air pollution mitigation plans with respect to perinatal outcomes, particularly those aimed at decreasing residential wood-burning emissions. We estimated the magnitude of reduction in prevalence and number of PTB cases associated with compliance with air quality guidelines and specific interventions to reduce fine particulate matter in Temuco/Padre Las Casas, Chile, an area heavily affected by wood burning from residential heating.

METHODS: A parametric G-computation approach was applied to quantify the relationship between PM_{2.5} and time to PTB. We relied on a retrospective cohort of all live births between 2009-2015 from a public hospital in Temuco (n=15,516). We simulated the effects of four scenarios to reduce PM_{2.5} as compared to “business as usual” (no intervention): compliance with i) WHO guidelines; ii) Chilean limit values; reductions associated with iii) a wood heater replacement program and iv) gradual prohibition of less efficient stoves/heaters.

RESULTS: Women were exposed to high levels of air pollution in each trimester of pregnancy (>30 µg/m³ in each trimester); 10% of births were PTB. Both prevalence and number of cases of PTB decreased with each intervention scenario, with larger decreases associated with compliance to national limits and international guidelines. For gradual prohibition of less efficient stoves, expected prevalence of PTB was 8% compared to 5.7% associated with compliance with Chilean limits, which



ABSTRACT E-BOOK

represented 225 (95% CI -395, -56) and 544 (95% CI -897, -190) fewer cases of PTB compared to business as usual.

CONCLUSIONS: We found large potential benefits for prevalence and number of PTB cases associated with the mitigation strategies, with larger reductions for norm compliance compared to specific wood-burning proposed.

Keywords: air pollution, mitigation strategies, adverse birth outcomes, G methods



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 4

Causal Inference, Novel Analysis Approaches, and Their Potential Role in Evidence Syntheses in Environmental Epidemiology

Chairs: Andreas Neophytou, United States & Mary Willis, United States

O-TO-021

Methods » Environmental epidemiology

Risk of bias assessments and evidence syntheses for observational epidemiologic studies of environmental and occupational exposures: strengths and limitations

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BACKGROUND AND AIM: Increasingly, risk of bias tools are used to evaluate epidemiologic studies as part of evidence synthesis (evidence integration), often involving meta-analyses. Some of these tools consider hypothetical randomized controlled trials (RCTs) as gold standards.

METHODS: We review the strengths and limitations of risk of bias assessments, in particular, for reviews of observational studies of environmental exposures, and we also comment more generally on methods of evidence synthesis.

RESULTS: Although RCTs may provide a useful starting point to think about bias, they do not provide a gold standard for environmental studies. Observational studies should not be considered inherently biased versus a hypothetical RCT. Rather than a 'checklist' approach when evaluating individual studies using risk of bias tools, we call for identifying and quantifying possible biases, their direction, and their impacts on parameter estimates. As is recognized in many guidelines, evidence synthesis requires a broader approach than simply evaluating risk of bias in individual studies followed by synthesis of studies judged unbiased, or with studies given more weight if judged less biased. It should include the use of classical considerations for judging causality in human studies, as well as triangulation, and integration of animal and mechanistic data.

CONCLUSIONS: Bias assessments are important in evidence synthesis, but we argue they can and should be improved to address the concerns we raise here. Simplistic, mechanical approaches to risk of bias assessments, which may particularly occur when these tools are used by non-experts, can result in erroneous conclusions, and sometimes may be used to dismiss important evidence. Evidence synthesis requires a broad approach which goes beyond assessing bias in individual human studies and then including a narrow range of human studies judged to be unbiased in evidence synthesis.

Keywords: Research translation to affect policy and practice, environmental epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 5

Climate and Health: Planetary Health

Chairs: Joan A Casey, United States & Amruta Nori-Sarma, United States

O-TO-022

Climate » Natural disasters

Long-term impacts of Atlantic hurricanes on asthma exacerbations among children with asthma in the eastern United States

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BACKGROUND AND AIM: Tropical cyclones (TCs) are associated with substantial, acute increases in mortality and morbidity. Relatively few studies have examined the longer-term health consequences of such storms. We assessed whether TCs increased the frequency of symptom exacerbation among children with a diagnosis of asthma in the 12 months following storms in counties in the eastern United States (US), 2000-2018.

METHODS: We defined exposure to TCs as maximum sustained windspeed at the county center >21 meters/second, and matched each exposed county to one or more unexposed counties on sociodemographic variables, climate, and distance from the coast. Within each exposed and matched unexposed county, we used data from the OptumLabs Data Warehouse, a longitudinal, real-world data asset with de-identified administrative claims and electronic health record (EHR) data, to estimate monthly rates of asthma exacerbations requiring medical attention among children aged 5-17 with a prior diagnosis of asthma. Finally, we used a difference-in-differences approach implemented via a log-linear fixed effects model with an offset for eligible population size to compare the rate of asthma exacerbations occurring in exposed versus unexposed counties, in the 12 months before versus 12 months after each storm.

RESULTS: Our analysis encompasses 43 TCs that affected at least one county during the study period. Overall, across these storms, we did not observe evidence of an increase in symptom exacerbation in the 12 months following the storm (random effects meta-analytic summary estimate: RR: 1.03 [95% CI: 0.96, 1.10], I² = 19%). However, we did find evidence of an increase in symptom exacerbation following specific storms, such as Hurricane Sandy.

CONCLUSIONS: These findings suggest that some TCs may be detrimental to the respiratory health of children, but that tropical cyclones are not in aggregate substantially associated with long-term exacerbation of asthma among a population of children with health insurance.

Keywords: Climate change, Tropical cyclones, Asthma



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 5

Climate and Health: Planetary Health

Chairs: Joan A Casey, United States & Amruta Nori-Sarma, United States

O-TO-023

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

Strategies for reducing the burden of climate-sensitive diarrheal infections on young children

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BACKGROUND AND AIM: Climate-sensitive infectious diseases are an issue of growing concern due to global warming and the related increase in extreme climate and weather events. Diarrhea, which is strongly associated with climatic factors, remains among the leading causes of child death globally, disproportionately affecting populations in low- and middle-income countries.

METHODS: We use Demographic and Health Survey data for 28 low- to middle-income countries in combination with high resolution climate data to estimate the association between precipitation shocks and symptoms of diarrhea in children under 3. We account for difference in exposure risk by climate zone and explore cost-effective intervention strategies, including immunization and caregiving practices.

RESULTS: We find that anomalously dry weather increases the risk of diarrhea symptoms in the tropical savannah regions. In the humid subtropical regions, the same health risk is increased due to anomalously wet weather. Our analysis of effect modifiers reveals that different interventions may be effective in both climate zones. Improved feeding practices are found to significantly reduce children's susceptibility to diarrheal infections associated with droughts. Basic immunization seems to provide some protection against diarrheal infections following heavy precipitation events. Moreover, we find evidence that the rotavirus vaccine can significantly reduce or even eliminate the risk of diarrhea symptoms associated with both droughts and heavy precipitation events.

CONCLUSIONS: We identified areas of intervention that can reduce the burden of climate-sensitive infectious diseases on children, focusing on diarrheal infections. The presented findings call for urgent action to improve child feeding practices and expand access to the rotavirus vaccine in low- and middle-income countries where climate change poses considerable risk to population health. Future research needs to explore other cost-effective interventions that can address the mounting risks to child health posed by climate change.

Keywords: precipitation, childhood diarrhea, immunization, child feeding practices



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 5

Climate and Health: Planetary Health

Chairs: Joan A Casey, United States & Amruta Nori-Sarma, United States

O-TO-024

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

The association of childhood exposure to crop yield variation and survival in a subsistence farming population in Burkina Faso

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BACKGROUND AND AIM: Populations reliant on subsistence agriculture are vulnerable to climate change effects on crop yields. A limited number of studies suggested selected associations of such effects, e.g., experienced in the year of birth, on child nutrition and survival. We estimate the cumulative effect of inter-annual crop yield variations experienced by children to 5 years of age on their survival chances to this age.

METHODS: We analysed 61,335 children under 5 years of age surveyed as a part of the Nouna Health and Demographic Surveillance System, 1992–2016, in relation to the level of annual food crop yield they experienced throughout their lifetime, using shared frailty Cox proportional hazards models. The analyses were adjusted for sex, season of birth, ethnicity, religion, mother's and fathers' literacy, household wealth index and occupation outside agriculture, time trend, introduction of an undernutrition treatment programme, rural vs semi-rural residence, village infrastructure, and exposure to weather patterns with potential direct effects on child health through heat stress and increased risk of vector borne diseases.

RESULTS: Survival was considerably lower in children who experienced on average lower levels of annual food crop yield throughout their lifetime, hazard ratio 1.74 (95% confidence interval 1.63 to 1.86) for a 90th to 10th centile decrease in lifetime average annual crop yield.

CONCLUSIONS: These findings suggest that crop yield reductions have a notable adverse effect on child survival in the study population, which could further increase under climate change.

Keywords: crop yield, survival, undernutrition, child health, agriculture, climate change



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 5

Climate and Health: Planetary Health

Chairs: Joan A Casey, United States & Amruta Nori-Sarma, United States

O-TO-025

Climate » General

Extreme Precipitation and Legionnaires Disease Hospitalizations in Boston, Massachusetts from 2002-2012

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BACKGROUND AND AIM: Legionnaires disease (LD) and Pontiac Fever are caused by exposure to *Legionella* spp. bacteria—environmental contaminants commonly found in water and soil. A milder disease, Pontiac Fever is typically self-limiting, and has a short incubation period of hours to days. The estimated incubation period for severe LD pneumonia is two–fourteen days and is the form of Legionellosis most likely to result in a hospital visit. Previous studies report LD associated with extreme weather conditions: higher humidity and increased precipitation. We conducted a retrospective study of air pollution, extreme precipitation, and LD-coded hospital visits in Boston, Massachusetts.

METHODS: We analyzed weather and air pollution data: humidity, temperature, precipitation, ozone, and fine particulates (PM_{2.5}) with LD ICD-9 code 482.84 hospital visits. Variables were assessed as continuous variables, at extremes, in different seasons, and at multiple LD case time lags. Using time-series analysis and negative binomial methods, final multivariable models included extreme precipitation events, temperature, and the occurrence of LD-related hospital visits.

RESULTS: A total of 466 hospital visits were identified during 2002-2012. The selected model had the lowest AIC and included an autocorrelation term for LD case frequency from lag 1 to 7 days, mean temperature, and extreme precipitation (90th percentile). Extreme precipitation events were associated after 9 and 11 lag days with IRR of 1.54 (95% CI, 1.1379 – 2.0496) and 1.38 (95% CI, 1.0086 – 1.8610) respectively. We did not find an association with temperature, particulates or ozone, and humidity was excluded because of collinearity with precipitation ($R = 0.39$).

CONCLUSIONS: Hospital visits for LD significantly increased at lag days nine and eleven occurred after extreme precipitation events. We did not find a significant association with air pollution. These findings agree with other reports of LD occurrence after wet weather. This abstract does not reflect EPA policy.

Keywords: Climate, Water quality, Infectious diseases



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 5

Climate and Health: Planetary Health

Chairs: Joan A Casey, United States & Amruta Nori-Sarma, United States

O-TO-026

Climate » Natural disasters

Tropical cyclones and mortality in the United States

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BACKGROUND AND AIM: In the US, tropical cyclones, such as hurricanes and tropical storms, have a devastating impact on society and are an important public health concern. Previous work has comprehensively examined the association of tropical cyclones with hospitalizations within the week of exposure, and case studies have quantified storm impacts on some causes of death for particular powerful hurricanes. But a comprehensive assessment of multiple causes of mortality across multiple years of study is currently missing.

METHODS: In the present study, we used data from over 85 million deaths from the National Center for Health Statistics and a comprehensive record of tropical cyclone occurrence in the US over 30 years (1988 – 2017). We formulated a Bayesian conditional quasi-Poisson model to examine how monthly tropical cyclone exposure—defined as number of days in a month with a sustained maximal wind speed of greater than 34 knots—by county affects monthly death rates up to six months after exposure using unconstrained distributed lag terms. We will also examine how changes in storm-related mortality vary by age and sex, as well as how less powerful but more common winds also impact mortality.

RESULTS: There was a total of 4,624 tropical cyclone exposure days (of which 202 were hurricane-level) in 1,174 counties distributed throughout 31 states during our study period. We found that each additional hurricane exposure day was associated with average increases in death rate for cardiovascular diseases only in the month following exposure (3.3%; 95% credible interval [CrI]:0.2, 6.3%); and for respiratory diseases (5.3%; 95%CrI:1.1, 9.7%) in the month of exposure with a positive association remaining until three months afterwards.

CONCLUSIONS: Our findings demonstrate the need for targeted interventions and additional preparedness for key causes of death before, during, and after tropical cyclones, especially as they are likely to increase in strength with global climate change.

Keywords: Tropical Cyclones, Hurricanes, Climate Change, Natural Disasters, Mortality, Weather



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 6

Bringing It All Back Home: Cancer and the Residential Environment

Chairs: Julia Heck, United States & Mary Ward, United States

O-TO-027

Cancer and Cancer-Precursors » Other (to be specified with keywords in the keywords section)

Neighborhood socioeconomic status and biomarkers among participants in the US-based Health Professionals' Follow-Up Study and Nurses' Health Study

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BACKGROUND AND AIM: Neighborhood socioeconomic status (nSES) may affect human health through stress pathways, but few studies to date have investigated this hypothesis. We studied the association between nSES and multiple biomarkers of cellular aging and inflammation.

METHODS: We used data from several nested case-control studies conducted within two US-based cohorts of men and women. Blood samples were collected for a subset of participants ten years after enrollment (1989/90 for NHS, 1996 for HPFS). Relative leukocyte telomere length (rLTL) was assayed using quantitative polymerase chain reaction. Inflammatory biomarkers (c-reactive protein (CRP), interleukin-6 (IL-6), soluble tumor necrosis factor receptor 2 (sTNFR-2)) were assessed. Nine census tract measures of income, home value, earnings from rent and dividends, education, and demographics in 1990 were assigned to each participant's address (home for NHS, home or work for HPFS) at the time of blood draw. We z-scaled component measures, and then summed together to create a nSES score. Associations between nSES and log-transformed biomarkers were estimated using linear regression models adjusted for individual level demographics, disease history, and lifestyle factors.

RESULTS: Participants with available biomarker data ranged from 9,481 (IL-6) to 15,400 (CRP). Women (57.4 years) were younger than men (62.5 years). Adjusted models revealed no association between nSES and rLTL in women (β for 1-unit increase in nSES z-score=0.001, 95% CI: -0.003, 0.005) or men (β =0.001, 95% CI: -0.001, 0.003). However, in women, higher nSES was associated with lower circulating levels of CRP (β =-0.008, 95% CI: -0.013, 0.002), IL-6 (β =-0.006, 95% CI: -0.010, 0.002), and sTNFR-2 (β =-0.002, 95% CI: -0.004, -0.0004). In men, nSES was not associated with CRP, but weaker



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inverse associations for IL-6 ($\beta=-0.004$, 95% CI: -0.010, 0.001) and sTNFR-2 ($\beta=-0.004$, 95% CI: -0.006, -0.0013) were observed.

CONCLUSIONS: Findings suggest that inflammation, rather than cellular aging, may mediate stress-related consequences of nSES.

Keywords: Built environment, internal exposome, socio-economic factors, cancer and cancer-precursors, environmental epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 6

Bringing It All Back Home: Cancer and the Residential Environment

Chairs: Julia Heck, United States & Mary Ward, United States

O-TO-028

Air pollution » General

Screening-level assessment of cancer risk associated with ambient air exposure in Aamjiwnaang First Nation

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BACKGROUND AND AIM: The manuscript reports findings from a screening-level assessment of cancer risk from outdoor air in and around Aamjiwnaang First Nation. Aamjiwnaang is situated in the Sarnia-Lambton area, which is known for its industrial and petrochemical industry. The area is also known for poor air quality, chemical spills and other environmental events. Residents are concerned about the health impacts of these exposures. Ambient air pollution can contribute to cardiovascular, respiratory diseases, and certain types of cancer. Some communities may be at higher risk to these negative health impacts due to their geographical proximity to pollution sources.

METHODS: Outdoor air concentrations were collected from four monitoring stations in the Aamjiwnaang region for known carcinogens benzene and 1,3-butadiene. Air quality data from both current (2015-2016) and historical (1995-1996, 2005-2006) records were examined. Air concentrations were mapped with geographic information systems to assess spatial variations. Outdoor air concentrations were compiled and the Lifetime Excess Cancer Risks (LECR) associated with long-term exposure to known carcinogens were estimated.

RESULTS: LECR results for both benzene and 1,3-butadiene were above one per million. The LECR for benzene was 6.4 per million when the Health Canada slope factor was applied and 12.0 when using the US EPA. For 1,3-butadiene the LECR estimate was 8.8 per million. While air quality has improved over time, in 2015-2016 benzene and 1,3-butadiene levels were higher in Aamjiwnaang than provincial averages. Furthermore, benzene levels were above the Ambient Air Quality Criteria target.

CONCLUSIONS: We found that ambient air in and around Aamjiwnaang contains a higher annual average concentration of benzene than recommended and may be related to higher cancer risks. This work provides a better understanding of environmental exposures and potential associated cancer risks for residents in the Aamjiwnaang community. This study highlights the need for further air monitoring and a more detailed risk assessment.

Keywords: Cancer and cancer-precursors, Risk assessment, Air pollution



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 6

Bringing It All Back Home: Cancer and the Residential Environment

Chairs: Julia Heck, United States & Mary Ward, United States

O-TO-029

Cancer and Cancer-Precursors » Incidence

Ethylene oxide emissions and risk of breast cancer and Non-Hodgkin lymphoma in a large U.S. cohort

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BACKGROUND AND AIM: Ethylene oxide (EtO) is a carcinogenic gas used to sterilize medical equipment; emissions increased during the COVID-19 pandemic. We investigated the relationship between environmental EtO exposure and risk of two *a priori* suspect cancers based on limited occupational studies.

METHODS: Using the U.S. Environmental Protection Agency's Toxic Release Inventory (TRI), we estimated historical exposures (1987-1995) at the address of NIH-AARP Diet and Health Study participants enrolled in 1995-1996. We computed distance-weighted average emissions indices ($AEI = \sum [lbs\ EtO/km^2]$) reflecting the sum of annual EtO emissions for all TRI facilities within 3, 5, or 10km of the residence, and further weighted AEIs by the proportion of time the home was downwind of each facility. We evaluated incident Non-Hodgkin lymphoma (NHL) in the full cohort (N=451,945) and breast cancer (invasive and *in situ*) among postmenopausal women (N=173,670), overall and by subtype and disease characteristics. Hazard ratios (HRs) and 95% confidence intervals (CIs) were estimated for AEI categories versus no exposure in Cox models adjusting for demographic and site-specific potential confounders.

RESULTS: A total of 3,796 breast cancers and 1,671 NHL cases were diagnosed through 2011. We observed a non-significantly increased risk of breast cancer overall among those in the 95th percentile of the AEI within 3km (HR[P95.vs.0]=1.48, CI=0.93-2.35). Risk of breast cancer *in situ* increased with the AEI (p-trend<0.03 at 3, 5, and 10km), and the strength of the association declined with increasing distance from the home (HRs[Q4.vs.0]=1.67, 1.55, 1.29, respectively). No statistically significant associations were found by extent of disease or by hormone receptor status. At 5km, we found an elevated risk of NHL driven by a non-monotonic increase in follicular lymphoma (p-trend=0.11).

CONCLUSIONS: Our novel study suggests a positive association between EtO emissions and risk of *in situ*, but not invasive, breast cancer; differences by stage may have mechanistic implications. Inconsistent patterns of risk for NHL subtypes warrant additional evaluation.

Keywords: cancer and cancer precursors, long-term exposure, chemical exposures, environmental epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 6

Bringing It All Back Home: Cancer and the Residential Environment

Chairs: Julia Heck, United States & Mary Ward, United States

O-TO-030

Cancer and Cancer-Precursors » Incidence

Air pollution and breast cancer: an examination of modification by familial breast cancer risk

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BACKGROUND AND AIM: Women with a breast cancer family history may differ in their susceptibility to carcinogenic effects of environmental exposures. We evaluated whether associations between air pollution and breast cancer varied by underlying breast cancer risk predicted by a family history-based score among a population enriched with high-risk women.

METHODS: We included 48,453 Sister Study participants living in the contiguous US who were ages 35-74 at enrollment (2003-2009) and were followed-up for breast cancer through September 2019. Annual PM₁₀, PM_{2.5}, and NO₂ concentrations at enrollment residences were estimated using a regionalized universal kriging model. We predicted each woman's 1-year risk of breast cancer using the Breast and Ovarian Analysis of Disease Incidence and Carrier Estimation Algorithm (BOADICEA), a pedigree-based model incorporating cancer information on first- and second-degree relatives. We estimated hazard ratios (HRs) and 95% confidence intervals (CIs) using Cox regression. Associations between each pollutant and breast cancer were stratified by BOADICEA (> vs. ≤ median (0.46%)) and modification was examined using an air pollution-by-BOADICEA interaction term. Given the regional heterogeneity of air pollution, we also evaluated differences across US regions.

RESULTS: BOADICEA did not significantly modify the associations between the air pollutants and breast cancer. However, PM_{2.5} was associated with a higher breast cancer risk among women > median BOADICEA (PM_{2.5} quartile 4 vs. 1: HR=1.12; 95% CI: 0.99-1.26), but not ≤ median (HR=0.95; 95% CI: 0.82-1.10) (p-heterogeneity=0.3). This was particularly evident in the Southern US: PM_{2.5} quartile 4 vs. HR=1.41 (95% CI: 1.10-1.80) among those > median and HR=0.89 (95% CI: 0.66-1.20) among those ≤ median BOADICEA (p-heterogeneity=0.1).

CONCLUSIONS: We did not find strong evidence that women at greater underlying breast cancer risk are more susceptible to air pollution. Suggestive associations for PM_{2.5} among women at greater underlying risk who reside in the Southern US may warrant further investigation.

Keywords: Air pollution, particulate matter, cancer and cancer precursors



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 6

Bringing It All Back Home: Cancer and the Residential Environment

Chairs: Julia Heck, United States & Mary Ward, United States

O-TO-031

Cancer and Cancer-Precursors » Incidence

Environmental and social risk factors in association with spatial clustering of childhood cancer incidence

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BACKGROUND AND AIM: Childhood cancer incidence is known to vary by age, sex, and race/ethnicity, but evidence is limited regarding external risk factors. We aim to identify harmful combinations of air pollutants and other environmental and social risk factors in association with the incidence of childhood cancer based on 2003-2017 data from the Georgia Cancer Registry.

METHODS: We calculated the standardized incidence ratios (SIR) of Central Nervous System (CNS) tumors, leukemia and lymphomas based on age, gender and ethnic composition in each of the 159 counties in Georgia, USA. County-level information on eight carcinogenic air pollutants (benzene, trichloroethylene, ethylene-oxide, formaldehyde, pentachlorophenol, styrene, tetrachloroethylene, 1,3-butadiene), socioeconomic status, tobacco smoking, alcohol drinking and obesity were derived from US EPA and other public data sources. We applied an unsupervised learning tool (self-organizing map, SOM) to identify pertinent types of multi-exposure combinations. Spatial Bayesian Poisson models (Leroux-CAR) were fit with indicators for each multi-exposure category as exposure and SIR of childhood cancers as outcomes.

RESULTS: Based on county-level information of external risk factors, the SOM algorithm divided the state of Georgia into 5 distinct clusters (clusters 4-5 comprising metropolitan/urban areas). Mean SIR ranged from 0.8 (rural-cluster-1) to 1.1 (urban-cluster-5) for leukemia, 1.0 (rural-cluster-3) to 1.4 (rural-cluster-1) for lymphomas and 1.5 (rural-cluster-1) to 1.8 (urban-cluster-4) for CNS tumors. Children living in urban counties characterized by higher air pollution concentrations and proportions of alcohol drinking (urban-cluster-4) had higher SIR of childhood leukemia and lymphomas than children living in rural-cluster-1 (risk ratio [95%-credible intervals]: 1.3 [1.0,1.6]) and rural-cluster-3 (1.2 [1.0, 1.4]), respectively. We found no significant associations for spatial variation of CNS tumors.



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ABSTRACT E-BOOK

CONCLUSIONS: We found spatial clustering of childhood cancer in counties with higher air pollution concentrations and larger proportions of alcohol drinking. More research is needed to identify the causal risk factors for these associations.

Keywords: Air pollution, Cancer and cancer precursors, Children's environmental health, Socio-economic factors, Multi-pollutant, Environmental epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 6

Bringing It All Back Home: Cancer and the Residential Environment

Chairs: Julia Heck, United States & Mary Ward, United States

O-TO-032

Cancer and Cancer-Precursors » Incidence

Residential proximity to animal feeding operations and risk of lymphohematopoietic cancers in the Iowa Women's Health Study

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BACKGROUND AND AIM: Animal feeding operations (AFOs) are important sources of hazardous emissions into the surrounding environment. Residential proximity to farm animals has been linked to the risk of lymphohematopoietic malignancies in farming populations; we evaluated this relationship for the first time in the general population residing in agricultural areas.

METHODS: We linked enrollment (1986) addresses of 28,196 participants in the Iowa Women's Health Study, a population-based cohort of postmenopausal women, to a statewide database of permitted AFOs that included animal counts standardized by animal size and manure production (animal units [AUs]). We computed inverse distance-weighted total and animal type-specific AUs within 5km of residences, weighted by the time over a 10-year period (1986-1996) the participant resided downwind from each AFO. We estimated the risk of incident lympho- and hematopoietic malignancies and non-Hodgkin lymphoma (NHL) subtypes (hazard ratio [HR]; 95% confidence interval [CI]) for AU quartiles compared to those with no AUs within 5km, adjusting for demographic and lifestyle factors.

RESULTS: Through 2014, there were 663 and 262 cases of NHL and leukemia, respectively. We observed increased risk of NHL and some subtypes; however, associations were inconsistently positive and lacked monotonic trend. NHL risk was increased for the second quartile of total AUs within 5km (HR_{Q2.vs0}=1.25; CI:1.00-1.56) but not for the other quartiles (HR_{Q1.vs0}=1.06; HR_{Q3.vs0}=1.00; HR_{Q4.vs0}=1.02; ptrend=0.71). This association appeared to be driven by cattle AUs (HR_{Q2.vs0}=1.29; CI:1.01-1.65, ptrend=0.71). We also found positive and significant associations with specific quartiles of cattle exposures for follicular lymphoma (HR_{Q2.vs.0}=1.95; CI:1.04-3.66; ptrend=0.59) and diffuse large B-cell lymphoma (HR_{Q1.vs.0}=1.66; CI:1.04-2.66; ptrend=0.76). There were no associations for other animal types, other NHL subtypes, or leukemia.

CONCLUSIONS: In this first investigation in a population-based cohort, our findings of modest increases in NHL risk associated with animal agriculture near the home are consistent with limited prior studies in farming populations.

Keywords: Cancer and cancer precursors, Environmental Epidemiology, Female



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 7

Built Environment and Health

Chairs: Keren Agayshay, Israel & Richard Remigio, United States

O-TO-033

Exposome » External exposome

Urban Environment and Growth and Obesity in Preschool Children from Six European Birth Cohorts

Serena Fossati¹, Sandra Marquez¹, Charline Warembourg¹, Xavier Basagaña¹, Montserrat de Castro¹, Silvia Fernandez¹, Lea Maitre¹, Jose Urquiza¹, Theano Roumeliotaki², Marina Vafeiadi², Barbara Heude³, Remy Slama⁴, Sandra Andrušaitytė⁵, Regina Gražulevičienė⁵, Rosemary R C McEachan⁶, Oliver Robinson⁷, Line Småstuen Haug⁸, Cathrine Thomssen⁸, John Wright⁶, Lida Chatzi⁹, Mark Nieuwenhuijsen¹, Martine Vrijheid¹

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BACKGROUND AND AIM: Urban environmental exposures have been investigated separately in relation to growth and childhood obesity. In this study we aim to determine which prenatal and postnatal outdoor exposures are associated with childhood BMI, weight and height at age 3-4 years.

METHODS: Height and weight were measured in 11,325 children aged 3-4 years from a multi-centre European cohort (France, Greece, Lithuania, Norway, Spain, and UK). BMI was calculated using the formula weight/height². Age-and-sex-standardized z-scores were calculated for height, weight and BMI. Urban environment exposures were estimated during pregnancy and childhood, including air pollution, built environment, green spaces, traffic, noise, meteorology, and socioeconomic deprivation index. Exposure-wide association study was performed using multiple single exposure linear regression models and accounting for multiple testing.

RESULTS: Non linear associations were observed between exposure to Normalized Difference Vegetation Index (NDVI), a measure of greenness, and the outcomes leading to its categorization into tertiles. Pregnancy and postnatal NDVI in the first tertile were associated with greater height compared to the reference (second tertile), and remained statistically significant after correction for multiple testing (prenatal corrected *p*-value threshold for significance = 0.002; postnatal corrected *p*-value =



ABSTRACT E-BOOK

0.003). Other prenatal and postnatal markers of the urban environment such as walkability, building density and land use, nitrogen dioxide and fine particles were also associated with greater height, but were no longer statistically significant after correction for multiple testing. Fine particles during pregnancy were associated with higher BMI, and prenatal NDVI in the first tertile and air pollution were also associated with higher weight, but the *p*-values for these associations were above the corrected threshold for multiple testing.

CONCLUSIONS: Living in a less green and more densely built and walkable area may affect preschool height in a positive manner.

Keywords: External exposome, Green space, Built environment, Children's environmental health, Obesity and metabolic disorders



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 7

Built Environment and Health

Chairs: Keren Agayshay, Israel & Richard Remigio, United States

O-TO-034

Birth and Pregnancy Outcomes » Birth outcomes

A Cross-sectional Study of Brownfields and Birth Defects

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²United States Environmental Protection Agency

BACKGROUND AND AIM: The term brownfield is used to denote a multitude of abandoned and disused sites, spanning many former purposes. Brownfields represent a heterogeneous yet ubiquitous exposure for many Americans, which may contain hazardous waste and represent urban blight. Neonates and pregnant individuals are often sensitive to subtle environmental exposures. For this reason, we conducted a study evaluating if residential brownfield exposure was associated with birth defects.

METHODS: Using North Carolina birth records from 2003-2015 we sampled 753,195 births, identifying 37,758 defects across 29 different birth defect phenotypes. Due to the rarity of some birth defects we also examined several defect groups. Number of brownfields within a 2000m buffer of the residential address at birth was summed. We utilized multivariable logistic regression models adjusted for multiple demographic and environmental covariates available from birth records, 2010 Census, and EPA's environmental quality index to calculate odds ratios (OR) and 95% confidence intervals (CI).

RESULTS: While we observed null associations for most individual defects, associations with Atrial Septal defect (ASD) and Ventricular Septal defect (VSD) were positive (OR 1.12; 95%CI 1.05-1.19 and OR 1.14; 95%CI 1.02-1.27, respectively). We observed an inverse association with gastroschisis (OR 0.72; 95%CI 0.56-0.92). We found null associations for central nervous, orofacial, urinary, and chromosomal defect groups, and positive associations for cardiovascular and external defect groups (OR 1.09; 95%CI 1.04-1.15 and OR 1.15; 95%CI 1.00-1.33, respectively). Additional analyses indicated an exposure-response relationship for several defects (i.e. ASD, VSD, and the cardiovascular defect group), where the magnitude of the OR increased as the number of brownfields in the 2000m buffer increased.

CONCLUSIONS: There is some indication that residential proximity to brownfields is associated with birth defects, especially cardiovascular defects. More tailored adjustment schemes and in-depth analyses of individual defects may reveal additional novel associations. This abstract does not reflect EPA policy.

Keywords: birth outcomes, built environment, hazardous waste



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 7

Built Environment and Health

Chairs: Keren Agayshay, Israel & Richard Remigio, United States

O-TO-035

Built environment » Green space

Associations of greenspace and cardiorespiratory mortality are driven by private residential gardens: observational evidence from UK Biobank

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BACKGROUND AND AIM: Longitudinal evidence linking urban greenspace to reduced rates of all-cause and cause-specific mortality has mostly been established using greenness measures of limited specificity such as indices of vegetation (e.g. the Normalized Difference Vegetation Index). Here, we explored the effect of greenspace function on premature cardiorespiratory mortality in a national cohort, by analyzing types of greenspace in proximity to place of residence.

METHODS: We assessed associations of greenspace type (including private residential garden, public park, etc.) with all-cause, non-injury, cardiovascular disease (CVD) and respiratory disease deaths using UK Biobank in England – a large, national prospective cohort of adults. We adjusted for individual and area-level confounders, and stratified analyses by sex, household income, and area-level deprivation. In sensitivity analyses, we further adjusted for air pollution, road-traffic noise, indirect household/workplace smoke exposure, physical activity, and length of time residing at address.

RESULTS: In 232,926 participants we observed 13,586 all-cause, 13,645 non-injury, 2881 CVD, and 1015 respiratory disease deaths during 2,577,044 person-years of follow-up. The amount of private residential garden cover was inversely associated with all-cause, non-injury, CVD, and respiratory disease mortality, after adjustment for confounders. Effect estimates were also protective, though attenuated, for total greenspace cover and premature mortality. Findings were robust to sensitivity analyses. Stratified analyses indicated that sex, household income, and area level deprivation modified associations.

CONCLUSIONS: Our finding that private residential gardens substantially contributed to protective associations of total greenspace and premature mortality has implications for greening policies. Inequities in access, ownership, and use of private residential gardens, and potential health inequities, should be addressed.

Keywords: Green space, Built environment, Cardiovascular diseases, Respiratory diseases, Mortality, Environmental disparities



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 7

Built Environment and Health

Chairs: Keren Agayshay, Israel & Richard Remigio, United States

O-TO-036

Air pollution » Particle components

Assessing the Effect of Ultraviolet Radiation, Residential Greenness and Air Pollution on Vitamin D Levels: A Cohort Study in China

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BACKGROUND AND AIM: Vitamin D is obtained in the diet or from exposure to ultraviolet rays, and thus can be modified by environment factors. We aim to assess individual and combined effects of ultraviolet (UV) radiation, residential greenness, and air fine particulate matter (PM_{2.5}) with vitamin D levels in a community-based cohort study of elderly aged over 65 years old in China.

METHODS: We used the 2012-2014 Chinese Longitudinal Healthy Longevity Survey data for analysis, obtained daily UV radiation from the closest monitoring station and measured residential greenness through satellite-derived Normalized Difference Vegetation Index (NDVI) in a 500 m radius around address. Annual PM_{2.5} was calculated using satellite-based data (0.1 degrees × 0.1 degrees). Vitamin D levels were defined according to serum 25-hydroxyvitamin D: non-deficiency (≥50 nmol/L) and deficiency (<50 nmol/L). We used the generalized estimating equation for longitudinal analysis, adjusting sociodemographic information, eating habits, lifestyle, and season of blood draw.

RESULTS: We included 1336 participants, with a mean age of 83 at baseline. In single exposure models, UV radiation and greenness were positively associated with vitamin D non-deficiency, while PM_{2.5} was inversely associated with it. In the saturated model with three-exposures, each 0.1-MJ/(m²·d) increase in annual UV radiation was associated with a 86% higher odds of vitamin D non-deficiency [odds ratio (OR) 95% CI: 1.50, 2.30], each 0.1-unit increase in annual NDVI was 22% higher odds of vitamin D non-deficiency (OR 95% CI: 1.10, 1.36), while each 10-μg/m³ increase annual PM_{2.5} was associated a 20% lower odds of vitamin D non-deficiency (OR 95% CI: 0.74, 0.85). In our stratified analysis assessing effect modification, the association of UV and vitamin D non-deficiency was strongest in the lowest PM_{2.5} area and highest greenness area.

CONCLUSIONS: UV radiation, residential greenness, and PM_{2.5} are associated with vitamin D deficiency, and can influence aging pathways and elderly health.

Keywords: Air pollution, Green Space, Environmental epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 7

Built Environment and Health

Chairs: Keren Agayshay, Israel & Richard Remigio, United States

O-TO-037

Built environment » Green space

More green, less lonely? A longitudinal cohort study

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BACKGROUND AND AIM: Urban greening may reduce loneliness by offering opportunities for solace, social reconnection, and supporting processes such as stress relief. We (i) assessed associations between residential green space and cumulative incidence of, and relief from, loneliness over four years; and (ii) explored contingencies by cohabitation status.

METHODS: Multilevel logistic regressions of change in loneliness status in 8,049 city-dwellers between 2013 (baseline) and 2017 (follow-up). Associations with objectively-measured discrete green space (e.g. parks) buffers (<400m, <800m and <1600m) were adjusted for age, sex, disability, cohabitation status, children and socioeconomic variables. Results were translated to absolute risk reductions in loneliness per 10% increase in urban greening.

RESULTS: The absolute risk of loneliness rose from 15.9% to 16.9% over the four years; however, 10% increase in urban greening within 1600m was associated with lower cumulative incident loneliness (OR=0.927, 95%CI=0.862 to 0.996; absolute risk reduction=0.66%). Stronger association was observed for people living alone (OR=0.828, 95%CI=0.725 to 0.944). In comparison to people with <10% green space, odds ratios for cumulative incident loneliness were 0.833 (95%CI=0.695 to 0.997), 0.790 (95%CI=0.624 to 1.000) and 0.736 (95%CI=0.549 to 0.986) for 10-20%, 20-30%, and >30% green space, respectively. Compared to the <10% green space reference group with a 13.78% baseline risk of cumulative incident loneliness and 15.9% prevalent loneliness, associations translated to absolute risk reductions of 1.70%, 2.26% and 2.72% within populations at 10-20%, at 20-30%, and at >30% green space, respectively. These associations were stronger again for people living alone with 10-20% (OR=0.608, 95%CI=0.448 to 0.826), 20-30% (OR=0.649, 95%CI=0.436 to 0.966) and >30% (OR=0.480, 95%CI=0.278 to 0.829) green space within 1600m. No associations with green space within 400m or 800m, or relief from loneliness reported at baseline were observed.

CONCLUSIONS: Lower cumulative incidence of loneliness was observed among people with more green space within 1600m of home, especially for people living alone.

Keywords: green space, environmental justice, mental health outcomes



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 8

Exposure Assessment: Air Pollution

Chairs: Yuming Guo, Australia & Rachel Tham, Australia

O-TO-038

Exposure Assessment Methods » Exposure assessment-air pollution

New monitoring paradigms and designs for air pollution assessment in epidemiologic cohorts

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BACKGROUND AND AIM: Both exposure monitoring and exposure prediction have played key roles in assessing individual-level long-term average exposure to air pollutants and their associations with mortality, incidence, and disease progression. While there have been notable advances in exposure prediction methods, improvements in monitoring designs are also necessary, particularly given new monitoring paradigms leveraging low cost sensors (LCS) and mobile platforms. We aimed to provide a conceptual summary of novel monitoring designs for air pollution cohort studies using new paradigms and technologies, and to investigate their characteristics in real-world examples.

METHODS: We propose a conceptual summary that focuses on two overarching types of monitoring designs: mobile and non-mobile, as well as their subtypes. We defined the mobile monitoring design as monitoring from a mobile platform; this was divided into stationary and non-stationary designs depending on whether stops in travel were included. We defined the non-mobile monitoring design as stationary monitoring from permanent or temporary locations that incorporate cost-effective sampling devices. In the non-mobile long-term design, monitoring equipment was deployed at a few fixed sites for one or several years, whereas the short-term design included a few weeks of simultaneous monitoring a few times a year at many rotating or non-rotating sites.

RESULTS: Each monitoring design type had different unique features in real-world studies. Mobile monitoring studies mostly focused on less commonly measured traffic-related pollutants such as ultrafine particles and operated from single platform given expensive instruments. In contrast, many non-mobile monitoring studies measured criteria pollutants and incorporated LCS at many sites owing to their reduced cost; they also allowed for community participation when data are shared online.

CONCLUSIONS: Our conceptual monitoring design framework and plans to compare input resources and corresponding costs for each design will provide practical guidance to exposure assessment campaigns that leverage new technology in epidemiological studies.

Keywords: Air pollution, Cohort, Epidemiology, Exposure assessment, Monitoring design, New technology



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 8

Exposure Assessment: Air Pollution

Chairs: Yuming Guo, Australia & Rachel Tham, Australia

O-TO-039

Exposure Assessment Methods » Exposure assessment-air pollution

A Random Forest Model for PM_{2.5} Personal Exposure Assessment for a Chinese Cohort

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BACKGROUND AND AIM: Errors in air pollution exposure assessment are often considered a major limitation in epidemiologic studies. However, it is difficult to obtain accurate personal level exposure on cohort populations due to the often prohibitively expensive costs. Personal exposure estimation models are used in lieu of personal exposures, but still suffer from the issues of availability and accuracy. We aim to establish a personal PM_{2.5} exposure assessment model for a cohort population, and assess its performance by applying our model on cohort subjects.

METHODS: We analyzed data from representative sites selected from the Sub-Clinical Outcomes of Polluted Air in China (SCOPA-China) cohort study, and established a random forest model to estimate PM_{2.5} personal exposure. Parameters obtained from questionnaires and outdoor and meteorological monitoring sites were pre-screened using the Boruta algorithm, and parameter contributions were evaluated using the rank of variable importance. We also applied the model among subjects recruited in the above project within the same area and study period to estimate the reliability of the model.

RESULTS: The established model showed good fit with an R² of 0.81. Ambient PM_{2.5} contributed the most to personal exposure concentrations, and indoor passive smoking, meteorological parameters, and durations in different microenvironments also ranked high in feature importance. The model application results showed similar patterns with empirically measured data, supporting the performance of our established model.

CONCLUSIONS: Our pilot study provided a validated and feasible modeling approach to assess personal PM_{2.5} exposure for large cohort populations, and the preliminary application among cohort subjects proved satisfactory. The promising model framework can improve PM_{2.5} exposure assessment accuracy for future environmental health studies of large populations.

Keywords: Particulate matter, Exposure assessment, Methodological study design, Modeling



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 8

Exposure Assessment: Air Pollution

Chairs: Yuming Guo, Australia & Rachel Tham, Australia

O-TO-040

Air pollution » Particulate matter

Personal exposure to particulate matter in various modes of transport in Kathmandu, Nepal

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BACKGROUND AND AIM: Particulate matter pollution concentration in Kathmandu valley exceeded up to 9 fold higher than the World Health Organization 24 hour guidelines. Daily commuting to work in a vehicle increases particulate matter exposure and it is influenced by mode and time of commuting. This study aims to investigate the effect of commuting in various modes of transportation on personal exposure to particulate matter with aerodynamic diameter $\leq 2.5 \mu\text{m}$ (PM_{2.5}).

METHODS: Real-time personal exposure to PM_{2.5} was monitored in four different modes of transportation: personal bike, private cars, public cars (taxi) and bicycle. The exposure was monitored for each transport mode in three different road stretches of Kathmandu twice a day for peak hours and off-peak hours. The measurements were repeated for each transport mode for 10 measurement days in all three routes.

RESULTS: The result showed that peak hour average concentration of PM_{2.5} for all mode of transport was higher than the average concentration during off peak hour in all three routes. There was a variation in average concentrations in all transport mode, and the commuters travelling through bicycle were exposed to highest average PM_{2.5} (205 $\mu\text{g}/\text{m}^3$) in all road stretches during peak hours. However, off peak hours average concentration was lowest for cyclists (86 $\mu\text{g}/\text{m}^3$) as compared to other transport modes. The commuters travelling through bike (193 $\mu\text{g}/\text{m}^3$), taxi (155 $\mu\text{g}/\text{m}^3$) and car (150 $\mu\text{g}/\text{m}^3$) were exposed to respective decreasing peak hour average concentrations of PM_{2.5}.

CONCLUSIONS: This study showed the effect of commuting on different modes of transport during peak and off peak hour on personal exposure to particulate matter. The result of this study hence helps commuters to choose appropriate travel arrangements to minimize exposure to ambient air particulates.

Keywords: Personal exposure, Particulate matter, PM_{2.5}, Mode of transport



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 8

Exposure Assessment: Air Pollution

Chairs: Yuming Guo, Australia & Rachel Tham, Australia

O-TO-041

Air pollution » Particulate matter

Predictors of indoor PM_{2.5} and CO in an urban slum settlement in Fort Portal city, Uganda

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BACKGROUND AND AIM: Poor Indoor Air Quality (IAQ) is one of the leading causes of respiratory and cardiopulmonary ailments. This study assessed household predictor characteristics of concentration of PM_{2.5} and CO concentration in cooking and living areas in Kisenyi-Mugunu an urban slum in Fort Portal city, Uganda.

METHODS: A cross sectional study was conducted by identifying of household predictor characteristics using household interviews and observational checklists. PM_{2.5} and CO concentration were measured using Temtop Air Quality Monitor LKC-1000E and EXTECH CO260 Carbon Monoxide/Carbon Dioxide IAQ Meter respectively. Linear logistic regression was used to determine associations between household predictor characteristics and level of PM_{2.5} and CO concentration in cooking and living areas.

RESULTS: Wood fuel was used by 97.59% (365/374) respondents and 88.77% (332/374) using charcoal with 83.16% (311/374) using traditional cook stoves. Half, 51.87% (194/374) of respondents cooked from outdoors and 32.09% (120/374) cooked in a separate building outside the house. Mean PM_{2.5} concentration for the cooking and living areas was 175.93µg/m³ and 124.29 µg/m³ respectively above the WHO Air Quality Guidance of 35µg/m³ for 24hr. Mean CO for cooking areas and living areas were 41.22ppm and 5.23ppm respectively above the 24hr WHO Air Quality Guidance of 6ppm. PM_{2.5} in the cooking area was associated with the main type of cooking fuel (coefficient=60.36, 95% CI: 43.76 - 76.95, 95) and distance of cooking area from main entrance (coefficient=20.32, 95% CI: 3.14 -37.50). CO in the living area was associated with hours spent cooking (coefficient = -2.37, 95% CI: -4.46 - -0.25) and cooking outdoors (coefficient = -9.95, 95% CI: -17.83 - -2.06).

CONCLUSIONS: The PM_{2.5} and CO concentrations were found to be unacceptable for the cooking and living areas. This implies the need for both health and city authorities to priorities promoting cleaner cooking energy and planned development.

Keywords: PM_{2.5}, CO, predictors, slum, Uganda



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 8

Exposure Assessment: Air Pollution

Chairs: Yuming Guo, Australia & Rachel Tham, Australia

O-TO-042

Air pollution » Particulate matter

A Deep Learning Approach for Meter-Scale Air Quality Estimation in Urban Environments Using Very High-Resolution Satellite Imagery

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BACKGROUND AND AIM: Air Quality (AQ) is currently measured using ground monitoring stations which require funding and infrastructure to support and lack spatial coverage. In contrast, high-resolution commercial satellite imagery (≤ 2 m/pixel) can be produced for almost any location on Earth and is readily available. The goal of this project is to develop a pipeline that uses MAXAR satellite imagery to produce meter-scale, continuous maps of AQ for any city around the globe, with greater resolution and coverage than existing methods.

METHODS: We developed a Deep Neural Network (DNN) model that can produce AQ estimates for previously unseen urban locations using satellite imagery. The model is based on the VGG-16 pretrained neural network architecture. We used this architecture to extract spatial features from satellite imagery that are passed on to Fully Connected layers to produce an estimate of PM_{2.5} and NO₂ concentrations. We partitioned satellite imagery into 612,248 patches and fed these patches into the model to produce a 100m (200m) continuous grid of PM_{2.5} (NO₂) estimates.

RESULTS: We fed the high-resolution (0.5m–2.5m) commercial satellite imagery to a DNN to learn the association between visual urban features and air pollutants. The developed model, which solely uses satellite imagery, was tested and evaluated using both ground monitoring observations and land-use regression modeled PM_{2.5} and NO₂ concentrations over London, Vancouver (BC), Los Angeles, and New York City. The results demonstrate a low error with a total RMSE $< 2 \mu\text{g}/\text{m}^3$ and highlight the contribution of specific urban features, such as green areas and roads, to continuous meter-scale AQ estimations.

CONCLUSIONS: This approach offers promise for scaling to global applications in developed and developing urban environments. Further analysis on domain transferability will enable application of a parsimonious model based merely on satellite images to create meter-scale AQ maps in developing cities, where current and historical ground data is limited.

Keywords: Air quality, Remote Sensing, Urban environment, Deep learning, Satellite Imagery



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 9

Phthalate Exposures and Health

Chairs: Nan Li, United States & Nikolas Stratakis, United States

O-TO-043

Chemical exposures » Phthalates

Association between urinary concentration of phthalate metabolites and allergic disorders in Korean children: Korean National Environmental Health Survey (KoNEHS) 2015-2017

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BACKGROUND AND AIM: Phthalates are common industrial chemicals used primarily as plasticizers that make plastic flexible. Children are more prone to these chemicals through various routes of exposure including dermal absorption, inhalation, and ingestion (such as food, water, and dust) than adults and several studies have reported that phthalate exposure may increase the risk of allergic diseases. Therefore, we aimed to examine the association between urinary concentration of phthalate metabolites and allergic disorders in a nationally representative sample of Korean children.

METHODS: In this study, we used data on urinary phthalate metabolites, allergic symptoms such as atopic dermatitis (AD), asthma, and allergic rhinitis (AR), and serum total immunoglobulin E (IgE) levels from participants aged 3–17 in the Korean National Environmental Health Survey 2015–2017. After adjusted for all covariates, Odds ratio (OR) and their 95% confidence intervals (95% CI) per one ln–unit increase change in the concentration of phthalate metabolites were estimated using logistic regression.

RESULTS: Urinary high–molecular–weight phthalate metabolites (HMW) were positively associated with current AD and AR. A significant increase of the OR for high group of IgE levels with increase of urinary mono-(carboxynonyl) phthalate (MCNP) concentrations was found [OR=1.43 (1.06, 1.91)]. Mono–benzyl phthalate, mono–(carboxyoctyl) phthalate, and mono–(2–ethyl–5–oxohexyl) phthalate were positively associated with allergic multimorbidity which means co–occurrence of at least two allergic diseases in one individual. Children with high IgE were more likely to have an AR associated MCNP than those with low IgE or high IgE only ($p = 0.007$). Specifically, we estimated that 14.7% of total effect of MCNP on AR was mediated by IgE. However, no phthalate metabolites were significantly associated with current asthma.

CONCLUSIONS: Our observations revealed that some HMW phthalate metabolites were positively associated with current allergic symptoms and high total IgE levels in children. These results suggested that environmental exposure to phthalates could enhance allergic response in children.

Keywords: Atopic dermatitis, Asthma, Allergic rhinitis, Allergic multimorbidity, Total immunoglobulin E, Phthalate metabolites



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TRADITIONAL ORAL SESSION 9

Phthalate Exposures and Health

Chairs: Nan Li, United States & Nikolas Stratakis, United States

O-TO-044

Chemical exposures » Phthalates

Prenatal Maternal Phthalate Exposures and Trajectories of Childhood Adiposity from Four to Twelve Years

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BACKGROUND AND AIM: Trajectories of child adiposity have lifelong consequences for future cardiometabolic risk. Prenatal phthalate exposures may affect processes that pre-program later childhood adiposity, but findings from studies examining these associations are conflicting. We examined associations between individual phthalate exposure biomarkers and total phthalate mixture during pregnancy with child adiposity trajectories.

METHODS: Data were from 514 mother-child pairs in the PROGRESS cohort of Mexico City. We quantified 15 phthalate metabolites in 2nd and 3rd trimester maternal urine samples and created an average pregnancy measure using the geometric mean. We evaluated the 15 metabolites as nine biomarkers, including four metabolite molar sums. We measured child BMI z-score, bioimpedance-based fat mass index (FMI), and waist-to-height ratio (WHtR) at three visits between four and twelve years of age. We identified trajectories using multivariate latent class growth modeling, considering BMI z-score, FMI, and WHtR as joint indicators of latent adiposity. We then estimated associations of phthalate biomarkers with class membership using multinomial logistic regression. We used quantile g-computation to estimate the effect of the total phthalates mixture and assessed effect modification by sex.

RESULTS: We detected three trajectories of child adiposity, “low-stable” remained stable at low adiposity (n=260), “low-high” started low then increased to high (n=147), and “high-high” started high and remained high (n=107). A doubling of the sum of di(2-ethylhexyl) phthalate metabolites (Σ DEHP), was associated with greater odds of being in the “high-high” trajectory (adjusted odds ratio [OR] = 1.53



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[1.08, 2.19]; $p = 0.02$) in comparison to the “low-stable” group, whereas a doubling in mono(carboxy-isononyl) phthalate (MCNP) was associated with lower odds of being in the “low-high” trajectory (adjusted OR = 0.66 [0.45, 97]; $p = 0.03$). No sex-specific or total mixtures associations were detected. **CONCLUSIONS:** Pregnancy urinary concentrations of Σ DEHP metabolites and MCNP were associated with trajectories of child adiposity in opposing directions.

Keywords: Phthalates, Children's environmental health, Environmental epidemiology, Mixtures analysis



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TRADITIONAL ORAL SESSION 9

Phthalate Exposures and Health

Chairs: Nan Li, United States & Nikolas Stratakis, United States

O-TO-045

Chemical exposures » Phthalates

Association of phthalate replacement DINCH metabolite concentrations with adiposity in a multi-site, multi-racial cohort of children

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BACKGROUND AND AIM: 1,2-cyclohexane dicarboxylic acid diisononyl ester (DINCH) is a recent plasticizer replacing high molecular weight phthalate diesters in items such as toys, medical devices, and food packaging. Little is known regarding the association of DINCH exposure and adiposity in children.

METHODS: Analyses included 629 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 at 10 US sites. Urinary oxidative metabolites of DINCH (cyclohexane-1,2-dicarboxylic acid mono carboxyisooctyl [MCOCH] and cyclohexane-1,2-dicarboxylic acid mono hydroxyisononyl [MHNCH] esters) were determined using liquid chromatography tandem-mass spectrometry (UPLC-ESI-MS/MS). Values were divided by molecular weight and summed to obtain a composite DINCH value (nmol/ml). Outcomes were child's body mass index (BMI) z-score, waist circumference z-score, percent body fat, and categorized BMI percentiles (<85, 85 to <95, ≥95). Multivariable linear and logistic regression models adjusted for urine specific gravity, gender, age, race/ethnicity, birth weight, prolonged exclusive breastfeeding, reported physical activity level, frequency of fast-food consumption, cigarette smoke exposure, neighborhood traffic, mother's education and pre-pregnancy BMI were used to analyze the association between natural log transformed DINCH levels and outcomes.

RESULTS: 88% of children had DINCH levels at or above the limit of detection. For each unit increase in natural log transformed DINCH there was a significant decrease in BMI z-score (β [95% CI]: -0.103 [-0.180, -0.026]), waist circumference z-score (β [95% CI]: -0.126 [-0.198, -0.054]) and percent body fat (β [95% CI]: -0.022 [-0.035, -0.009]). DINCH levels were not associated with overweight [OR=0.82 (95% CI: 0.66, 1.02)] or obese [OR=0.88 (95% CI: 0.69, 1.12)] versus normal BMI percentile categories.

CONCLUSIONS: In this cross-sectional analysis there were significant inverse associations between children's DINCH exposure levels and adiposity measures. Additional research is needed to confirm this association and identify possible interactions between DINCH and joint exposure to other related chemicals.

Keywords: Phthalates, Obesity and metabolic disorders, Children's environmental health



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TRADITIONAL ORAL SESSION 9

Phthalate Exposures and Health

Chairs: Nan Li, United States & Nikolas Stratakis, United States

O-TO-046

Chemical exposures » Phthalates

The association of gestational and childhood phthalate exposure with adolescent hair cortisol: The HOME Study

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BACKGROUND AND AIM: Phthalate exposure during gestation and childhood may disrupt the hypothalamic-pituitary-adrenocortical (HPA) axis to adversely impact children's neurodevelopment and cardiometabolic health. We evaluated associations of serial urinary phthalate metabolite concentrations with hair cortisol, a measure of HPA-axis homeostasis, to identify periods of heightened susceptibility during gestation, infancy, and childhood.

METHODS: We recruited pregnant women from Cincinnati, Ohio (2003-2006) and followed their children until age 12 years. We quantified urinary phthalate metabolites twice during gestation and up to six-times during childhood (1, 2, 3, 4, 5, 8 years). At age 12 years, we quantified children's hair cortisol concentrations (pg/mg hair). We estimated covariate-adjusted associations of log₁₀-transformed average gestational or average childhood (1-8 years) phthalate metabolites with log₁₀-transformed hair cortisol using linear regression. We used multiple informant models to estimate associations of serial phthalate measures with hair cortisol and assess the heterogeneity of this association across ages (n=207).

RESULTS: The median hair cortisol concentration was 2.2 pg/mg (25th,75th percentile= 1.3, 5.2). We did not find evidence of an association between gestational phthalate metabolites and hair cortisol. However, each interquartile range (IQR) increase in average childhood ΣDEHP, MCP, and MEP was associated with 289% (95%CI: 38, 996%), 78% (95%CI: -9, 255%), and 78% (95%CI: 15, 175%) higher hair cortisol concentrations, respectively; these associations did not vary by exposure period (heterogeneity p-values=0.53, 0.41, and 0.35, respectively). Positive associations of MBzP and MCOP with hair cortisol were stronger for exposure at infancy than in later childhood (heterogeneity p-values=0.06 and 0.16, respectively). An IQR increase in MBzP at age one year and MCOP at age two years was associated with 164% (95%CI: 56, 349%) and 77% (95%CI: 22, 155%) higher hair cortisol concentrations, respectively.

CONCLUSIONS: Higher urinary concentrations of several phthalate metabolites during childhood, but not gestation, were associated with elevated hair cortisol concentrations in adolescence.



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ABSTRACT E-BOOK

Keywords: phthalates, cortisol, development, susceptibility



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August 23, 2021 / 19:00 - 20:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 9

Phthalate Exposures and Health

Chairs: Nan Li, United States & Nikolas Stratakis, United States

O-TO-047

Chemical exposures » Phthalates

Assessment of metabolic perturbations associated with prenatal phthalate exposure among pregnant African American women

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BACKGROUND AND AIM: Phthalates have been linked with numerous harmful health effects. Limited data are available on the molecular mechanism underlying phthalate toxicity on human health. In this analysis, we measured urinary phthalate metabolites and conducted high-resolution metabolomics (HRM) to identify biological perturbations associated with phthalate exposures among pregnant African American (AA) women, who are disproportionately exposed to high phthalates levels.

METHODS: We used untargeted HRM profiling to characterize serum samples collected during early (8-14 weeks gestation) and late (24-30 weeks gestation) pregnancy from 73 participants from the Atlanta AA Maternal-Child cohort. We measured 8 urinary phthalate metabolites in early and late pregnancy, including Monoethyl phthalate (MEP), Mono-n-butyl phthalate (MBP), Mono(2-ethylhexyl) phthalate (MEHP), and Mono (2-ethyl-5-hydroxyhexyl) phthalate (MEHHP), to assess maternal exposures to phthalates. Metabolite and metabolic pathway perturbation were evaluated using an untargeted HRM workflow.

RESULTS: Geometric mean creatinine-adjusted levels of urinary MEP, MBP, MEHP, and MEHHP were 67.3, 6.6, 1.4, and 4.1 $\mu\text{g/g}$ creatinine, respectively, with MEP and MEHP higher than the mean levels of Non-Hispanic blacks in the general US population (2015-2016). There were 814 and 1,435 metabolic features significantly associated with at least one phthalate metabolites during early and late pregnancy, respectively. Metabolic pathway enrichment analysis revealed perturbations in four inflammation- and oxidative stress-related pathways associated with phthalate metabolite levels during both early and late pregnancy, including glycerophospholipid, urea cycle, arginine, and tyrosine metabolism. We confirmed 10 metabolites associated with urinary phthalates, including thyroxine and thiamine, which were negatively associated with MEP, as well as tyramine and phenethylamine, which were positively associated with MEHP and MEHHP.

CONCLUSIONS: Our results demonstrate that urinary phthalate levels are associated with perturbations in biological pathways connected with inflammation and oxidative stress. The findings support future hypothesis-testing investigations on potential molecular mechanisms underlying the impact of maternal phthalates exposure on adverse health outcomes.

Keywords: Phthalates, Metabolomics, Prenatal Phthalate Exposures, Biological Pathway



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 9

Phthalate Exposures and Health

Chairs: Nan Li, United States & Nikolas Stratakis, United States

O-TO-048

Chemical exposures » Phthalates

Pregnancy exposure to phthalates and placental DNA methylation in the French EDEN cohort

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BACKGROUND AND AIM: Foetal growth and development strongly depend upon the health of the placenta. Prenatal exposure to phthalates has been hypothesized to be associated with differential DNA methylation, however epigenome-wide studies on placental tissue are lacking.

The aim of this study was to characterize associations between pregnancy urinary concentrations of phthalate metabolites and placental DNA methylation.

METHODS: We measured concentrations of 11 phthalate metabolites in maternal spot urine samples collected between 22-29 gestational weeks in 202 mother-son pairs. We analysed DNA methylation levels in term placental tissue using IlluminaHM450 BeadChips. We performed an adjusted epigenome-wide association study (EWAS) and identified differentially methylated regions (DMRs, ≥ 5 CpGs). We also evaluated DNA methylation of repetitive elements Alu and LINE-1.

RESULTS: We identified 6 DMRs associated with urinary concentrations of phthalate metabolites. Monoethyl phthalate (MEP) was positively associated with 2 DMRs encompassing imprinted genes (SGCE/PEG10) and a gene involved in the immunological response (GCA). Other positive associations were detected for: monocarboxy-iso-nonyl-phthalate (MCNP) and HSPA1A/HSPA1L genes encoding heat shock proteins; mono(3-carboxypropyl)-phthalate (MCPP) and ART5 encoding protein responsible for protein function regulation; mono-iso-butyl-phthalate (MiBP) and transcription factor coding REPIN1 gene. The only negative association was identified between mono(2-ethylhexyl)-phthalate (MEHP) exposure and DMR encompassing transcription factor coding ZSCAN16 gene. Finally, we found that pregnancy monobenzyl phthalate concentrations were negatively associated with placental methylation of Alu repeats.



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CONCLUSIONS: Our study is the first one to describe the genome-wide epigenetic modifications of placental DNA in association with pregnancy exposure to phthalates. Some phthalates may be associated with differential methylation of placental DNA, including changes in repetitive element methylation. Interestingly, 1 of the 5 highlighted phthalate metabolites has been associated with the placental-to-foetal weight ratio in a previous study relying on EDEN cohort.

Keywords: Phthalates, Endocrine disrupting chemicals, Chemical exposures, Birth outcomes, Epigenomics



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 10

Women's Environmental Health

Chairs: Lauren Wise, United States & Traci Bethea, United States

O-TO-049

Reproductive Outcomes » Female reproductive outcomes

Multiple exposures to persistent organic pollutants and diminished ovarian reserve: findings from a French case-control study

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BACKGROUND AND AIM: The main cause of female infertility after the age of 35 is diminished ovarian reserve (DOR). Several persistent organic pollutants (POPs) have been associated with an increased time-to-pregnancy but research on the effect of POPs on DOR is limited.

METHODS: Our study included 139 cases and 153 controls from the AROPE case-control study. Study participants were women between the ages of 18 and 40 recruited amongst couples consulting for infertility in four fertility centres in western France. Cases were women with DOR (defined as anti-müllerian hormone levels < 1.1 ng/ml and/or antral follicle count < 7) and controls were women with normal evaluations, no malformations, and regular menstrual cycles. 41 POPs (including 15 organochlorine pesticides, 15 polychlorinated biphenyls and 9 polybromodiphenylethers) were measured in blood serum at inclusion. We conducted logistic regression adjusted on potential confounders to study the effect of each POP on DOR separately. In addition, we used Bayesian Kernel Machine Regression (BKMR) to measure the mixture effect of POPs on DOR.

RESULTS: 17 POPs were detected in over 20% of the serum samples. Individual multivariate logistic regressions showed that p,p'-DDE was associated with an increased risk of DOR (OR=1.50 [0.78 - 2.89] for the second tercile and OR=1.93 [1.00 - 3.73] for the third tercile) and Beta-HCH was associated with a decreased risk of DOR (OR=0.76 [0.42 - 1.40] for the second tercile and OR=0.45 [0.23 - 0.88] for the third tercile). BKMR showed similar associations for individual exposures but found no significant associations for the total mixture effect. In addition, BKMR results suggested an absence of interactions between POPs.

CONCLUSIONS: Although BKMR indicated no interaction between POPs and no associations for POPs as a mixture, certain POPs could be individually associated with DOR.

Keywords: Reproductive outcomes, Female, Chemical exposures, Endocrine disrupting chemicals, Mixtures



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 10

Women's Environmental Health

Chairs: Lauren Wise, United States & Traci Bethea, United States

O-TO-050

Chemical exposures » PFAS

Associations of pregnancy per- and polyfluoroalkyl substance concentrations and fibroid changes across pregnancy: NICHD Fetal Growth Studies - Singletons cohort

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BACKGROUND AND AIM: Uterine fibroids are common, hormonally responsive benign tumors. Because endocrine disrupting chemicals mimic hormones, they might affect fibroid growth. We tested associations of per- and polyfluoroalkyl substances (PFAS) and fibroid changes in pregnancy.

METHODS: We quantified 11 PFAS, including perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluorooctanoic acid (PFOA) in first trimester blood from 2221 women. Sonographers recorded fibroid number and volume of the 3 largest fibroids in 1-6 ultrasounds at weeks 10-41. We used generalized linear mixed models with random intercepts and assessed associations of PFAS (quartiles) and changes in fibroid visualization (yes/no), number, and total volume by testing the PFAS*gestational age interaction, adjusted for race/ethnicity, body mass index, and age. Volume analyses were stratified by baseline total volume (equivalent to a <1cm (small), 1-<3cm (medium), or >3cm (large) diameter fibroid).

RESULTS: Visualized fibroid prevalence was 9.2% (n=204 women, 95% with ≥2 ultrasounds). PFAS were not associated with changes in fibroid number or visualization. Multiple PFAS were associated with volume changes. For example, among women with medium fibroids, PFDA and PFOA were inversely associated with volume growth. For PFDA, compared to Q1, fibroids in Q2 grew 4.7% (95%CI: 0.9, 8.4) less, Q3 grew 8.1% (95%CI: 4.2, 11.9) less, and Q4 grew 3.4% (95%CI: -0.1, 6.9) less per week; for PFOA, compared to Q1, fibroids in Q2 grew 0.4% (95%CI: -3.8, 4.8) more, Q3 grew 6.0% (95%CI: 2.2, 9.8) less, and Q4 grew 4.0% (95%CI: -0.0, 7.8) less per week. Among women with large fibroids, PFNA was positively associated with growth: compared to Q1, fibroids in Q2 shrank 4.7% (95%CI: 1.5, 7.9) less, Q3 shrank 4.6% (95%CI: 1.4, 8.0) less, and Q4 shrank 3.6% (95%CI: 0.9, 6.4) less per week.

CONCLUSIONS: Certain PFAS were associated with changes in fibroid volume during pregnancy, varying by fibroid size.

Keywords: PFAS, Pregnancy outcomes



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 10

Women's Environmental Health

Chairs: Lauren Wise, United States & Traci Bethea, United States

O-TO-051

Cancer and Cancer-Precursors » Incidence

Associations of Phthalates and Phenols, Telomere Length, and Breast Cancer in the Long Island Breast Cancer Study Project

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BACKGROUND AND AIM: Exposure to phthalates or phenols has been of concern as associated with breast cancer due to the endocrine disrupting effects of these chemicals. Studies related to the modifying role of cellular aging on these associations are lacking. We aim to evaluate the modifying effect of leukocyte telomere length (LTL), a biomarker of cellular aging, on the associations between phthalate and phenol exposure and breast cancer incidence and mortality.

METHODS: We used data from 1268 women whose urinary phthalates and phenols and LTL measurements were available from the Long Island Breast Cancer Study Project. Twenty-two metabolites of phthalates and phenols were measured in the spot urine collected from the study participants. The modifying effect of LTL on the association between each individual metabolite and breast cancer incidence and mortality was estimated using interaction terms between LTL and the individual metabolites in logistic regression models and Cox regression models. Odds ratios, hazard ratios, and corresponding 95% confidence intervals (CI) for a one-unit (ln ug/g creatinine) increase of urinary metabolite concentration were estimated at 10th, 50th, and 90th percentiles of LTL.

RESULTS: LTL significantly ($P < 0.05$) modified the associations between breast cancer incidence and metabolites for eleven phthalates and phenols. Metabolites were, in general, inversely and positively associated with breast cancer incidence at shorter and at longer LTL, respectively. No statistically significant modifying effect was found for LTL in the association between these metabolites and breast cancer mortality.

CONCLUSIONS: Women with longer LTL were more susceptible to exposure to phthalates and phenols in the development of breast cancer. But shorter LTL can still increase the detrimental effect of certain types of phenols to breast cancer.

Keywords: Phthalate, Phenol, Breast Cancer, Leukocyte Telomere Length



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 10

Women's Environmental Health

Chairs: Lauren Wise, United States & Traci Bethea, United States

O-TO-052

Cancer and Cancer-Precursors » Incidence

Exposure to particle radioactivity and breast cancer risk in a US-wide prospective cohort

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BACKGROUND AND AIM: Outdoor air pollution has been associated with breast cancer risk but underlying biologic mechanisms are not well understood. No previous study has considered whether radioactive airborne particle exposure may contribute to the carcinogenicity of air pollution. We aimed to investigate residential particle radioactivity in relation to breast cancer risk in a prospective cohort.

METHODS: Annual average ambient particle radioactivity exposure, defined as gross beta particle radiation, was estimated for the enrollment address (2003-2009) of 48,184 Sister Study participants using a nationwide spatiotemporal ensemble model that incorporated data from the U.S. Environmental Protection Agency's RadNet monitoring network. 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. Cox regression was used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for the association between breast cancer risk (invasive and ductal carcinoma in situ) and beta particle radiation in quartiles and per interquartile range (IQR) increase (0.079 mBq/m³). Models were adjusted for age, race/ethnicity, and education. We evaluated whether associations varied by tumor estrogen receptor (ER) status and additionally adjusted for levels of outdoor residential air pollutants (NO₂, PM_{2.5}, PM₁₀).

RESULTS: There were 3,796 incident breast cancer cases diagnosed over a median of 10 years of follow-up. Exposure to beta particle radiation was not associated with overall breast cancer risk. However, higher levels of beta particle radiation were associated with a higher risk of ER- breast cancer (HR_{Q4vsQ1}=1.35, 95% CI:1.04-1.74; HRIQR=1.15, 95% CI: 1.03-1.28) but not ER+ breast cancer (HRIQR=0.96, 95% CI: 0.91-1.02) (IQR heterogeneity p=0.003). Results were unchanged with adjustment for air pollution levels.

CONCLUSIONS: Our novel findings suggest that particle radioactivity may be a risk factor for ER- tumors, a more aggressive form of breast cancer, independent of air pollutant concentrations.

Keywords: Air pollution, ionizing radiation, cancer and cancer precursors, environmental epidemiology, particulate matter



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 10

Women's Environmental Health

Chairs: Lauren Wise, United States & Traci Bethea, United States

O-TO-053

Reproductive Outcomes » Female reproductive outcomes

Urinary Metals and Metal Mixtures and Incident Natural Menopause in Midlife Women: the Study of Women's Health Across the Nation

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BACKGROUND AND AIM: Exposure to metals and metal mixtures may have long-term effects on ovarian aging. However, limited data have reported the possible effects of metals on the timing of natural menopause. We prospectively examined the associations of 15 urinary metal concentrations and their mixtures with incident natural menopause in the Study of Women's Health Across the Nation Multi-Pollutant Study.

METHODS: The study population consisted of 1082 premenopausal women from multiple racial/ethnic groups, aged 45-56 years. Urinary concentrations of 15 metals, including arsenic, barium, cadmium, cobalt, cesium, copper, mercury, manganese, molybdenum, nickel, lead, antimony, tin, thallium, and zinc, were measured. Natural menopause was defined as the bleeding episode prior to at least 12 months of amenorrhea, not due to surgery or hormone therapy. Cox proportional hazards models were used to calculate hazard ratios (HRs) and 95% confidence intervals (95% CIs) for individual metals. The associations between metal mixtures and natural menopause were evaluated using elastic net (ENET) penalized Cox regression. An environmental risk score (ERS) was computed to represent individual risks of natural menopause related to metal mixtures.

RESULTS: The median age at natural menopause was 50.5 years. The adjusted HR (95% CI) for natural menopause was 1.36 (1.06-1.72) for arsenic and 1.39 (1.08-1.80) for lead, comparing the highest with the lowest quartiles of metal concentrations in Cox models. Women in the highest vs. the lowest quartiles of ERS had an HR of 1.69 (1.35-2.12), which is equivalent to a 1.4 year earlier median time to natural menopause. This estimate was roughly equivalent to or even larger than an effect estimate of 1.1 years comparing current smokers versus never smokers in our study.

CONCLUSIONS: This study suggests that arsenic, lead, and metal mixtures are associated with earlier natural menopause, a risk factor for adverse health outcomes in later life.

Keywords: Metals, mixtures, menopause, women, cohort study.



ABSTRACT E-BOOK

August 23, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 10

Women's Environmental Health

Chairs: Lauren Wise, United States & Traci Bethea, United States

O-TO-054

Air pollution » Long-term exposure

Long-term particulate matter exposure and bone mineral density in the Women's Health Initiative

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BACKGROUND AND AIM: Ambient particulate matter air pollution < 10 µm (PM₁₀) concentrations have been associated with several outcomes, but few studies have examined their association with bone mineral density (BMD). Previous studies have suggested an effect of air pollution on bone health, but none has evaluated its impact in postmenopausal women.

METHODS: We studied the longitudinal PM₁₀-BMD association among 5,080 postmenopausal women in the Women's Health Initiative Clinical Trials (WHI-CT). We used log-normal, ordinary kriging to estimate daily mean PM₁₀ concentrations (µg/m³) at geocoded participant addresses. We averaged the means over 1-, 3-, and 5-year periods before triennial, dual energy X-ray absorptiometry (DXA) exams. We estimated total hip, lumbar spine, and total body BMD (in g/cm²) and their corresponding T-scores. We estimated the association of PM₁₀ with BMD and T-scores using multivariable linear mixed models while controlling for correlation of repeated measures among participants and adjusting for age at DXA, race/ethnicity, income, body mass index (kg/m²), smoking status, coffee consumption, physical activity, CT randomization arm, US region of residence, and DXA equipment serial number. Multiple imputation was done for missing data.

RESULTS: At baseline, women were aged 50-79 years, 78% were White, 40% were college graduates, and 71% earned <\$40,000/year. PM₁₀ concentrations at baseline were cross-sectionally associated with both hip, lumbar spine, and whole-body BMD and T-scores (p < 0.05). Longitudinally, lumbar spine BMD decreased 0.052 (95% confidence interval [95%CI]: 0.067, 0.037) g/cm²/year per 10% (2.21



ABSTRACT E-BOOK

ug/m³) increase in 5-year mean PM₁₀ concentration. Lumbar spine T-scores also decreased with increasing duration of the 3- and 5-year mean PM₁₀ concentrations: -0.362 Standard Deviations (SD) (-0.490, -0.235) and -0.512 SD (-0.649, -0.375), respectively. No association was seen with changes in hip or total body BMD.

CONCLUSIONS: This is the first study suggesting an inverse association of ambient PM₁₀ with BMD among postmenopausal women.

Keywords: Air pollution, long-term, PM₁₀, bone mineral density, t-score, osteoporosis.



ABSTRACT E-BOOK

August 24, 2021 / 07:30 - 08:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 11

Source-specific Air Pollution and Health

Chairs: George Thurston, United States & Xueying Zhang, United States

O-TO-055

Air pollution » Long-term exposure

Cardio-respiratory disease with contrasted air pollution levels in three municipalities of Abidjan district hospitals, Cote d'Ivoire

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BACKGROUND AND AIM: The human health effects for both particulate matter and gaseous contaminants are global public health concern.

The objective of this study was to assess any variations of air pollution in contributions from waste burning, heavy motor vehicle traffic and biomass burning and the impact on health in Abidjan, with special attention to cardiorespiratory diseases,

METHODS: A survey was conducted during two years in 5 hospitals, 3 months during the rainy and the dry season. We estimated air pollution levels simultaneously with health care assessment with a particular attention for cardio-respiratory diseases. PM_{2.5} concentration and cardiorespiratory diseases outcomes were recorded in a questionnaire sheet in the district hospitals. The relative Risks (RR) of the relationship between the observed cardiorespiratory outcomes and air pollution exposure were estimated using a Poisson regression model.

RESULTS: The results showed that PM_{2.5} Concentrations from the waste burning and traffic sites were comparable with annual averages of 28.51 µg/m³ and 29.69 µg/m³ respectively. In Yopougon, where domestic fires are common, the annual average is drastically higher at 155.1 µg/m³. PM_{2.5} were elevated in both seasons with an average of 145µ/m³; more than the one recommended by WHO. Also, cardiorespiratory diseases occurred in 66% and the most affected were women (54%) and children under 18 years old. The highest PM_{2.5} concentrations were due to biomass burning, seen in Yopougon. Outpatient visits for cardiorespiratory symptoms showed a significant association with PM_{2.5} concentrations during the rainy season and respiratory outpatient visits were significant throughout the entire year. Overall, we estimate that 143 hospital visits could have been avoided during the rainy seasons of our study period

CONCLUSIONS: Accessing to air pollution data has been difficult in developing countries. This survey was one the first conducted so far in Côte d'Ivoire addressing pollutant concentrations and cardiorespiratory outcomes.

Keywords: Air pollution, Cardio-respiratory disease, health care



ABSTRACT E-BOOK

August 24, 2021 / 07:30 - 08:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 11

Source-specific Air Pollution and Health

Chairs: George Thurston, United States & Xueying Zhang, United States

O-TO-057

Respiratory and Allergic Outcomes » Respiratory outcomes

Replacing wood with charcoal fuel prevents 1.7 million acute respiratory infections worldwide; evidence from 360,000 children in 30 low-and-middle-income countries

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BACKGROUND AND AIM: Household air pollution from solid biomass fuel cooking is responsible for 45% of acute respiratory infections (ARI) in children under five years in low and middle income countries (LMICs). Transition towards less polluting solid biomass fuel sources in LMIC settings, such as moving from wood to charcoal, may reduce HAP-related global respiratory disease burden in the short to medium-term. However, there remains a paucity of evidence concerning the relative health benefits. This study aimed to assess the association between ARIs in children under five years residing in wood and charcoal cooking households in 30 LMICs using the Demographic and Health survey (DHS) data.

METHODS: Cross-sectional data was extracted for 30 LMIC countries with 359,647 children residing in wood or charcoal, using outcome measures obtained from maternally reported respiratory symptoms two weeks prior to interview. Composite measures of ARI (cough and shortness of breath) and severe ARI (cough, shortness of breath and fever) were formed. Multilevel logistic regression analyses was deployed, with adjustment for relevant factors at an individual, household, regional and country level.

RESULTS: Residence in a wood cooking household was observed to increase the odds ratio of shortness of breath (AOR:1.04[1.00-1.08]) fever (AOR:1.08[1.04-1.13]), ARI (AOR:1.04[1.00-1.08]) and severe ARI (AOR:1.09[1.05-1.13]) compared to residing in charcoal cooking households. Living in a rural areas has an observed association with cough (AOR:1.11[1.04-1.19]), fever (AOR:1.10[1.04-1.18]), ARI (AOR:1.10[1.04-1.18]) and severe ARI (AOR:1.08[1.01-1.15]) and wood fuel usage, whereas only fever (AOR:1.10[1.02-1.18]) was associated with living in urban areas

CONCLUSIONS: Evidence from this population-based multilevel study suggest that 1.7 million ARI cases annually could be prevented in children under five years through transitioning from wood to charcoal cooking fuel in resource poor settings.

Keywords: Air pollution, Children's environmental health, Risk assessment, Environmental Epidemiology, Infectious Disease



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 11

Source-specific Air Pollution and Health

Chairs: George Thurston, United States & Xueying Zhang, United States

O-TO-058

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

Health Impact Assessment of PM_{2.5} control legislation in Korea

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BACKGROUND AND AIM: Exposure to PM_{2.5} has been associated with increased all-cause mortality. The metropolitan area particulate matter reduction policy is enacted to reduce PM_{2.5} concentration in 2008. The policy selected substances subject to particulate matter management, implemented total emission regulations in Seoul and Incheon, strengthened standards for allowing emissions for production vehicles, and promoted reduction of diesel car emissions. The aim of the present analysis is to evaluate the effectiveness of the policy on health.

METHODS: The policy was applied to Seoul and Incheon, and other metropolitan cities in Korea were selected as control groups. We conducted interrupted time series analyses to examine changes in PM_{2.5} concentration and concentration-response function after the enactment of the policy. Based on the calculated change, we estimated the health benefit in terms of reduced mortality.

RESULTS: We observed a decrease in the slope of concentration-response function of all-cause mortality after intervention in Seoul and Incheon. PM_{2.5} concentrations also decreased. The interaction coefficient about intervention was -0.537 (p value=0.001) in Seoul and -0.0276 (p value=0.64) in Incheon. We calculated the number of excess deaths when there was no intervention effect, when only PM_{2.5} concentrations were decreased, when only concentration-response function was decreased, when both concentration-response function and PM_{2.5} were reduced. The number of excess death in Seoul was 684.1 (221-1112.3), 654 (230.1-1149.1), 450.9 (0-883.1), and 432.2 (0-919.1), respectively. We observed 137.1 (0-673.4), 113.8 (0-560.7), 82 (0-236.2), and 68.7 (0-196.7), in Incheon, respectively.

CONCLUSIONS: The all-cause mortality caused by PM_{2.5} in Seoul and Incheon decreased after intervention.

Keywords: All-cause mortality, Health impact assessment, Legislation, PM_{2.5} concentration, Excess death



ABSTRACT E-BOOK

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Source-specific Air Pollution and Health

Chairs: George Thurston, United States & Xueying Zhang, United States

O-TO-059

Air pollution » Particulate matter

Global health burden of PM_{2.5}, black and organic carbon aerosols

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BACKGROUND AND AIM: Exposure to ambient particulate matter with a diameter smaller than 2.5µm (PM_{2.5}) poses a major global health risk, commonly assessed with exposure-response functions that presume equivalent toxicity for different PM_{2.5} constituents. In this study, we assume anthropogenic organic aerosols and black carbon to be more health hazardous than other PM_{2.5} components as indicated by recent epidemiological and toxicological studies.

METHODS: We used a data-informed global atmospheric chemistry model and exposure-response functions of the Global Burden of Disease study in 2020 to estimate the health burden of ambient PM_{2.5}, and to attribute source categories. We also calculated the contributions of black carbon (BC), primary organic aerosols (POA) and anthropogenic secondary organic aerosols (aSOA).

RESULTS: We estimated 4.23(95% confidence interval 3.0-6.14) million excess deaths per year from exposure to ambient PM_{2.5} of which, ~67% may be attributed to anthropogenic sources assuming uniform toxicity for all types of PM_{2.5}. Globally, 92%, 5% and 3% of excess deaths occur among adults, neonates and children, respectively, although these proportions vary largely by region. We find that domestic energy use, mostly from the burning of solid biofuels, is the largest contributor to BC, POA and aSOA globally. Considering these species to be twice as toxic as other compounds, domestic energy use emerges as the leading source of excess mortality from PM_{2.5} exposure, notably in Asia and Africa but also, in North America and Europe, where fossil fuel use in energy generation and transportation is the largest source category of anthropogenic PM_{2.5}, mitigating emissions from domestic burning would have major health benefits.



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CONCLUSIONS: We suggest that relative toxicities of anthropogenic PM_{2.5} components and their sources should be considered in air quality policies. Our results offer a basis for country-specific mitigation measures, which will be more effective in improving air quality and public health than the conventional PM_{2.5} abatement measures.

Keywords: Particulate matter, Particle components, Policy research



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 11

Source-specific Air Pollution and Health

Chairs: George Thurston, United States & Xueying Zhang, United States

O-TO-060

Air pollution » Particulate matter

Source-specific fine particulate matter and hospitalization due to myocardial infarction

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BACKGROUND AND AIM: The association between fine particulate matter (PM_{2.5}) air pollution and cardiovascular outcomes is well-established. PM_{2.5} is a heterogeneous mixture of chemical constituents and its composition can vary by air pollution source. To evaluate whether PM_{2.5} from certain sources may be differentially associated with cardiovascular disease, we examined the association between same-day exposure to source-specific PM_{2.5} and risk of hospital admission for myocardial infarction (MI) in New York City (NYC).

METHODS: We applied Absolute Principal Components Analysis to identify sources of PM_{2.5} pollution using data from three NYC monitors. We used data from the New York Department of Health Statewide Planning and Research Cooperative System on daily city-wide counts of MI admissions (2007–2015). We examined associations between same-day exposure to source-specific PM_{2.5} and MI admissions in a time-series analysis, using a quasi-Poisson regression model and adjusting for temperature, relative humidity, day of week, and seasonal and long-term time trends.

RESULTS: We identified six sources of PM_{2.5} pollution: 1) traffic emissions, 2) salt, 3) crustal dust, 4) secondary/regional sulfate and nitrate, 5) road dust, and 6) industrial emissions. In adjusted models, an interquartile range (IQR) increase in PM_{2.5} from crustal dust was associated with a 0.68% increase in the rate of hospitalization for MI, on average (95% CI: 0.12, 1.25%). We observed a 1.01% (95% CI: -0.11, 2.16%) and a 0.62% (95%CI: -0.13, 1.36%) increase in MI admission rates per one IQR increase in traffic-related and regional PM_{2.5}, respectively. We observed no association with PM_{2.5} from other sources.

CONCLUSIONS: Identifying particularly toxic sources of PM_{2.5} can lead to maximally efficient policies. In our NYC study we identified crustal dust and traffic-related PM_{2.5} as potentially toxic sources for cardiovascular disease.

Keywords: Air pollution, Particle components, Particulate matter, Cardiovascular diseases, Mixtures analysis, Short-term exposure



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 12

Environmental Exposures and Neurodevelopment

Chairs: Youssef Oulhote, United States & Raanan Raz, Israel

O-TO-061

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Prenatal Triclosan Exposure and Neurodevelopment of 2-Year-Old Children in Shandong, China

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BACKGROUND AND AIM: The neurodevelopment effects of triclosan (TCS) have been observed in animals and school-age children. However, epidemiologic studies are limited to confirm the associations for young children. We investigated the potential effect of prenatal TCS exposure on neurodevelopment of 2-year-old children.

METHODS: From September 2010 to December 2013, 294 mother-infant pairs were enrolled from a prospective cohort study in Shandong, China. Maternal urine samples were collected for TCS measurement. Gesell Developmental Schedules (GDS) were used to assess children's neurodevelopment at 2 years of age. Multiple linear regression models and generalized linear models were used to analyze the association between prenatal TCS exposure and the children's developmental quotient scores (DQs).

RESULTS: The median value of TCS concentration was 0.24ug/L or 0.67ug/g creatinine. When TCS were modeled as quartile variables, maternal TCS levels were adversely associated with children's DQs in gross motor domain (2ndquartile: $\beta=-3.44$, 95% CI: -6.39 to -4.89, $p=0.02$) and adaptive domain (3rdquartile: $\beta=-3.11$, 95% CI: -5.95 to -0.28, $p=0.03$). In gender-stratified analyses, maternal TCS levels were significantly adversely associated with the gross motor domain DQs only among girls (p -trend=0.03) and the adaptive domain DQs only among boys (p -trend=0.01). Additionally, a log-unit increase in TCS was related to decrease in language domain DQs among boys ($\beta=-2.13$, 95% CI: -4.06 to -0.19, $p=0.03$).

CONCLUSIONS: The findings suggested the potential impacts of prenatal TCS exposure on neurodevelopment of 2-year-old children in gross motor domain, adaptive domain and language domain. Further studies on the biological mechanisms of these associations are needed.

Keywords: Triclosan, Prenatal exposure, Neurodevelopment



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TRADITIONAL ORAL SESSION 12

Environmental Exposures and Neurodevelopment

Chairs: Youssef Oulhote, United States & Raanan Raz, Israel

O-TO-062

Air pollution » Particulate matter

Systematic Review and Meta-analysis on Association Between Air Pollutants and Hippocampal Volume from Magnetic Resonance Imaging in Adults

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BACKGROUND AND AIM: The neurotoxicity of air pollutants has been actively investigated in recent years, and there is increasing epidemiological evidence suggesting that air pollution can adversely affect the central nervous system. In neurodegenerative disease, one important diagnostic biomarker is volume reduction in a key brain structure, the hippocampus, as assessed with neuroimaging techniques. Few epidemiological articles investigated the association of hippocampal volume with air pollution, with inconsistent results. In this paper, we aimed to estimate such association through a systematic review and meta-analysis.

METHODS: Scopus and PubMed literature databases were searched through 31 March 2021. Eligibility criteria were: 1) assessment of air pollutant levels; 2) assessment of hippocampal volume through structural magnetic resonance imaging; 3) reporting of correlation coefficients along with standard error. We performed a meta-analysis using a random-effects model.

RESULTS: We retrieved four studies using linear regression models to evaluate the possible effect of air pollutants on hippocampal volume of adult populations. The investigated air pollutants were nitrogen dioxide (NO₂) and particulate matter, with diameter $\leq 2.5\mu\text{m}$ (PM_{2.5}) and $\leq 10\mu\text{m}$ (PM₁₀). All studies used a similar methodology based on standard spatial coordinates of images, and considered intracranial volume as a covariate. We found that hippocampal volume was inversely associated with PM_{2.5} concentration (β regression coefficient -7.90, 95% confidence interval (CI) -14.60 to -1.20) and more slightly with PM₁₀ concentrations (β -1.70, 95%CI -3.96 to 0.57), whereas no association with NO₂ concentrations emerged (β -0.29, 95%CI -1.13 to 0.55).

CONCLUSIONS: Our results suggest that PM_{2.5} and less clearly PM₁₀ have an adverse effect on hippocampal volume, a phenomenon associated with cognitive decline and increased risk of neurodegenerative disease. These epidemiologic findings appear to be biologically plausible especially for PM_{2.5}, also taking into account some studies carried out in animals.

Keywords: Neurotoxicity, Neuroimaging, Magnetic Resonance Imaging, Hippocampus, Meta-analysis, Nitrogen dioxide



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 12

Environmental Exposures and Neurodevelopment

Chairs: Youssef Oulhote, United States & Raanan Raz, Israel

O-TO-063

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Sex-specific associations of prenatal metal exposures with longitudinal child behavior in the New Hampshire Birth Cohort Study

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BACKGROUND AND AIM: Research on the neurodevelopmental effects of metals has focused mainly on outcomes assessed at one time point, even though brain development progresses over time. We investigated biomarkers of prenatal exposure to metals and changes in child behavior over time.

METHODS: We followed 268 participants from the New Hampshire Birth Cohort Study between birth and age five years. We measured arsenic (As), copper (Cu), manganese (Mn), lead (Pb), selenium (Se) and zinc (Zn) in toenails from 6-week-old infants. The Behavioral Symptoms Index (BSI), externalizing, and internalizing symptoms were assessed using the Behavior Assessment System for Children, 2nd edition (BASC-2) at ages 3 and 5 years. Multivariable linear regression and Bayesian Kernel Machine Regression were used to estimate associations of the metal mixture with behavior change, calculated as the change in raw score from 3 to 5 years. Sex specific associations were explored in stratified models.

RESULTS: Adjusted associations of metals with behavior varied by metal, sex, and outcome. Among boys, higher ln-Pb was associated with increased overall behavioral problems, externalizing symptoms, and internalizing symptoms over time as compared to girls [boys: $\beta = 4.3$ (95%CI: -0.5, 9.0) vs. girls: -3.8 (-7.8, 0.3); 1.8 (-1.1, 4.6) vs. -2.5 (-5.0, 0.01); 1.1 (-1.7, 3.9) vs. -2.9 (-5.6, -0.2); sex-Pb interaction term p-values<0.05]. Among boys, higher ln-Cu was associated with decreased overall behavioral problems, externalizing symptoms, and internalizing symptoms over time as compared to girls [boys: -6.4 (-10.9, -2.0) vs. girls: 1.1 (-4.0, 6.1); -3.6 (-6.2, -0.9) vs. 0.7 (-2.4, 3.8); -2.4 (-5.0, 0.3) vs. 1.3 (-2.1, 4.6); sex-Cu interaction term p-values<0.05].

CONCLUSIONS: Prenatal exposure to metals may alter symptoms of maladaptive behavior between ages 3 and 5 years. Findings support the need for more research on sex differences in associations between metals and neurodevelopment over longer time periods and at multiple time points.

Keywords: Metals, neurodevelopment, pediatric, mixtures, sex-differences



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 12

Environmental Exposures and Neurodevelopment

Chairs: Youssef Oulhote, United States & Raanan Raz, Israel

O-TO-064

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Neurodevelopmental effects of prenatal co-exposure to heavy metals and phthalates

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BACKGROUND AND AIM: There is a continuously growing evidence on the neurodevelopmental effects of co-exposure to heavy metals and plasticisers, but also a lack of mechanistic interpretation.

METHODS: Phthalate and heavy metals (Pb and Hg) prenatal exposure was determined measuring 11 phthalate metabolites in urine, Pb in blood and Hg in hair of (n=149) mothers during the third trimester of pregnancy (prenatal exposure) and from their children at the 24th month of age (postnatal exposure). Urine untargeted metabolomics analysis was also carried out in a Thermo Orbitrap LC/MS-MS. Psychomotor development was assessed in children at the age of 2 years using the Bayley Scale. Associations were investigated using the linkage disequilibrium method of EWAS, while pathway analysis was mapped with the Mass Profiler Pro (Agilent Technologies).

RESULTS: Child motor development was inversely associated with natural log concentrations of 3OH-MnBP (log₁₀p=1.6), 5OH-MEHP (log₁₀p=1.9), and the sum of DEHP (log₁₀p=1.7) and DnBP (log₁₀p=1.7) metabolites, in the urine, as well as the Pb (log₁₀p=2.3) in blood and the Hg (log₁₀p=1.9) in hair collected from mothers. With regard to post-natal exposure, the only statistically significant associated association was the inverse correlation of Hg (log₁₀p=1.9) in hair and cognitive functions for females. Metabolic pathway analysis revealed that alterations in selected phthalates urine metabolites, are related to the tricarboxylic acid (TCA) cycle, suggesting impaired mitochondrial respiration, which is central to energy metabolism and cellular signalling. The latter is enhanced by the oxidative stress induced by heavy metals. This defective mitochondrial energy production during the process of fetus formation and development is reflected in early life neurodevelopment.

CONCLUSIONS: The key finding of the study is that although phthalates and metals affect mitochondrial respiration through different mechanisms (endocrine disruption and oxidative stress respectively), this synergistic effect is essential for the deployment of neurodevelopmental defects.

Keywords: Neurodevelopmental outcomes, Phthalates, Heavy metals; exposome, metabolomics



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Environmental Exposures and Neurodevelopment

Chairs: Youssef Oulhote, United States & Raanan Raz, Israel

O-TO-065

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Building blocks of executive function as mediators of the association of prenatal manganese exposure with problem-solving skills among adolescents

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BACKGROUND AND AIM: Problem-solving skills build upon three core executive functions: inhibition, working memory, and cognitive flexibility. There is evidence of adverse associations of prenatal exposure to manganese (Mn) with core executive functions, but less is known about Mn associations with problem-solving. This study aimed to investigate the association of prenatal Mn exposure with problem-solving and to identify potential neuropsychological mechanisms through which this association may be mediated.

METHODS: Study participants were 379 adolescents from the New Bedford Cohort (NBC) who have undergone periodic evaluations since their birth (1993-1998) to mothers residing near a Massachusetts Superfund site. We assessed the association of cord blood Mn with problem-solving measured by the Delis-Kaplan Executive Function System (D-KEFS) Sorting and Tower subtests [scores scaled to a mean (SD) of 10 (3)] using multivariable linear regression. Inhibition and cognitive flexibility were also measured with the D-KEFS; working memory was measured with the Wide Range Assessment of Memory and Learning, 2nd edition. Regression-based causal mediation was used to assess the proportion of the Mn-problem-solving association mediated by inhibition, working memory, and cognitive flexibility.

RESULTS: NBC adolescents (age 13-17 years) were diverse with 29% non-white and 31% in a low-income household at birth. Their cord blood Mn concentrations were similar to other general population samples. Mn was associated with Sorting but not Tower scores. Specifically, a doubling of cord blood Mn concentrations was associated with a -0.66 points lower (95% CI: -1.26, -0.06) Sort Recognition score. In mediation analyses, inhibition, working memory, and cognitive flexibility



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combined mediated 44% of the total effect of Mn on Sort Recognition. When analyzed individually, working memory mediated a larger proportion (37%) of the effect than inhibition (14%) or cognitive flexibility (23%).

CONCLUSIONS: We observed adverse associations of cord blood Mn with problem-solving among adolescents. Working memory was an important mediator of this association.

Keywords: Neurodevelopment outcomes, children's environmental health, environmental epidemiology, chemical exposures



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TRADITIONAL ORAL SESSION 12

Environmental Exposures and Neurodevelopment

Chairs: Youssef Oulhote, United States & Raanan Raz, Israel

O-TO-066

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

In-utero exposure to indoor air pollution or tobacco smoke and cognitive development in a South African birth cohort study

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BACKGROUND AND AIM: There is increasing evidence indicating that air pollution exposure is associated with neuronal damage. Since pregnancy is a critical window of vulnerability, air pollution exposure during this period could have adverse effects on neurodevelopment. This study aims 1) to analyze associations of prenatal exposure to indoor air pollution (particulate matter with diameters $\leq 10\mu\text{m}$, PM₁₀) and tobacco smoke on neurodevelopment and 2) to determine if these associations are mediated by deviations of epigenetic gestational age from chronological gestational age (ΔGA).



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METHODS: Data of 734 children from the South African Drakenstein Child Health Study were analyzed. Antenatal PM₁₀ exposure was measured using devices placed in the families' homes. Maternal smoking during pregnancy was determined by maternal urine cotinine measures. Bayley Scales of Infant Development were used to measure cognition, language, motor, and adaptive behavior development at two years of age. Overall composite scores were calculated as the average of the four sub-scores. Linear regression models adjusted for maternal age, gestational age, sex of child, ancestry, birth weight/length, and socioeconomic status were used to explore associations. A mediation analysis was conducted to analyze if the associations were mediated by Δ GA using DNA methylation measurements from cord blood.

RESULTS: An increase of one interquartile range in PM₁₀ (54.40 μ g/m³) was significantly associated with lower cognition sub-scores (β -estimate [95%-confidence interval]: -0.01 [-0.22, 0.00]). Maternal smoking was significantly associated with lower overall composite scores (-1.84 [-3.52, -0.16]) and lower adaptive behavior sub-scores (-3.39 [-5.63, -1.14]). Other scores were not associated with PM₁₀ or smoking. Associations were not significantly mediated by Δ GA (e.g., for PM₁₀ and cognition, proportion mediated [95%-confidence interval]: 1% [-18, -20%]).

CONCLUSIONS: We found an association of prenatal exposure to indoor air pollution (PM₁₀) and tobacco smoke on neurodevelopment at 2 years of age. Further research is needed to understand underlying biological mediators.

Keywords: Air pollution, Particulate matter, Neurodevelopmental outcomes, Environmental epidemiology, Epigenomics



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 13

Endocrine Disrupting Chemicals and Cardiometabolic Health across the Life Course

Chairs: Tamarra James-Todd, United States & Barrett Welch, United States

O-TO-067

Chemical exposures » Endocrine disrupting chemicals

Chlorinated persistent organic pollutants in plasma and risk of cardiovascular disease: a prospective nested case-control study in two Swedish cohorts

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BACKGROUND AND AIM: Cardiovascular toxic effects derived from high exposures to persistent organic pollutants (POPs) are well documented. Evidence in general population with low-dose and long-term exposures is limited. To analyze the association of chlorinated POP plasma levels, which include polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs), with risk of composite cardiovascular disease (CVD) and separate ischemic stroke and myocardial infarction (MI) in a general Swedish population.

METHODS: Within the Swedish Mammography Cohort-Clinical (SMC-C) and the Cohort of 60-Year-Old (60YO), we conducted a population-based nested case-control study with first incident stroke (n=708) and MI (n=820) ascertained via linkage. Controls were matched by age, sex, and sampling date. Baseline blood sampling occurred during 2003-2009 and 1997-1999 with follow-up through 2017 and 2014 for the SMC-C and the 60YO, respectively. POP levels were evaluated as cohort-specific tertiles based on controls. Multivariable adjusted logistic regressions were conducted to estimate odds ratios (OR) and 95% confidence intervals (CI).

RESULTS: Mean age was 72 (± 7) years in SMC-C and 61 (± 0.1) years in 60YO. The individual chlorinated POPs found in highest concentrations (ng/ml) were by far PCB-153 [1016 (721–1365) in controls and 1072 (816–1366) in cases] and pp-DDE [1889 (1057–3240) in controls and 2348 (1296–3724) in cases]. Sum of standardized chlorinated POP levels associated with composite CVD, OR (95% CI) 1.40 (1.03–1.92), and with stroke 1.62 (1.01–2.59) but not with MI, 1.24 (0.77–1.98), comparing extreme tertiles. These associations were mainly driven by OCPs, which associated with composite CVD 1.45 (1.07–1.99), and with MI 1.91 (1.16–1.37), but less clear with stroke 1.52 (0.92–2.50).

CONCLUSIONS: These findings indicate that high levels of OCPs in human blood might increase the risk of both stroke and MI, while the cardiovascular risk associated with PCBs was less clear. More evidence from studies using biological samples is needed.

Keywords: Chlorinated persistent organic pollutants, endocrine disrupting chemicals, prospective nested case-control study, Swedish cohorts, cardiovascular disease



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 13

Endocrine Disrupting Chemicals and Cardiometabolic Health across the Life Course

Chairs: Tamarra James-Todd, United States & Barrett Welch, United States

O-TO-068

Chemical exposures » General

Exposure to lipophilic chemicals and glucose homeostasis in youth

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BACKGROUND AND AIM: Exposure to metabolism disrupting lipophilic compounds, including organochlorine compounds and polybrominated diphenyl ethers, is prevalent. The aim of this study was to examine the potential diabetogenic effects of youth exposure to lipophilic chemicals.

METHODS: Overweight adolescents from the Study of Latino Adolescents at Risk of type II diabetes (SOLAR; n=301) participated in annual clinical visits (average of 3.3±2.9 years). At each visit, oral glucose tolerance tests were performed to estimate glucose metabolism and insulin sensitivity. Eleven lipophilic chemicals (HCB, DDE, PCB-118, PCB-138, PCB-153, PCB-180, PBDE-100, PBDE-153, PBDE-154, PBDE-85, and PBDE-47) were measured at baseline using gas chromatography/high-resolution-mass-spectrometry. Chemicals detected in less than 75% of samples were treated as dichotomous (detect vs. non-detect); all other chemicals were treated as continuous. Linear mixed models were used to examine associations between exposures and changes in glucose homeostasis across age and pubertal stage, controlling for important covariates. Effect estimates were calculated for the 80th vs. 20th percentile of exposure or for detected vs. non-detected levels.

RESULTS: Childhood exposure to HCB, PBDE-100, PBDE-153, and PCB-118 was associated with dysregulated glucose metabolism. PCB-118 exposure was associated with 5 mg/dL higher glucose at 30-minutes post glucose challenge (p=0.02), and elevated HCB was associated with a 6 mg/dL higher 60-minute glucose (p=0.03) and 9.2 mg/dL/hour higher glucose area under the curve (p=0.01). In contrast, PBDE-100 and-153 were associated with the development of dysregulated glucose metabolism beginning in late puberty. PBDE-153 exposure was associated with 7 mg/dL higher 2-hour glucose post puberty (p=0.04), and of PBDE-100 exposure was associated with 16% lower insulin sensitivity post puberty (p=0.001). For both PBDE's, associations in pre- and early puberty were null.

CONCLUSIONS: Our results indicate that youth exposure to lipophilic chemicals is associated with dysregulated glucose metabolism, which may increase risk for type 2 diabetes.

Keywords: Organochlorines, polybrominated compounds, persistent pollutants, flame retardants, pesticides, type II diabetes



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 13

Endocrine Disrupting Chemicals and Cardiometabolic Health across the Life Course

Chairs: Tamarra James-Todd, United States & Barrett Welch, United States

O-TO-069

Chemical exposures » PFAS

Per- and polyfluoroalkyl substances and sleep quality among reproductive-aged Black women

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BACKGROUND AND AIM: High concentrations of per- and polyfluoroalkyl substances (PFAS) have been associated with sleep disturbances, but studies are limited. Black women have disproportionately higher concentrations of some PFAS and report a greater prevalence of sleep disturbances.

METHODS: We assessed the association between plasma PFAS concentrations and poor sleep quality among 871 participants from the ongoing Study of Environment, Lifestyle, and Fibroids, a Detroit-area prospective cohort study of Black women recruited during 2010-2012. Using liquid chromatography-tandem mass spectrometry, we measured PFAS in non-fasting plasma collected at the baseline visit, including MeFOSAA, PFDA, PFHxS, PFNA, PFUnDA, PFOA, and PFOS. At the 80-month follow-up visit, participants completed the validated Pittsburgh Sleep Quality Index (PSQI). We used modified Poisson regression models to estimate risk ratios (RRs) and 95% confidence intervals (CIs) for associations, after adjusting for the following baseline covariates (identified from directed acyclic graphs and literature): age, income, body mass index, cigarette smoking, education, heavy menstrual bleeding, oral contraceptive use, parity, and time since last birth.

RESULTS: Poor sleep quality (PSQI>5) was reported by 61% of women. RRs comparing PFDA concentrations of 0.2, 0.3-0.4, and ≥0.5 ng/ml with <0.2 ng/ml were 1.09 (95% CI: 0.94-1.27), 1.26 (95% CI: 1.06-1.49) and 1.11 (95% CI: 0.96-1.28), respectively. Little association was observed with other PFAS. Among nulliparous women (n=334, with 58% PSQI>5), RRs were elevated for those with higher concentrations of PFNA (≥1.0 vs. <0.6 ng/ml: RR=1.25, 95% CI: 0.96-1.64), PFDA (≥0.5 vs. <0.2 ng/ml: RR=1.17, 95% CI: 0.92-1.49), PFOA (≥2.3 vs. <1.3 ng/ml: RR=1.24, 95% CI: 0.95-1.61), and PFOS (≥9.0 vs. <4.2 ng/ml: RR=1.26, 95% CI: 0.98-1.60).

CONCLUSIONS: We found no strong associations between PFAS exposure and poor sleep quality overall, except for PFDA. Among nulliparous women, greater concentrations of PFNA, PFDA, PFOA, and PFOS were positively associated with poor sleep quality, with PFOA and PFOS displaying dose-response associations.

Keywords: chemical exposures, endocrine disrupting chemicals, epidemiology, female, PFAS



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 13

Endocrine Disrupting Chemicals and Cardiometabolic Health across the Life Course

Chairs: Tamarra James-Todd, United States & Barrett Welch, United States

O-TO-070

Chemical exposures » PFAS

Early-life associations between per- and polyfluoroalkyl substances and serum lipids in a longitudinal birth cohort

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BACKGROUND AND AIM: Exposures to per- and polyfluoroalkyl substances (PFASs) may affect metabolic outcomes, including serum lipid concentrations. However, few studies have evaluated potential associations between PFASs and lipids longitudinally. In this study we estimated associations between PFAS and lipid concentrations at birth and at several points in childhood and identified sensitive periods of exposure.

METHODS: This study included 490 children from a prospective cohort in the Faroe Islands. Concentrations of five PFASs were measured in serum collected at birth and ages 18 months, 5 years and 9 years. Serum lipid concentrations were measured at birth, 18 months and 9 years. We estimated associations between PFAS and lipid concentrations and evaluated possible effect modification by sex. We further tested whether PFAS associations with age-9 lipids varied by exposure period using multiple informant models of repeated PFAS exposures.

RESULTS: Childhood PFAS exposures were positively associated with lipids at age 9. Increases in age-9 concentrations of perfluorodecanoic acid (PFDA), perfluorononanoic acid (PFNA) and perfluorooctanesulfonic acid (PFOS) were positively associated with total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C). For example, a doubling of PFDA at age nine was associated with a 0.19 mmol/L increase in TC (95% CI: 0.07, 0.32), a 0.10 mmol/L increase in HDL-C (95% CI: 0.05, 0.15) and a 0.12 mmol/L increase in LDL-C (95% CI: 0.02, 0.22). We found significant differences in estimated effects by sex, with stronger positive associations between PFASs and TC and LDL-C in girls, and stronger positive associations with HDL-C in boys. Exposure period was a significant modifier of PFAS effects in multiple informant models.



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ABSTRACT E-BOOK

CONCLUSIONS: These findings suggest that childhood PFAS exposures may be associated with elevated serum lipid concentrations. This is a public health concern, as a detrimental lipid profile in childhood is a risk factor for later development of hyperlipidemia and cardiovascular disease.

Keywords: Chemical exposures, Children's environmental health, Endocrine disrupting chemicals, Obesity and metabolic disorders, PFAS



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 13

Endocrine Disrupting Chemicals and Cardiometabolic Health across the Life Course

Chairs: Tamarra James-Todd, United States & Barrett Welch, United States

O-TO-071

Chemical exposures » PFAS

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) and PFAS Mixtures with Incident Hypertension: the Study of Women's Health Across the Nation 1999-2017

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BACKGROUND AND AIM: Perfluoroalkyl and polyfluoroalkyl substances (PFAS) exposure may cause a variety of hypertension-inducing pathophysiological responses. However, the one epidemiologic study that has examined PFAS and hypertension incidence in adults reported no significant associations. This study aimed to examine the associations between PFAS and incident hypertension.

METHODS: This study included 1,058 midlife women free of hypertension from the multi-racial/ethnic Study of Women's Health Across the Nation (SWAN) Multi-Pollutant Study with approximately annual follow-up visits between 1999 and 2017. Baseline serum PFAS concentrations were quantified by high-performance liquid chromatography-isotope dilution-tandem mass spectrometry. Hypertension was defined as blood pressure ≥ 140 mmHg systolic or ≥ 90 mmHg diastolic or receiving anti-hypertensive treatment. Cox proportional hazards (PH) model were utilized to calculate hazards ratios (HR) and 95% confidence intervals (CI) with adjustment for race/ethnicity, study site, educational attainment, financial strain, smoking status, passive smoking, alcohol consumption, total calorie intake, menopausal status, and body mass index. Elastic net-penalized Cox PH regression was implemented to model PFAS mixtures and construct an integrative index, environmental risk score (ERS), to evaluate the joint effect of PFAS mixtures.

RESULTS: During 11,843 person-years of follow-up, 470 participants developed incident hypertension. Compared with the lowest tertile, women in the highest tertile of baseline serum concentrations had adjusted HRs of 1.36 (95% CI: 1.08-1.73) for total perfluorooctane sulfonate (PFOS) (P-trend=0.01), 1.31 (95% CI: 1.03-1.67) for linear perfluorooctanoate (n-PFOA) (P-trend=0.01), and 1.37 (95% CI: 1.07-1.75) for 2-(N-ethyl-perfluorooctane sulfonamido) acetate (EtFOSAA) (P-trend=0.01). No significant associations were observed for perfluorononanoate (PFNA) and perfluorohexane sulfonate (PFHxS). In the mixture analysis, women in the highest tertile of ERS had an HR of 1.53 (95% CI: 1.20-1.96) (P-trend=0.0008), compared with those in the lowest tertile.

CONCLUSIONS: Our findings suggest an association between PFAS and incident hypertension. PFAS may be an underappreciated contributing factor to women's cardiovascular disease risk.

Keywords: PFAS, Mixtures, Mixture analysis, Cardiovascular diseases



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 13

Endocrine Disrupting Chemicals and Cardiometabolic Health across the Life Course

Chairs: Tamarra James-Todd, United States & Barrett Welch, United States

O-TO-072

Chemical exposures » Phenols

Racial/ethnic-specific associations of urinary phenols and parabens with adipokines in midlife women: The Study of Women's Health Across the Nation

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BACKGROUND AND AIM: Environmental phenols have been associated with metabolic phenotypes. Adipokines, cytokines secreted by adipose tissue, may contribute to obesity-related metabolic disease. Growing evidence supports racial/ethnic difference in adipokine levels. We examined the ethnic-specific associations of urinary phenols and parabens with adipokines.

METHODS: Urinary concentrations of 5 phenols (bisphenol-A, bisphenol-F, 2,4-dichlorophenol, 2,5-dichlorophenol, triclosan) and 4 parabens (Methyl-paraben, Ethyl-paraben, Butyl-paraben, Propyl-paraben) were measured in 2002-2003 among 1200 women of the Study of Women's Health Across the Nation Multi-Pollutant Study. Covariate-adjusted standardization approach was used for urine dilution adjustments of exposure concentrations. Serum adipokines included adiponectin, high molecular weight (HMW)-adiponectin, leptin, soluble leptin receptor (sOB-R), and adiponectin/leptin ratio (ALR). Linear regression models were used to estimate the percentage change in adipokines per doubling of individual urinary phenols and parabens after adjusting for age, site, education level, physical activity score, smoking status, menopausal status, total caloric intake, and obesity status.

RESULTS: Participants included white (52.5%), black (19.3%), and Asians (Chinese and Japanese, 28.1%) women. In white women, urinary bisphenol-F were associated with 6.79% (95% confidence interval: 0.58%, 13%) higher HMW-adiponectin and 2.9% (0.52%, 5.27%) higher sOB-R levels. Urinary 2,4-dichlorophenol were associated with 3.92% (0.58%, 7.27%) higher adiponectin and 7.42% (1.79%, 13.06%) higher HMW-adiponectin. Urinary methyl-paraben and propyl-paraben were associated with 5.56% (-9.07%, -2.06%) and 3.27% (95% CI: -6.01%, -0.53%) lower in leptin levels and 6.28% (1.75%, 10.82%) and 4.09% (95% CI: 0.56%, 7.63%) higher ALR. In black women, urinary methyl-paraben was associated with 7.01% (2.09%, 11.92%) higher leptin levels and 8.78% (-15.76%, -1.80%) lower ALR. No significant associations were observed in Asian.

CONCLUSIONS: We found urinary bisphenol-F, 2,4-dichlorophenol and parabens were associated with favorable profiles of adipokines in white women whereas urinary methyl-paraben was associated with adverse profiles in black women. Our findings suggested that exposure to phenols and parabens were associated with adipokine profiles but the association could differ by race/ethnicity.

Keywords: Environmental epidemiology, Phenols, adipokines



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 14

Water Exposures and Adverse Health Outcomes

Chairs: Agneta Akesson, Sweden & Elise Elliott, United States

O-TO-073

Chemical exposures » PFAS

Breastfeeding Initiation and Duration after High Exposure to Perfluoroalkyl Substances through Contaminated Drinking Water: A Cohort Study from Ronneby, Sweden

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BACKGROUND AND AIM: The drinking water in parts of Ronneby municipality was heavily contaminated with perfluoroalkyl substances (PFAS) for decades. Although PFAS has endocrine-disrupting properties and may interfere with breastfeeding, the supporting epidemiologic literature is conflicting and based solely on populations with background levels of exposure. The effects on breastfeeding in populations with a point source of exposure are unknown. The aim was to investigate the potential associations between high PFAS exposure and 1) initiation and 2) duration of breastfeeding in a population-based cohort.

METHODS: We retrieved data on infant feeding practices for 2,374 children born between 1999 and 2009 from Child Health Care centers in Ronneby and Karlshamn, a nearby municipality with background levels of exposure. Maternal residential address before delivery was used as a proxy for exposure, and confounder data were obtained from charts and national registers. We used modified Poisson regressions to estimate the risk of not initiating breastfeeding and, among initiators, the risks of not breastfeeding exclusively after 3 months and not breastfeeding at all at 6 months.

RESULTS: Mothers who had received the contaminated water at their residential address had a 2.4 times higher risk (95% CI: 0.8, 6.7) of not initiating breastfeeding. Among initiators, primiparous mothers from the exposed area were at a 1.2 times increased risk (95% CI: 0.9, 1.6) of not exclusively breastfeeding at 3 months and a 1.6 times increased risk (95% CI: 1.2, 2.1) of not breastfeeding at all at 6 months. Multiparous women seemed less vulnerable to these effects, although we observed slightly increased risk estimates towards the end of the study period.

CONCLUSIONS: Exposure to high levels of PFAS was associated with increased risks of not initiating breastfeeding as well as with shorter breastfeeding duration. Initiation among primiparous mothers was the most critical outcome, and targeted intervention might be warranted.

Keywords: PFAS, Long-term exposure, Reproductive Outcomes, Environmental Epidemiology



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 14

Water Exposures and Adverse Health Outcomes

Chairs: Agneta Akesson, Sweden & Elise Elliott, United States

O-TO-074

Birth and Pregnancy Outcomes » Birth outcomes

Nitrate in drinking water and risk of birth defects: Findings from a study of over one million births in Denmark

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BACKGROUND AND AIM: A few epidemiologic studies have reported an association between nitrate in drinking water and the risk of birth defects (BD). Our objective was to examine this association in a large, population-based study with individual-level exposure estimates.

METHODS: We studied a cohort of all Danish singletons liveborn to Danish-born parents from 1991–2013 (N=1,018,914). In total, 33,182 BD diagnosed until the age of two were identified. Nitrate concentrations during pregnancy were analyzed using continuous and categorical variables. Odds ratios (OR) and 95% confidence intervals (95% CI) were estimated using logistic regression with generalized estimating equations and controlling for parental age, birth year, birth order, maternal smoking, education, employment, and income. Analyses were conducted for ten major BD categories, and for subcategories that were of interest.

RESULTS: Nitrate pregnancy concentrations were generally low (median=1.9 mg/L NO₃⁻) and below US and European limits (44 and 50 mg/L NO₃⁻). An association was observed between nitrate and eye BD in the highest exposure group (OR for >25 versus 0 to <2 mg/L (OR₂₅)=1.29 95% CI=1.00, 1.66), and there was evidence of an exposure-response relationship (p=0.004). A large excess risk for the eye subcategory of congenital cataracts was observed among children with young mothers (<25) (OR₂₅=4.20 95% CI=1.87, 9.45). An interaction (p<0.005) was also observed between maternal age and nervous system BD indicating an effect among young mothers (OR₂₅=1.19, 95% CI=1.06, 1.35), particularly for spina bifida (OR₂₅=1.23, 95%CI=1.03, 1.48). No evidence of an association was observed for other BD categories.

CONCLUSIONS: Our study is the first to report an association between nitrate and eye BD and provides support to prior reports of an association between nitrate in drinking water and nervous system BD. Our findings raise serious concerns about the adequacy of current regulatory standards for nitrate in drinking water given the low levels of exposures in our study.

Keywords: nitrate, drinking water, birth defects, congenital malformations



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 14

Water Exposures and Adverse Health Outcomes

Chairs: Agneta Akesson, Sweden & Elise Elliott, United States

O-TO-075

Exposures » Water quality

Drinking water disinfection byproducts and ingested nitrate with the risk of endometrial cancer in postmenopausal women

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BACKGROUND AND AIM: Disinfection by-products (DBPs) and *N*-nitroso compounds, formed endogenously after nitrate/nitrite ingestion, are suspected endometrial carcinogens but epidemiologic studies are limited. We investigated their relationship with endometrial cancer risk in a large prospective cohort.

METHODS: Among postmenopausal women in the Iowa Women's Health Study cohort, we evaluated ingestion of total trihalomethanes (TTHM), the sum of five haloacetic acids (HAA5), and nitrate-nitrogen (NO₃-N) in public water supplies (PWS), and dietary nitrate/nitrite in relation to incident primary endometrial cancer (1986-2014). For women using their PWS ≥10 years at enrollment (N=10,501; cases=261), we computed historical averages of annual concentrations based on years of use. We assessed dietary nitrate/nitrite intakes with a food frequency questionnaire (N=22,897; cases=566). We estimated hazard ratios (HR) and 95% confidence intervals (CI) via Cox models adjusted for age, endometrial cancer risk factors (e.g., body mass index, hormone therapy), and mutually adjusted for DBPs or NO₃-N. We used a competing risk model to evaluate associations with low-grade (cases=99) versus high-grade (cases=114) type I tumors. We evaluated joint effects between drinking water exposures and risk factors.

RESULTS: Average DBPs ≥95th percentile (TTHM ≥93; HAA5 ≥49 µg/L) were associated with endometrial cancer risk (TTHM HR_{95vsQ1}=2.22;CI=1.43–3.46; HAA5 HR_{95vsQ1}=1.87;CI=1.21–2.88; *p*trends< 0.01). Associations with TTHM exposure at the fourth quartile remained significant for low-grade (HR_{Q4vsQ1}=2.11;CI=1.16–3.85) but not high-grade tumors (HR_{Q4vsQ1}=1.39;CI=0.79–2.43; *p*heterogeneity=0.44). For women who ever used estrogen therapy compared to never users, we observed a greater than additive risk at the highest quartile of TTHM (relative excess risk due to interaction, RERI=1.74;CI=0.16–3.33). Associations with NO₃-N in drinking water and dietary nitrate/nitrite were null.

CONCLUSIONS: We report the first epidemiologic analysis to demonstrate an association between relatively high DBP levels and endometrial cancer. This observation warrants future evaluation.

Keywords: Environmental epidemiology, Cancer and cancer precursors, Female, Water quality



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 14

Water Exposures and Adverse Health Outcomes

Chairs: Agneta Akesson, Sweden & Elise Elliott, United States

O-TO-076

Birth and Pregnancy Outcomes » Birth outcomes

Associations between exposure to drinking water chlorination by-products and congenital malformations—a nation-wide register-based prospective study including 600,000 births

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BACKGROUND AND AIM: Chlorination is globally used as a drinking water disinfectant, but chlorination by-products, like trihalomethanes (THM), are easily formed. There are indications that THM may increase the risk of certain adverse reproductive outcomes, although the results are inconsistent. We conducted a nation-wide register-based prospective study to assess whether gestational exposure to THM via drinking water was associated with risk of congenital malformations.

METHODS: We included all births during 2005-2015 of mothers residing in Swedish localities with >10,000 inhabitants, ≤ two operating water treatment plants, adequate information on chlorination procedures and sufficient number of THM measurements from the municipal monitoring. Individual maternal exposure was obtained by linking THM measurements to residential history, and categorized into no chlorination, <5, 5-15 and >15 µg THM/L. We also stratified the analyses by chlorination procedure. Outcomes and covariates were obtained via linkage of several Swedish health and administrative registers. Odds ratios (OR) and 95% confidence interval (CI) were estimated by logistic regression.

RESULTS: Based on ~600,000 births and after full multivariable adjustment, we observed indications of associations between prenatal THM exposure in areas using chloramine and malformations of the nervous system (OR 1.82, 95% CI: 1.07-3.12), urinary system (2.06: 1.53-2.78), genitals (1.77: 1.38-2.26) and limbs (1.34: 1.10-1.64), comparing the population exposed to >15 µg THM/L with the unexposed. No associations were observed in areas using hypochlorite alone.

CONCLUSIONS: This is one of the largest studies assessing chlorination by-products and congenital malformations. In areas using chloramine, we observed that THM was associated with an increased the risk of malformations of the nervous system, urinary system, genitals, and limb. An association between chloramine related chlorination by-products and congenital malformations has not previously been highlighted and needs attention.

Keywords: Water quality, Birth outcomes



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 14

Water Exposures and Adverse Health Outcomes

Chairs: Agneta Akesson, Sweden & Elise Elliott, United States

O-TO-077

Exposures » Water quality

Chlorination by-products in drinking water and risk of bladder cancer – a population-based cohort study

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BACKGROUND AND AIM: Exposure to chlorination by-products has been consistently associated with an increased risk of bladder cancer in case-control studies, but confirmation from large-scale cohort studies are lacking. We assessed the association of drinking water trihalomethanes (THM), a surrogate for chlorination by-products, with risk of bladder cancer in 58,672 men and women in two population-based cohorts.

METHODS: We used data, including questionnaire information, from the Swedish Infrastructure for Medical Population-Based Life-Course and Environmental Research (SIMPLER). Individual exposure to THM was assessed by combining residential information from register with municipal THM monitoring data. Participants were categorized into no chlorination, low (<15 µg/L) or high (>15 µg/L) THM exposure dependent on their area of residence. Incident bladder cancer cases were ascertained from 1998 through 2019 via register linkage. Associations were examined using multivariable-adjusted Cox proportional hazards regression models, including information on smoking habits and drinking water arsenic concentrations.

RESULTS: The mean THM concentration was 6.6 ± 2.2 µg/L and 17.1 ± 2.1 µg/L in the low and the high exposure category, respectively. During a mean follow-up of 16 years (965,590 person-years), 831 bladder cancer cases were ascertained. We observed no overall association of THM with risk of bladder cancer. The hazard ratio was 0.90 (95% confidence interval: 0.73 – 1.11) when comparing the highest exposed group with those in the non-chlorinated areas. The null association remained after restricting the analysis to long-term residents and across strata of smoking status and cancer stage.

CONCLUSIONS: Our results suggest that at THM concentrations below 20 µg/L, which is representative of chlorinated drinking waters in most European countries, chlorination by-product exposure is not associated with risk of bladder cancer.

Keywords: Chlorination by-products, Disinfection by-products, Trihalomethanes, Bladder cancer, Water quality, Drinking water



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 15

Environmental Exposure Impacts on Reproductive Outcomes

Chairs: Mildred Maisonet, United States & Musa Kana, United States

O-TO-078

Birth and Pregnancy Outcomes » Pregnancy outcomes

Prenatal exposure to toxic and essential metal/metalloid mixtures is associated with placental genomic signatures

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BACKGROUND AND AIM: Prenatal exposure to toxic metals (and metalloids) is linked to numerous adverse perinatal and later-in-life outcomes. During pregnancy, metals pass through the placental barrier to reach the developing fetus. In doing so, metals may alter placental functioning; a potential mechanism underlying adverse health outcomes. In this study, we evaluated placental gene expression in relation to cord tissue concentrations of metals/metalloids, individually and in mixtures.

METHODS: Matched samples of placenta and cord tissue were collected in the ELGAN cohort (n=251), which enrolled infants delivered <28 weeks' gestation between 2002-2004. Genome-wide RNA-sequencing of placentas quantified expression levels of >37,000 mRNA transcripts. Concentrations of 8 metals (barium, cadmium, copper, lead, manganese, mercury, strontium, zinc) and 3 metalloids (arsenic, antimony, selenium) were measured in cord tissue using inductively coupled plasma tandem-mass spectrometry. Negative binomial generalized linear models were fit within the DeSeq2 R package to identify differentially expressed genes (false discovery rate < 0.1) with respect to each metal/metalloid. To assess metal mixtures, principal components analysis was also conducted.

RESULTS: Individually, lead, mercury and manganese were associated with the strongest placental genomic responses, with 181, 64 and 55 differentially expressed genes, respectively. In contrast, arsenic, cadmium, antimony, selenium and strontium individually did not display associations with gene expression levels. However, in a mixtures-based analysis, the principal component that was loaded primarily with arsenic, mercury and manganese was associated with 569 differentially expressed genes. The gene that displayed the most significant association with the metals mixture was DNA Methyl Transferase 1 (DNMT1).



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ABSTRACT E-BOOK

CONCLUSIONS: By combining environmental mixtures and high-dimensional -OMICs approaches, we elucidated target genes and potential molecular pathways within the placenta altered by metal/metalloid-exposure. Lead, mercury and manganese were most strongly associated with distinct placental molecular signatures. A multi-metal analysis highlighted a critical gene involved in epigenetic patterning in the placenta.

Keywords: Mixtures, Molecular epidemiology, Heavy metals, Pregnancy outcomes, Birth outcomes



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 15

Environmental Exposure Impacts on Reproductive Outcomes

Chairs: Mildred Maisonet, United States & Musa Kana, United States

O-TO-079

Birth and Pregnancy Outcomes » Birth outcomes

Increased arsenic levels in both environmental measurements and biomonitoring results are associated with elevated risk of spina bifida

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BACKGROUND AND AIM: Arsenic is associated with multiple adverse reproductive outcomes, and previous studies suggested higher risk of neural tube defects among mothers exposed to higher concentration of well water arsenic in Bangladesh. We further examine the association using water arsenic as proxy for external exposure and toenail as biomarkers for internal dose.

METHODS: Parental toenail and water arsenic concentrations were examined in a case-control study in National Institute of Neurosciences & Hospital, Dhaka, Bangladesh. The associations between log-transformed and percentile arsenic concentrations and physician-diagnosed spina bifida were evaluated with logistic regression and cluster analysis, adjusted for maternal age, maternal BMI, parity, educational level, folic acid use and second-hand smoke exposure during pregnancy and weighted by self-reported dietary patterns.

RESULTS: Median concentration for water, maternal and paternal arsenic are 2.0 ppb, 0.4 and 0.5 microgram per gram toenail among 280 included child-parent trios (156 with spina bifida) with complete exposure data. We observed associations between highest quartile maternal arsenic levels, higher than 10 ppb arsenic in water and spina bifida risk for their children after weighted for diet (Adjusted OR for water arsenic=1.49, 95% CI=1.00-2.06; adjusted OR for maternal arsenic=1.57, 95% CI=1.10-2.24), and higher composite exposure in both hierarchical clustering and k-means clustering were also associated with increased risk after weighting. Effect heterogeneity was observed between different folic acid supplement conditions, in which dose-response was attenuated for both water and paternal concentrations.

CONCLUSIONS: Prenatal inorganic arsenic exposure was associated with elevated risk of spina bifida in Bangladesh, and joint parental exposure is associated with a higher risk. Investigations and interventions to mitigate arsenic exposure during for pregnant women are warranted.

Keywords: Heavy metals, birth outcomes, children's environmental health



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 15

Environmental Exposure Impacts on Reproductive Outcomes

Chairs: Mildred Maisonet, United States & Musa Kana, United States

O-TO-080

Birth and Pregnancy Outcomes » Birth outcomes

Performance of Urine, Blood, and Integrated Metal Biomarkers in Relation to Birth Outcomes in a Mixture Setting

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BACKGROUND AND AIM: The ability to evaluate mixture effects of metal mixtures are limited by the uncertainty whether a single biological medium can fully capture exposure for each metal. The aim of this study was to examine the mixture predictive performance of urine and blood metal biomarkers and integrated multi-media biomarkers in association with birth outcomes.

METHODS: In our analysis of 847 women from the Puerto Rico Testsite for Exploring Contamination Threats (PROTECT) study, we measured 10 essential and non-essential metals in repeated and paired samples of urine and blood during pregnancy. For each metal, we integrated exposure estimates from paired urine and blood biomarkers into multi-media biomarkers (MMBs), using intraclass-correlation coefficient (ICC) and weighted quantile sum (WQS) approaches. Using Ridge regressions, four separate Environmental risk scores (ERSs) for metals in urine, blood, MMBICC, and MMBWQS were computed as a weighted sum of the 10 metal concentrations. We then examined associations between urine, blood, and multi-media biomarker ERSs and birth outcomes using linear and logistic regressions, adjusting for maternal age, maternal education, pre-pregnancy body mass index (BMI), and second-hand smoke exposure.

RESULTS: Individuals with high ERS (3rd tertile) showed increased odds of preterm birth compared to individuals with low ERS (1st tertile), with 2.8-fold for urine (specific gravity corrected); 3.2-fold for blood; 3.9-fold for the multi-media biomarkers composed using ICC; and 5.2-fold for multi-media biomarkers composed using WQS. The four ERSs had comparable predictive performances (AUC ranging from 0.64 to 0.68) when urine is examined with specific gravity corrected concentrations; the performances were also significantly better than the performance of urine ERS without accounting for specific gravity.

CONCLUSIONS: Within a practical metal panel, measuring metals in either urine or blood may be an equally good approach to evaluate the metals as a mixture, but only when the urine measurements are corrected for urinary dilution.

Keywords: Metals, prenatal stress, social support, manganese, Puerto Rico.



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 15

Environmental Exposure Impacts on Reproductive Outcomes

Chairs: Mildred Maisonet, United States & Musa Kana, United States

O-TO-081

Birth and Pregnancy Outcomes » Pregnancy outcomes

Association between Urinary Phthalate Metabolites and Biomarkers of Oxidative Stress in Pregnant Women - Tainan Birth Cohort Study (TBCS)

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BACKGROUND AND AIM: Oxidative stress biomarkers were suggested to be intermediates link between phthalate exposure and adverse health outcomes in pregnant women. This study explored the relationship between urinary phthalate metabolites and biomarkers indicative of lipid peroxidation and oxidative and nitrosative DNA damage.

METHODS: Measurements from 97 Taiwanese women were taken across three trimesters. Five oxidative/nitrosative stress biomarkers - 8-hydroxy-2'-deoxyguanosine (8-OHdG), 8-nitroguanine (8-NO₂Gua), 4-hydroxy-2-nonenal-mercapturic acid (HNE-MA), 8-isoprostaglandin F_{2α} (8-isoPF_{2α}), and malondialdehyde (MDA), and 11 phthalate metabolites were measured in urine samples. Linear regressions in each trimester and a linear mixed-model regression were fitted to estimate percent changes in oxidative/nitrosative stress biomarkers resulting from any inter-tertile increase of phthalate metabolite level and the cumulative concentration of di (2-ethylhexyl) phthalate and dibutyl phthalate.

RESULTS: The highest urine concentrations of phthalate metabolites and the greatest number of significant positive associations between phthalate metabolites and oxidative/nitrosative stress biomarkers were observed in the third trimester and through repeated measurements analysis, respectively. Of the biomarkers related to DNA damage, 8-OHdG (25.4% increasing for monoiso-butyl phthalate tertile increased) was more sensitive to phthalate exposure than 8-NO₂Gua. Among the biomarkers of lipid peroxidation, HNE-MA (61.2% increasing for sum DEHP tertile increased) was more sensitive than 8-isoPF_{2α} and MDA.

CONCLUSIONS: Our results suggest an enhanced susceptibility to phthalate exposure in the third trimester. Future research is necessary to evaluate the mediating role of oxidative/nitrosative stress biomarkers in the link between phthalate exposure and adverse reproductive outcomes.

Keywords: Phthalate, Oxidative stress, Nitrosative stress, DNA damage, Lipid peroxidation, Pregnancy



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 15

Environmental Exposure Impacts on Reproductive Outcomes

Chairs: Mildred Maisonet, United States & Musa Kana, United States

O-TO-082

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

Prenatal phthalate exposure in relation to placental corticotropin releasing hormone (pCRH) concentrations in the CANDLE study

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BACKGROUND AND AIM: Studies suggest that prenatal phthalate exposure may contribute to preterm birth. Placental corticotropin releasing hormone (pCRH) may be a “placental clock” whereby levels rise in late pregnancy, triggering parturition. To explore a possible mechanism linking phthalates to preterm birth, the ECHO-PATHWAYS Consortium examined associations between phthalate exposure and pCRH concentrations in mid-late pregnancy.

METHODS: We measured urinary phthalate metabolites and serum pCRH in the 2nd(T2: mean 23.0 weeks) and 3rd(T3: mean 31.8 weeks) trimesters in CANDLE study participants (n=1018). We fit covariate adjusted models associating log(pCRH) (at each timepoint) with 15 log-transformed phthalate metabolites and Σdi(2-ethylhexyl)phthalate(ΣDEHP), in individual regression models and as mixtures using weighted quantile sums (WQS) regression. We evaluated effect modification by gestational diabetes (GDM) and gestational hypertension (GHTN).



ABSTRACT E-BOOK

RESULTS: Median pCRH was 37.6 ± 75.0 and 235.2 ± 429.0 pg/mL in T2 and T3, respectively. In WQS models, phthalate mixtures were not associated with CRH at either timepoint. Monobutyl phthalate was associated with higher T2 pCRH ($\beta=0.07$, 95%CI:0.004, 0.13). Monoethyl phthalate was associated with lower pCRH at both visits, while monomethyl phthalate was associated with higher T3 pCRH ($\beta=0.04$, 95%CI:0.01, 0.08). In interaction models, positive associations were observed between each phthalate metabolite and T3 pCRH among women with GHTN ($n=102$), whereas each association was negative for women without GHTN ($p<0.05$ for interaction in 9 of 15 models). By contrast, among women with GDM ($n=59$), most individual phthalate metabolites were associated with lower pCRH at T3, with associations being strongest for the DEHP metabolites.

CONCLUSIONS: In the whole cohort, we observed few associations between phthalate metabolites and CRH. However associations between phthalate exposure and pCRH in late pregnancy may differ among women with or without GDM or GHTN. More research is needed to understand whether women with pregnancy complications may be more vulnerable to reproductive effects of phthalates.

Keywords: phthalates, pregnancy, CRH, preterm birth, pregnancy complications, endocrine disruption



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August 24, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 15

Environmental Exposure Impacts on Reproductive Outcomes

Chairs: Mildred Maisonet, United States & Musa Kana, United States

O-TO-083

Reproductive Outcomes » Female reproductive outcomes

Ultraviolet radiation and age at natural menopause in a nationwide, prospective US cohort

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BACKGROUND AND AIM: Ultraviolet radiation (UV) is essential for dermal conversion of vitamin D, which is suggested to support reproductive health. However, little is known about the association of UV exposure with reproductive aging. Thus, we aimed to examine the associations between long-term UV exposure and age at natural menopause in a large, nationwide, prospective cohort.

METHODS: Women in the Nurses' Health Study II, a nationwide prospective US cohort enrolled in 1989, were included if they were premenopausal at age 40 (N=105,631) and were followed through 2015 or self-reported menopause, whichever came first. Data on menopause, residence, and confounders were available every two years. Erythemal UV radiation from a high-resolution geospatial model was linked to the participants' residential histories. Early-life UV was estimated using UV measures in the reported state of residence at birth, age 15, and age 30. We used time-varying Cox proportional hazard models to estimate the hazard ratio (HR) and 95% confidence intervals (CIs) for natural menopause, adjusting for potential confounders and predictors of menopause.

RESULTS: A total of 63,801 women reported natural menopause during the 1,051,185 person-years of follow-up. We found weak associations with delayed menopause for long-term UV exposure after age 40 (adjusted HR comparing Q4 to Q1 of cumulative average UV: 0.96, 95% CI: 0.94, 0.99). There was a suggestive association between UV at age 30 with later onset of menopause (adjusted HR comparing Q4 to Q1: 0.97, 95% CI: 0.95, 1.00) but not with UV at birth or age 15. Similar weak associations were found when restricting the outcome to women who reported menopause between age 40 and 45.



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CONCLUSIONS: UV exposure in adulthood was weakly associated with later onset of menopause. Although consistent with previous findings on vitamin D intake and menopause in the same population, the associations are unlikely to be of clinical relevance.

Keywords: reproductive outcomes, long-term exposure, female



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 16

Air Pollution and Respiratory Health

Chairs: Michelle Turner, Spain & Ashtyn Areal, Germany

O-TO-084

Air pollution » Particulate matter

Modification of Asthma Clinical Trial Treatment Efficacy by Social and Environmental Exposures

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BACKGROUND AND AIM: Randomized controlled trials (RCTs) are considered the gold standard for examining effectiveness of clinical interventions, though they rarely evaluate social and environmental exposures that may modify underlying disease states. This is a particular concern for asthma, which is consistently linked to air pollution and social stressors.

METHODS: We reexamined the AsthmaNet Step-up Yellow Zone Inhaled Corticosteroids to Prevent Exacerbations (STICS) trial, in which participants were randomly assigned to low (44 µg/inhalation) or high (220 µg/inhalation) dose of fluticasone inhaled corticosteroid treatment (ICS) upon asthma exacerbation, and followed to assess subsequent exacerbations. AsthmaNet reported no significant differences between dose groups in number of exacerbations, or time to first rescue prednisone use (Jackson et al, NEJM 2018).

We geocoded participant residences, estimated mean exposures over follow-up using a validated national spatiotemporal model for fine particles (PM_{2.5}), and derived census tract-level indicators for poverty rates and medically-underserved areas (MUAs). We used Cox proportional hazard models to assess time-to-prednisone use, and tested whether co-exposures modified associations between treatment arm and outcomes.

RESULTS: Individuals with above-median (7.4 µg/m³) PM_{2.5} exposures had, on average, more exacerbation events over the study, than did those with below-median PM_{2.5} [μ = 1.75 events (SD = 1.84) vs. μ = 1.45 events (SD = 1.71)]. The high ICS dose was associated with shorter time-to-prednisone-use, compared to low ICS dose, *only* among those with above-median PM_{2.5} exposure (p = .048), or living in lower-poverty areas (p = .08) or non-MUAs (p = .02).

CONCLUSIONS: While the overall impact of quintupling ICS dose on exacerbations was null, specific social and environmental factors modified observed treatment effects. In high-PM_{2.5} or less-deprived areas, higher ICS doses conferred shorter times to exacerbation. Clinical trials should account for social and environmental exposures, to better understand intervention impacts and identify sub-groups for whom interventions may be particularly effective.

Keywords: asthma exacerbations, PM_{2.5}, inhaled corticosteroids, RCT



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 16

Air Pollution and Respiratory Health

Chairs: Michelle Turner, Spain & Ashtyn Areal, Germany

O-TO-085

Air pollution » Long-term exposure

Association between prenatal and early life household air pollution exposure and child lung function in rural Ghana

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BACKGROUND AND AIM: Impaired lung development in early childhood increases risk for future pulmonary disease. Millions of people worldwide are exposed to household air pollution (HAP), however the impact of early life HAP on childhood lung development is poorly described. Leveraging the Ghana Randomized Air Pollution and Health Study (GRAPHS) birth cohort, we examined associations between prenatal and early life HAP exposure, as indexed by carbon monoxide (CO), and age four lung function.

METHODS: GRAPHS enrolled pregnant women prior to 24 weeks gestation. We quantified HAP exposure by repeated personal prenatal (maternal) and early life (child) carbon monoxide (CO) assessments. Mother-child dyads were followed prospectively and children performed impulse oscillometry (IOS) at age four years. For analyses, IOS lung function variables were converted to z-scores adjusting for age, sex, ethnicity, height and weight. We then employed multivariable generalized linear regression models to examine associations between prenatal and early childhood CO and IOS variables. Sex-specific effects were explored.

RESULTS: Of the 699 study children, 612 (88%) performed acceptable IOS. Children were aged 4.1 years (0.35 SD) on average at the time of IOS and 52% (N=315) were female. In adjusted models, increased prenatal CO exposure was associated with increased R5 (R5 z-score $\beta=0.17$ (95% CI 0.00, 0.34) and R20 ($\beta = 0.20$ (95% CI 0.03, 0.37), indicative of increased total and large airway resistance, respectively. Exploratory analyses suggested that boys were more vulnerable to the effects of prenatal CO exposure on both R5 and R20.

CONCLUSIONS: Higher prenatal HAP exposure, as indexed by CO, is associated with impaired lung function at age four years and boys may be more vulnerable. These findings add to the growing literature of the adverse health effects of early life HAP exposure on child health.

Keywords: household air pollution exposure, carbon monoxide, child lung function, sex-specific effects



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 16

Air Pollution and Respiratory Health

Chairs: Michelle Turner, Spain & Ashtyn Areal, Germany

O-TO-086

Air pollution » Long-term exposure

The Breathe Easy Study: Impacts of Ventilation Improvements on IAQ and Adult Asthma in 40 Existing Homes in Chicago, IL

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BACKGROUND AND AIM: This paper presents preliminary results of the Breathe Easy Project, which as designed to improve indoor air quality (IAQ) and asthma-related health outcomes by installing residential mechanical ventilation systems in forty existing homes in Chicago, IL. Each home had at least one self-reported adult resident with asthma and received one of three types of ventilation systems half-way through the study: exhaust-only system, central-fan-integrated-supply (CFIS) system, or balanced system with an energy recovery ventilator (ERV).

METHODS: We conducted quarterly field measurements to monitor indoor and outdoor pollutants, including size-resolved particles (0.3-10 µm), ozone (O₃), nitrogen dioxide (NO₂), carbon dioxide (CO₂), carbon monoxide (CO), and formaldehyde (HCHO). Monthly asthma control test (ACT) surveys were administered for each participant throughout the study. Wilcoxon signed-rank tests were used to evaluate the impacts of ventilation system retrofits on IAQ, indoor/outdoor (I/O) ratio, and ACT score. Chi-square tests for independence and multiple logistic regression were used to analyze associations between IAQ, asthma severity, and baseline characteristics of participants and homes.

RESULTS: Indoor pollutant concentrations and I/O ratios were significantly lower after ventilation system retrofits for indoor concentrations of HCHO, CO₂, PM_{1.0}, PM_{2.5}, and PM₁₀, and I/O ratios of CO₂, NO₂, PM_{1.0}, and PM_{2.5} (P < 0.05). There was a small but significant increase in average ACT score of 1.04 across the entire study population after the ventilation system retrofits (P < 0.001). Based on association analysis of the pre-intervention period, higher NO₂ concentrations were associated with increased odds of poorly controlled asthma, with crude odds ratios (OR) (95% CI) of 2.8 (1.2–6.4). Also, Black participants showed OR (95% CI) of 5.7 (1.3–25.9) for poorly controlled asthma compared to White participants.

CONCLUSIONS: The results can potentially provide information on the influence of exposure for many air toxics and will furnish an opportunity to evaluate exposure models for these compounds.

Keywords: Air pollution, asthma, exposures, occupational epidemiology



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 16

Air Pollution and Respiratory Health

Chairs: Michelle Turner, Spain & Ashtyn Areal, Germany

O-TO-087

Respiratory and Allergic Outcomes » Respiratory outcomes

Comparing types of exposure metrics for identifying the effects of air pollution: an application in a panel of COPD patients

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Environmental Research Group, Imperial College London

BACKGROUND AND AIM: Measured or modelled concentrations used in epidemiological studies can differ from true exposures, a difference known as measurement error. To account for this, personal exposure measurements can be regarded as the “gold-standard” method but do not differentiate between the effects of indoor- and outdoor-generated pollution. We apply a statistical apportionment method to identify and separate the effects of personal exposure to air pollution from indoor and outdoor sources on chronic obstructive pulmonary disease (COPD) patients in London.

METHODS: A panel of 130 patients was followed up for an average period of 128 days during which each patient carried sensors measuring PM_{2.5}, PM₁₀, NO₂, NO, CO and O₃ at one-minute resolution. Total personal exposures (PE_T) were separated into those from indoor- (PE_I) and outdoor-generated pollution (PE_O) using GPS data and matching ambient concentrations from the London reference ambient air quality monitoring network. Each patient recorded daily respiratory symptoms, peak expiratory flow (PEF) and exacerbation of symptoms. The associations of these outcomes with PE_T, PE_I, PE_O and ambient pollution were assessed with mixed-effects models.

RESULTS: Preliminary results for PM_{2.5} have shown that while total personal exposure was not associated with any outcome, a unit increase in PE_O was found to increase the odds of exacerbation, cough and sputum by approximately 1.0%. Using ambient concentrations, which is the equivalent error-prone proxy to PE_O, these odds were decreased to 0.6-0.7% for exacerbation and cough, while for sputum the finding was not statistically significant. PEF was negatively associated only with PE_I. Work is ongoing for the other pollutants.

CONCLUSIONS: Our findings suggest that the exposure metric used in identifying the health effects of air pollution is important in epidemiological studies. Using proxies can introduce measurement error bias. For decision-making, it is important to separate the effects of indoor- and outdoor-generated pollution as different policies apply to each.

Keywords: Air pollution, Respiratory outcomes, Methodological study design, Exposure assessment, Measurement error



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 16

Air Pollution and Respiratory Health

Chairs: Michelle Turner, Spain & Ashtyn Areal, Germany

O-TO-088

Respiratory and Allergic Outcomes » Respiratory outcomes

Genetic susceptibility in air pollution-induced airway inflammation in elderly women

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BACKGROUND AND AIM: Evidence is supporting that air pollutants can activate inflammatory responses which increase oxidative stress and further affect respiratory health. So far, epidemiological studies on this pathway have mainly disregarded genetic effects. Thus, we aim to investigate the role of genetic susceptibility in air pollution-induced airway inflammation.

METHODS: We used data from 445 women (68–79 years) enrolled in the ongoing cohort study on the influence of air pollution on lung function, inflammation and aging (SALIA) between baseline (years 1984–94) and first follow-up (years 2007–10). Biomarkers of airway inflammation were determined at follow-up in induced-sputum samples (levels of leukotriene (LT)B₄, tumour necrosis factor- α (TNF- α), the total number of cells and nitric oxide derivatives). Out of 272 lung function-related single nucleotide polymorphisms, we calculated biomarker-specific weighted genetic risk scores (GRS) using internal weights from elastic net regression. Interactions between GRS and chronic NO₂, NO_x, PM_{2.5}, PM₁₀, PM_{coarse}, and PM_{2.5} absorbance exposure (the centred means of cumulative exposure to each air pollutant over observation time) on inflammation were investigated by adjusted linear regression models.

RESULTS: Our results confirm that higher exposure to each air pollutant increase airway inflammation (TNF- α) and additionally, higher exposure to PM_{coarse} increases LTB₄ level. Furthermore, we observed significant gene-environment interaction effects for TNF- α (adj. GRSxNO_x: p-value=0.036, adj. GRSxPM_{2.5}: p-value=0.021, adj. GRSxPM_{coarse}: p-value=0.001) and for LTB₄ (adj. GRSxPM_{coarse}: p-value=0.001). Women with high GRS compared to low GRS had an increased risk of air pollution-induced higher TNF- α level as well as higher LTB₄ level.

CONCLUSIONS: Genetic susceptibility may play a role in the pathway of chronic air pollution exposure to airway inflammation responses.

Keywords: Air pollution, Epigenomics, Female, Long-term exposure, Respiratory outcomes, Risk assessment



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 16

Air Pollution and Respiratory Health

Chairs: Michelle Turner, Spain & Ashtyn Areal, Germany

O-TO-089

Respiratory and Allergic Outcomes » Asthma

Is respiratory care carbon conscious? Rationale and future implications for the CARBON respiratory program

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BACKGROUND AND AIM: Healthcare systems need to substantially reduce greenhouse gas (GHG) emissions as societies decarbonize their economies. In respiratory medicine, contributions from healthcare resource utilization (HCRU) and short-acting β_2 -agonist (SABA) relievers, which provide rapid relief from asthma symptoms, are significant. SABA relievers contribute to the majority of inhaler usage and total carbon footprint of inhaler devices across Europe. In asthma, high SABA use is common and associated with poor disease control and increased exacerbation risk.¹ In chronic obstructive pulmonary disease (COPD), exacerbation history is linked with increased rate of future exacerbations;² both SABA use and exacerbations increase HCRU requirements. Here, we provide an overview of the healthCARE-Based carbonON cost of treatment (CARBON) sustainability program, which evaluates the carbon footprint associated with poorly and well-managed care of common respiratory diseases.

METHODS: CARBON is the first program to quantify the carbon footprint of HCRU and medications in respiratory healthcare by using a combination of certified published studies and methodologies.

RESULTS: Patients with well-managed asthma and COPD are likely to have a lower carbon impact through reduced requirements for SABA medication use and HCRU. This CARBON group of studies is evaluating the overall carbon footprint associated with SABA use, exacerbations, and HCRU in over 1.5 million patients with asthma or COPD in over 30 European and North American countries.

CONCLUSIONS: Understanding what comprises the carbon footprint of respiratory healthcare and how it is impacted by poor disease control or disease progression is the first step in understanding how innovative treatments and guideline implementation can drive carbon reduction without risking improvements in patient outcomes. The principle of evidence-led care improvement as a means to achieve greater sustainability will have multiple benefits for patients and society.

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Keywords: Allergies, Asthma, Pharmaceuticals



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 17

Exposure to Pesticides and Adverse Health Outcomes

Chair: Jonathan Chevrier, Canada & Yun-Hee Choi, South Korea

O-TO-090

Chemical exposures » Pesticides

Associations between 3-phenoxybenzoic acid levels and hematological measures in adults: Korean National Environmental Health Survey 2012–2014

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BACKGROUND AND AIM: Pyrethroid insecticides have been widely used for pest control in agriculture and residential spaces due to their high insecticidal effectiveness and low toxicity to humans. Several animal studies suggested that exposure to pyrethroids may induce bone marrow toxicity, resulting in inhibiting blood cell production. However, no studies have reported the effect of pyrethroid insecticide exposure on hematological changes in humans without occupational exposure. This study aimed to investigate the effect of 3-phenoxybenzoic acid (3-PBA) concentrations in urine on hematological parameters in Korea's representative adult population.

METHODS: We analyzed data from 6,296 Korean adults recruited in the Korean National Environmental Health Survey (2nd round, 2012–2014). A multiple linear regression analysis was used to evaluate the association of urinary 3-PBA levels with eight hematological profiles of white blood cell (WBC), red blood cell (RBC), hemoglobin (Hb), hematocrit (Hct), platelet, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC).

RESULTS: Urinary 3-PBA levels showed a negative association with WBC, RBC, Hb levels and a positive association with MCV levels. The association varied by sex and age. The adverse effects of 3-PBA levels on hematological parameters were more pronounced among men aged 60 years and older. Among this age group, 3-PBA concentrations were negatively associated with WBC, RBC, Hb, Hct, and MCHC levels in men. However, among adults aged below 60 years, no associations were found between 3-PBA concentrations and any of hematological measure in either male or female. The associations remained significant on sensitivity analysis after controlling other urinary chemicals.

CONCLUSIONS: This is the first study reporting evidence that 3-PBA concentration in urine, at levels found in a Korean population, may influence blood cell counts. This novel finding merits further investigation to understand the impact of 3-PBA on human blood function and population health.

Keywords: Pesticides, Environmental epidemiology, Biomarkers of exposure, Epidemiology, Big data



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 17

Exposure to Pesticides and Adverse Health Outcomes

Chair: Jonathan Chevrier, Canada & Yun-Hee Choi, South Korea

O-TO-091

Chemical exposures » Pesticides

Residential Proximity and Cumulative Risk Assessment of Agricultural Pesticide Applications in California

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Environmental Working Group

BACKGROUND AND AIM: Pesticide exposure based on residential proximity to agricultural applications has been associated with adverse health outcomes including developmental neurotoxicity such as reduced IQ and autism spectrum disorder, adverse birth outcomes such as low birth weight and birth defects as well as increased risk of cancer. However, epidemiological studies have primarily assessed individual pesticides or groups of pesticides sharing a common mechanism of action. In reality, individuals living near agricultural pesticide applications are exposed to a complex mixture of pesticides impacting a broad range of potential health harms. Here we develop a toxicity index for pesticide mixtures based on multiple chronic toxicity endpoints, and identify residential areas at greatest risk of adverse health outcomes due to pesticide exposure.

METHODS: Data for pesticide applications were downloaded from the California Pesticide Use Reporting program (PUR). Over 400 active ingredients were assessed for chronic toxicity endpoints including carcinogenicity, neurotoxicity, endocrine disruption, thyroid toxicity and respiratory toxicity based on classifications from authoritative bodies including the EPA, IARC, and EFSA. We developed a toxicity index for each active ingredient based on the severity of the health outcome, the strength of the association, the reliability of the data source and the NOAEL if available. We then combined the toxicity index with application rates for all pesticides applied within a square mile.

RESULTS: Pesticides with the greatest toxicity index include active ingredients previously associated with adverse health outcomes including organophosphates and carbamates. Other pesticides with high toxicity indices include neonicotinoids, pyrethroids and triazole fungicides. Residential areas of high risk of potential adverse health effects due to pesticide exposure from nearby agricultural applications were identified.

CONCLUSIONS: Using the pesticide toxicity index and application rates in combination with residential proximity agricultural applications can help identify and prioritize high risk areas for future pesticide policy actions to best protect public health.

Keywords: pesticides, cumulative risk assessment, residential proximity



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Exposure to Pesticides and Adverse Health Outcomes

Chair: Jonathan Chevrier, Canada & Yun-Hee Choi, South Korea

O-TO-092

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Gestational Exposure to Toxicants and Autistic Behaviors using Bayesian Quantile Regression

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BACKGROUND AND AIM: Autism Spectrum Disorder, which is characterized by impaired social communication and stereotypic behaviors, affects 1-2% of children. While prenatal exposure to toxicants has been associated with autistic behaviors, most studies have focused on shifts in mean behavior scores.

METHODS: We used Bayesian quantile regression to assess the associations between log₂-transformed toxicant concentrations and autistic behaviors across the distribution of behaviors. We used data from the Maternal-Infant Research on Environmental Chemicals study, a pan-Canadian cohort (2008-2011). We measured metal, pesticide, polychlorinated biphenyl, phthalate, bisphenol-A, and triclosan concentrations in blood or urine samples collected during the first trimester of pregnancy. Autistic behaviors were assessed in 478 3-4-year-old children using the Social Responsiveness Scale (SRS), where higher scores denote more autistic-like behaviors.

RESULTS: Lead, cadmium, and most phthalate metabolites were associated with mild increases in SRS scores at the 90th percentile of the SRS distribution. Manganese and some pesticides were associated with mild decreases in SRS scores at the 90th percentile of the SRS distribution. We identified several monotonic trends where associations increased in magnitude from the bottom to the top of the SRS distribution.

CONCLUSIONS: These results suggest that Quantile regression can reveal nuanced relationships and should thus be more widely used by epidemiologists.

Keywords: Endocrine disrupting chemicals; Neurodevelopmental outcomes



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Exposure to Pesticides and Adverse Health Outcomes

Chair: Jonathan Chevrier, Canada & Yun-Hee Choi, South Korea

O-TO-093

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Residential proximity to agricultural crops and adaptive behaviors in children with autism spectrum disorder from the French ELENA cohort

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BACKGROUND AND AIM: Exposures to pesticides during key periods of brain development (pregnancy and early childhood) have been associated with increased risk of autism spectrum disorder (ASD) in children. No study has yet investigated the influence of these exposures on the clinical expression of children with ASD. The aim of this study was to investigate the associations between early residential exposure to agricultural crops and adaptive behaviors in children with ASD.

METHODS: Children with ASD were recruited within the Etude Longitudinale de l'Enfant avec Autisme (ELENA) French cohort. Adaptive behaviors were assessed with the second edition of the Vineland Adaptive Behavior Scales (VABS-II). Baseline subscores in communication, daily living skills and socialization were considered. Residential exposure to agricultural crops was estimated by crops acreage within a 1000m radius around homes. We used multiple linear regression models to analyze the associations between exposures to agricultural crops during the pregnancy (n=183), the first two years of life (n=193) and adaptive behaviors in children with ASD.

RESULTS: The mean (SD) age of children at the inclusion in the ELENA cohort was 6 (3) years, 39% of them presented an intellectual disability (ID). The mean communication score was 73.0 (15.8). On average, the crop acreage covered 29(27)% of the acreage formed by the 1000m radius around homes. Each increase of 20% in the crop acreage was associated with a significant decrease in communication



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score of the VABS-II in children without ID for pregnancy ($\beta = -2.21$, 95%CI: -4.16 to -0.27) and the first two years of life ($\beta = -1.90$, 95%CI: -3.68 to -0.11). No association was found in children with ID.

CONCLUSIONS: This is the first study in children with ASD investigating and showing an association between early residential exposure to agricultural crops and impairments in adaptive behaviors. This study opens perspectives for future works to better understand ASD phenotypes.

Keywords: Exposure assessment, Pesticides, Neurodevelopmental outcomes, Children's environmental health, Environmental epidemiology



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Exposure to Pesticides and Adverse Health Outcomes

Chair: Jonathan Chevrier, Canada & Yun-Hee Choi, South Korea

O-TO-094

Omics Technologies » Metabolomics

Metabolomics profiles associated with an organic diet intervention in school children in Limassol, Cyprus: A cluster-randomized cross-over trial

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BACKGROUND AND AIM: Exposure to pesticides has been associated with oxidative stress in animals and humans. Previously, we showed that an organic food intervention reduced pesticide exposure and oxidative damage biomarkers over time, however associated metabolic changes are not fully understood yet. We assessed perturbations of the urine metabolome in response to an organic food intervention for children and its association with pesticides biomarkers [3-phenoxybenzoic acid (3-PBA) and 6-chloronicotinic acid (6-CN)]. We also evaluated the molecular signatures of metabolites associated with biomarkers of oxidative damage (OD) (8-iso-PGF2a and 8-OHdG) and related biological pathways.

METHODS: We used data from the ORGANIKO LIFE+ trial (NCT02998203), a cluster-randomized cross-over trial conducted among primary school children in Cyprus. Participants (n=149) were asked to follow an organic food intervention for 40 days and their usual food habits for another 40 days, providing up to six first morning urine samples (>850 samples in total). Untargeted GC-MS metabolomics analysis was performed. Metabolites with RSD≤20% and D-ratio≤50% were retained for analysis. Associations were examined using mixed-effect regression models and corrected for false-discovery rate of 0.05. Pathway analysis followed.

RESULTS: Following strict quality checks, 156 features remained out of a total of 610. D-glucose was associated with the organic food intervention ($\beta=-0.23$, 95% CI: -0.37,-0.10), aminomalonic acid with the organic food intervention ($\beta=-0.44$, 95% CI:-0.68,-0.19) and the two OD biomarkers ($\beta=-0.27$, 95% CI:-0.34,-0.20 for 8-iso-PGF2a and $\beta=0.19$, 95% CI:0.11,0.28 for 8-OHdG) and uric acid with 8-OHdG ($\beta=0.19$, 95% CI:0.11,0.26). The most affected pathways were the starch and sucrose metabolism and pentose and glucuronate interconversions.

CONCLUSIONS: Changes in the metabolomic profile of primary school children following a 40-day long systematic organic food intervention were observed. This is the first study providing evidence of differential expression of metabolites by an organic food intervention, corroborating the reduction in biomarkers of oxidative damage using metabolomics.

Keywords: organic food, metabolomics, pesticides, cluster randomized trial, oxidative stress, lipid damage



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Exposure to Pesticides and Adverse Health Outcomes

Chair: Jonathan Chevrier, Canada & Yun-Hee Choi, South Korea

O-TO-095

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Combined exposure to low level neurotoxic chemicals and child's neuropsychological performance

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BACKGROUND AND AIM: Generally, early life exposures to environmental pollutants occur at low levels and their contribution to child's cognitive abilities, still largely unknown, is a subject of many on-going studies. At low exposures, accounting for multiple neurotoxicants, as well as beneficial elements and genetic variability is important. This study explored prenatal and childhood exposure to trace elements, organophosphate and pyrethroid pesticides and its association with neuropsychological scores.

METHODS: Children were recruited in the Ljubljana Maternity Hospital (Slovenia) at birth and were assessed for neuropsychological performance at 7-8 years of age (WISC IV, n=178). Extensive information on life-style was obtained for both periods. Essential and non-essential trace element levels were determined at birth (cord blood), and at follow-up in peripheral whole blood, plasma and urine. Organophosphate and pyrethroid pesticides metabolites were determined in children's urine at follow-up.

RESULTS: Among the potentially neurotoxic substances, 4-nitrophenol, representing parathion exposure, showed negative association with full scale IQ of the children (coeff=-2.09, p=0.022) in a model adjusted for plasma selenium (coeff=16.5, p=0.037) and whole blood copper (coeff=-14.5, p=0.033) (Model R²=0.10, p=0.005). Additional adjustment revealed borderline significant positive effect of breastfeeding in infancy, language classes, and negative effect of watching TV during weekdays, and resulted in a stronger correlation coefficient between 4-nitrophenol and IQ (coeff=-3.03, p=0.004) and stronger overall model (R²=0.27, p<0.001). Mercury exposure in prenatal period was positively associated with IQ in the same model (coeff=2.77, p=0.046), most probably indicating beneficial effect of fish consumption during pregnancy.

CONCLUSIONS: Although the majority of children had their exposure estimates below the known health-based values, this study demonstrated an importance of evaluating mixed exposures, essential elements as well as child's cognitive activities along the critical periods of development when estimating their neuropsychological impacts. Continuing this work, paraoxonase genetic polymorphism will be considered and model outcomes will be verified using machine learning approaches.

Keywords: trace elements, pesticides, nutrients, neuropsychological performance



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Short-term Air Pollution Exposures and Adverse Health Outcomes

Chairs: Evangelia Samoli, Greece & Chen Chen, United States

O-TO-096

Respiratory and Allergic Outcomes » Respiratory outcomes

Air pollution and hospitalization of patients with idiopathic pulmonary fibrosis in Beijing: a time-series study

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BACKGROUND AND AIM: A few studies from high-income countries suggested that traffic-related air pollutants (e.g. nitrogen oxides, elemental carbon) were associated with morbidity and mortality from idiopathic pulmonary fibrosis (IPF), a severe respiratory disease but is relatively less studied in relation to air pollution. Air quality in Beijing has been progressively improving since the 2013 Clean Air Act. We compiled data five years before and after 2013, and ran time-series analyses for 2008-2012 and 2013-2017 separately to investigate acute effects of ambient air pollution on IPF hospitalization risk in Beijing.

METHODS: Daily counts of IPF hospitalizations were obtained from Beijing Public Health Information Center for the period 2008-2017 while daily city-wide average concentrations of each air pollutant (PM_{2.5}, NO₂, Ozone, SO₂) were obtained from a single monitoring station set up in the US Embassy for 2008-2012 (for PM_{2.5} only) and from 35 municipal monitoring stations for 2013-2017. The associations between daily IPF hospitalization and average concentration of each pollutant were analyzed with a generalized additive model (GAM) estimating Poisson distribution.

RESULTS: Across Beijing, daily 24-hour mean PM_{2.5} concentration during 2008-2012 and 2013-2017 was 88.9 and 76.7 µg/m³ respectively. During 2008-2012, relative risk (RR) of IPF hospitalization at lag0 per interquartile range (IQR) increase (83 µg/m³) in PM_{2.5} was 1.062 (95%CI: 1.025-1.101). The RR was reduced at lag1, lag2 and lag3 but remained significantly positive. In contrast, during 2013-2017, the RR was 1.049 (95%CI: 1.024-1.074) at lag0, but no significant associations were seen for all other lags. No associations were seen for NO₂ whilst significant associations were observed with both SO₂ and cool-season ozone.

CONCLUSIONS: Despite improvement in overall air quality, acute exposure to high-level air pollution is a risk factor for IPF hospitalization in Beijing. Air quality policy should be continuously enforced and carefully monitored to protect public health in the long-term.

Keywords: air pollution, respiratory disease, time-series, LMIC



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Short-term Air Pollution Exposures and Adverse Health Outcomes

Chairs: Evangelia Samoli, Greece & Chen Chen, United States

O-TO-097

Air pollution » Short-term exposure

Recent exposure to air pollution and its effect on cognitive and mental health: A citizen science panel study in Barcelona

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BACKGROUND AND AIM: The association between recent exposure to air pollution and cognitive and mental health has not been thoroughly investigated so far. We conducted a panel study co-designed with citizens to assess whether air pollution can affect attention processes and self-perceived stress and mood.

METHODS: From September 2020 to January 2021, we followed 290 adults (mean age = 37.9 years; standard deviation = 12.2 years) for 14 days in Barcelona, Spain. Two tasks were self-administered daily through a mobile application: the Stroop color-word test to assess attention performance and a set of 0-to-10 rating scale questions to evaluate well-being (sad to happy), energy (asleep to active) and stress (low to high). From the Stroop test, three outcomes were calculated and z-score-transformed: cognitive speed, cognitive throughput and inhibitory control. Air pollution was assessed using the mean nitrogen dioxide (NO₂) concentrations (mean of all Barcelona monitoring stations) 24 hours before the tasks were completed. We applied conditional linear regression using participant as strata to estimate intra-individual associations, controlling for day of the week and time-varying factors such as alcohol consumption and physical activity. Also, we tested the interaction effect of the presence of natural (green and blue) spaces within 300 m from the residence.

RESULTS: Repeated attention test performances (n = 2,971) of the participants reflected lower cognitive throughput (β -0.02, p = 0.04) with a recent increase of 10 $\mu\text{g}/\text{m}^3$ exposure to NO₂. This association was stronger (β -0.05, p = 0.02) when participants were not residing close to natural spaces. We did not find significant associations with cognitive speed, inhibitory control, well-being, energy and perceived stress.

CONCLUSIONS: Our findings suggested that short-term exposure to air pollution has a negative effect on attention performance. This effect may be modified by the presence of natural spaces.

Keywords: Air pollution, citizen science, attention processes, mental health, observational panel study



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Short-term Air Pollution Exposures and Adverse Health Outcomes

Chairs: Evangelia Samoli, Greece & Chen Chen, United States

O-TO-098

Air pollution » Short-term exposure

Air Pollution Exposure is Associated with Cognitive Performance: Results from the Einstein Aging Study

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BACKGROUND AND AIM: Prior research has established that those exposed to higher levels of fine particulate matter (PM_{2.5}) air pollution have higher levels of accumulated amyloid-beta (A β) and tau in frontal cortex at autopsy, higher error rates on cognitive function assessments, and lower scores on memory and both verbal and non-verbal intelligence assessments.

METHODS: We explored the relationship between regional PM_{2.5} measures (from EPA) and baseline cognitive performance of 312 older adults, from the Einstein Aging Study (EAS, NIA P01AG003949) across ambulatory cognitive assessments (completed on study-provided smartphones) and standard in-clinic neuropsychological assessments. Each year, participants completed standard neuropsychological assessments and ambulatory cognitive assessments for 14 days. For each participant, we computed average PM_{2.5} exposure at various windows (1-15, 30-60, 60-90, 90-120 days prior to baseline).

RESULTS: Controlling for age, education, and gender across all models, mean of daily PM exposure was significantly related to performance on ambulatory cognitive assessments of: processing speed (i.e., significantly slower with increased exposure, across all windows), working memory (i.e., higher error score; across all windows), and memory binding (i.e., higher error score; 60-90 and 90-120 day windows). To compare these results, we ran parallel models with (clinic-based) neuropsychological assessments. Mean of PM_{2.5} at exposure windows tested above, was related to the MoCA and Trails A & B, in expected directions (i.e., higher pollution, worse cognitive performance - more error, slower speed). Models with memory performance as the outcome indicated that distant time horizons (60-90, 90-120 days) were related. These findings taken together suggest that PM exposure affects different cognitive domains at different timescales (i.e., short-term exposure linked with processing speed; long-term exposure with memory).

CONCLUSIONS: An important limitation, this methodology cannot address contributions from indoor air quality and mobility - an exposure misclassification likely resulting in significant biases towards the null in the estimation of the effects of air pollution.

Keywords: particulate matter, cognition, Alzheimer's Disease and Alzheimer's Disease Related Dementias (AD/ADRD)



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Short-term Air Pollution Exposures and Adverse Health Outcomes

Chairs: Evangelia Samoli, Greece & Chen Chen, United States

O-TO-099

Air pollution » Short-term exposure

Personal exposure to outdoor particulate matter and greenspace in Delhi, India

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BACKGROUND AND AIM: Research suggests urban greenspace promotes better health, with reduced air pollution being a potential mechanism; however, much of this work is based on static environments in lower air pollution settings. Our aim was to study the association between particulate matter of <2.5 µm (PM_{2.5}) and greenspace during outdoor walking trips in a higher air pollution context.

METHODS: Study subjects included adolescents (age 10-18 years) with asthma recruited within the Delhi Air Pollution and Health Effects (DAPHNE) study. Participants were provided with an AirSpeck personal sensor to monitor continuously their exposure to PM_{2.5} during 48-hour monitoring periods. We identified walking journeys based on personal GPS data and assigned three indicators of greenspace according to four buffer sizes (25m, 50m, 100m, 250m): the mean Normalised Difference Vegetation Index (NDVI), mean tree cover density (TCD), and proportion overlap with green land use (GLU). We assessed the relationship between greenspace and PM_{2.5} using multilevel modelling, controlling for individual (e.g., age, sex), spatial (e.g., roads, population density) and temporal (e.g., season, meteorology) covariates.

RESULTS: There were 86 participants who provided 219 walking journeys, a cumulative total of 2029 minutes. The mean PM_{2.5} concentration was 129 µg/m³ (standard deviation=121). Results from preliminary analyses have not elucidated clear associations with greenspace. For example, in fully adjusted models (100 m buffer), the corresponding change in PM_{2.5} (µg/m³) for a 1-unit change in greenspace was 0.03 (95% confidence interval [CI]: -0.71 to 0.78) for NDVI, -1.4 (95% CI: -5.5 to 2.7) for TCD, and 0.42 (95% CI: -0.04 to 0.87) for GLU.

CONCLUSIONS: Our initial findings do not support lower exposure to PM_{2.5} with greenspace. A possible explanation is that any reductions linked to vegetation may be too modest to detect in the presence of substantial spatiotemporal variation as that which exists in Delhi.

Keywords: Air pollution, Particulate matter, Green space, Short-term exposure, Built environment



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Short-term Air Pollution Exposures and Adverse Health Outcomes

Chairs: Evangelia Samoli, Greece & Chen Chen, United States

O-TO-100

Air pollution » Short-term exposure

Cumulative joint effects of air pollution and extreme heat events among hemodialysis patients

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BACKGROUND AND AIM: Increasing number of studies have linked air pollution exposure with renal function decline and disease. However, there is a lack of data on its impact among end-stage renal disease (ESRD) patients and its potential modifying effect from extreme heat events (EHE).

METHODS: Fresenius Kidney Care (FKC) records from 28 selected northeastern counties were used to pool daily all-cause mortality (ACM) and all-cause hospital admissions (ACHA) counts. County-level daily ambient PM_{2.5} and ozone were estimated using a high-resolution spatiotemporal coupled model and matched to ESRD patients based on ZIP codes of treatment sites. We used time-stratified case-crossover analyses to characterize acute exposures using same day (Lag 0) and cumulative exposure for up to 3 days (Lag 0-3). A distributed lag non-linear model (DLNM) framework was applied in non-stratified and EHE-stratified analyses. We used a nested model comparison hypothesis test to evaluate for interaction effects.

RESULTS: From 2001 to 2016, the sample population consisted of 43,338 ESRD patients and yielded 5,217 deaths and 78,433 hospital admissions. A 10-unit increase in PM_{2.5} concentration was associated with a 5% increase in ACM (rate ratio [RR_{Lag0-3}], 1.05; 95% CI, 1.00-1.10) and same-day O₃ (RR_{Lag0}, 1.02; 95% CI, 1.01-1.03) after adjusting for extreme heat exposures. Exceedance of ozone national ambient air quality standard (NAAQS) in the prior 3 days (Lag 0-3) was associated with a 29% increase in ACM (RR_{Lag0-3}, 1.29; 95% CI, 1.00-1.66) during EHE days. Data suggest that EHE can modify the association between ground-level Lag 0-3 ozone and mortality and Lag 0-3 PM_{2.5} exposures and mortality.

CONCLUSIONS: Our findings suggest that extreme heat events may modify the association between air pollution and ACM among ESRD patients. National level assessments are needed to investigate how this relationship may vary by individual-level determinants and geographic region.

Keywords: Air pollution, Ozone, Particulate matter, Short-term exposure, Temperature extremes



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 18

Short-term Air Pollution Exposures and Adverse Health Outcomes

Chairs: Evangelia Samoli, Greece & Chen Chen, United States

O-TO-101

Air pollution » Particulate matter

Daily levels of coarse inhalable particles and sick leaves

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BACKGROUND AND AIM: Road traffic is typically the main source of coarse inhalable particles (2.5 μm < diameter < 10 μm) in urban areas. Consequently, exposure is high e.g. during commuting to work, in northern conditions especially during the spring time. Our aim was to evaluate whether daily outdoor levels of coarse inhalable particles are associated with the daily number of new sick leaves in Helsinki, Finland.

METHODS: Data on work absenteeism among the employees of the city of Helsinki (approx. 50 000) was obtained for the years 2001-2017. Concentration of coarse inhalable particles was calculated by subtracting daily fine particle concentration from the concentration of inhalable particles, both measured at an urban background monitoring site. Statistical analyses were conducted using generalized additive quasi-Poisson regression, separately for the whole year and the spring dust period (15.3.-15.5).

RESULTS: There were almost 2 million sick leaves in the data. The same day coarse particle concentration was associated with an increased risk of sick leave: relative risk for a 10 $\mu\text{g}/\text{m}^3$ increase in exposure was 1.018 (95% confidence intervals 1.005-1.030). Fine particles had similar effect but with one day lag. During the spring dust period, coarse particles were not associated with the outcome.

CONCLUSIONS: Exposure to road dust seems to increase the risk of work absenteeism. However, during the spring dust period particle toxicity may be reduced e.g. because of aging of the material during winter.

Keywords: air pollution, coarse particles, work absenteeism, short-term



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 19

Exposure Assessment: Biomarkers

Chair: Douglas Walker, United States & Haotian Wu, United States

O-TO-102

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Central Nervous System (CNS)-Derived Extracellular Vesicles (EVs) as Novel Biomarkers for Environmental Exposure and Disease Progression in ALS

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BACKGROUND AND AIM: Metal exposure is linked to amyotrophic lateral sclerosis (ALS) but biomarkers of central nervous system (CNS) metal burden are lacking. Here, we tested the use of blood-isolated CNS-derived extracellular vesicles (EVs) as biomarkers of metal exposure and disease progression in ALS. Specifically, we examined whether: 1) cultured brain cells can eliminate metals via EV release, 2) metal levels in ALS patient blood-isolated CNS-EVs predict metal load in their brain and spinal cord, and 3) differences in CNS-EV metal levels are associated with ALS disease progression (ongoing).

METHODS: Metal levels were measured by ICP-MS. Cultured astrocytes were treated with 2.5µM Mn or As for 3 or 7 days. Released EVs were isolated by ultracentrifugation. In a pilot of N = 7 National ALS Registry patients, we measured metal levels in blood, CNS-EVs, spinal cord, and cortex to assess their correlations. CNS-EVs of neuronal (L1CAM) and astrocyte (GLAST) origin were enriched via immunoprecipitation. In 97 ALS patients at two disease stages, GLAST-EVs were immunopurified from blood and analyzed for Cu, Pb, Hg, Al, Mn, Cd, and Fe levels. Linear models are being employed to examine associations between changes in CNS-EV metal levels and ALS Functional Rating Scale progression.

RESULTS: Mn and As levels in treated astrocyte EVs increased over time, whereas these metals were not detected in control cells. Circulating GLAST-EV metal load was overall more predictive of spinal cord and cortex metal levels than total blood or L1CAM-EV metal levels. Hg and Cd were not detected in ALS patient GLAST-EV samples, while geometric means of Cu, Pb, Al, Mn, and Fe decreased between the two timepoints.

CONCLUSIONS: Preliminary evidence suggests that peripheral GLAST-EVs metal levels may reflect internal CNS metal exposure and that metal regulation via CNS-EVs weakens over time. The association of GLAST-EVs with ALS disease progression deserves further exploration.

Keywords: Heavy metals, Exposures, Biomarkers of exposure, Neurodegenerative outcomes, ALS, Extracellular vesicles



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 19

Exposure Assessment: Biomarkers

Chair: Douglas Walker, United States & Haotian Wu, United States

O-TO-103

Chemical exposures » PFAS

Determinants for serum half-lives for linear and branched perfluoroalkyl substances after long-term, high exposure — a study in Ronneby, Sweden

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BACKGROUND AND AIM: Per- and polyfluoroalkyl substances (PFAS) are persistent, ubiquitous substances with long elimination periods and various health effects. Although elimination rates and half-lives for PFAS have been described in both animal and human studies, few studies have explored the determinants behind the human elimination. The purpose of the current study was to estimate serum half-lives and the determinants for different PFAS.

METHODS: Municipal drinking water contaminated with PFAS had been distributed to one third of households in Ronneby, Sweden. The source was firefighting foam used in a nearby airfield since the mid-1980s. Clean water was provided from December, 2013. Between 2014 and 2018, 114 individuals aged between 4-84 from Ronneby participated in up to 10 serum sampling occasions. Potential determinants were collected at baseline, including Age, Sex, Body Mass Index, and estimated Glomerular Filtration Rate (eGFR). Urine was collected three times for calculating urine/serum ratio of PFAS, and faeces once for faecal calprotectin and zonulin. 19 PFAS were analyzed, and 8 of them were increased in Ronneby: perfluorooctanoic acid (PFOA), perfluoropentane sulfonate (PFPeS), perfluorohexane sulfonate (PFHxS), perfluoroheptane sulfonate (PFHpS), linear perfluorooctane sulfonate (L-PFOS) and three branched perfluorooctane sulfonates (1m-PFOS, 3/4/5m-PFOS and 2/6m-PFOS).

RESULTS: The mean estimated half-lives (in years) were 2.47 (95%CI 2.27-2.7) for PFOA, 0.94 (0.86-1.02) for PFPeS, 4.52 (4.14-4.99) for PFHxS, 4.55 (4.14-5.06) for PFHpS, 2.73 (2.55-2.92) for L-PFOS, 5.01 (4.56-5.55) for 1m-PFOS, 3.43 (3.19-3.71) for 3/4/5m-PFOS, and 2.67 (2.51-2.85) for 2/6m-PFOS. Young age (<14), females in fertile age (14-50), high eGFR (>90 ml/min/1.73 m²), high urine/serum ratio, high calprotectin and low zonulin were associated with shorter half-lives.

CONCLUSIONS: These results provide observational support for elimination routes – renal, faecal and maternal; are in line with past estimates for some PFAS such as PFOA; and are the first results for different PFOS isomers.

Keywords: PFAS, Environmental Epidemiology, Water Quality, Long-term exposure



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 19

Exposure Assessment: Biomarkers

Chair: Douglas Walker, United States & Haotian Wu, United States

O-TO-104

Chemical exposures » General

Widespread Exposure to Emerging and Previously Unmeasured Chemicals in Commerce in Pregnant women Across the US

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BACKGROUND AND AIM: Prenatal chemical exposures are ubiquitous, can influence maternal, fetal and child health, and lead to adverse pregnancy and child health outcomes. The NIH Environmental influences on Child Health Outcomes (ECHO) Program, –comprised of geographically, racially, and ethnically diverse prospective pregnancy and birth cohorts, provides an unparalleled opportunity for understanding environmental exposures among US pregnant women. Our study applies a new and efficient biomonitoring method for quantifying >100 priority chemicals in commerce among pregnant women and characterizes predictors of prenatal exposures.



ABSTRACT E-BOOK

METHODS: We developed methods to prioritize and measure 148 chemicals and their metabolites in eight priority classes in urine: pesticides (30), environmental phenols (17), parabens (6), organophosphate flame retardants/esters (OPFRs/OPEs) (9), phthalates/alternative plasticizers (31), polycyclic aromatic hydrocarbons (11), aromatic amines (42), and tobacco biomarkers (2). Using HPLC-MS/MS methodology, we analyzed 172 urine samples from pregnant women in nine of 72 ECHO pregnancy cohorts from five US states (CA, GA, IL, NH, NY) and Puerto Rico, representing a broad range of demographic characteristics as well as recruitment and sample collection strategies. We calculated detection frequencies and descriptive statistics for concentrations and assessed predictors by estimating associations of sociodemographic and sample collection characteristics with creatinine-standardized analyte concentrations.

RESULTS: We detected 56 analytes in greater than 50% of samples (6 pesticides, 6 environmental phenols, 3 parabens, 2 OPFRs/OPEs, 18 phthalates/alternative plasticizers, 10 polycyclic aromatic hydrocarbons, and 11 aromatic amines). Forty-two analytes were not detected in any sample. Among widely detected analytes were three pesticides (two neonicotinoids and a metabolite of chlorpyrifos), BPS (a BPA replacement), several previously unmeasured phthalate metabolites, melamine and cyanuric acid. For many analytes, concentrations varied by cohort/location.

CONCLUSIONS: Our study is the largest to date to measure these mostly understudied chemicals for which we found widespread exposure in a diverse sample of U.S. pregnant women.

Keywords: Chemical exposures, Phthalates, Phenols, Pesticides, Children's environmental health, Pregnancy outcomes



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 19

Exposure Assessment: Biomarkers

Chair: Douglas Walker, United States & Haotian Wu, United States

O-TO-105

Exposome » Internal exposome

Combination of multi-residue methods for organic pollutant(s) and metal(s) analysis in hair - Towards a comprehensive assessment of population exposome

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BACKGROUND AND AIM: Awareness of the adverse effects of exposure to pollutant mixtures, possibly much more severe than individual chemicals, has drawn attention towards the necessity of using multi-residue methods to obtain the most possible comprehensive information on exposome. Among the different biological matrices used for exposure assessment, hair enables to detect the largest number of chemicals, including many classes such as persistent pollutants, hydrophilic metabolites and metals. Most biomonitoring studies are however focused on a limited number of pollutants and only give a partial information on exposure.

Combining several multi-residue methods, the present study aimed at assessing the exposure of a population to an extensive variety of chemicals by hair analysis.

METHODS: One hair sample was collected from each participant (40 children and 117 adults). Samples were analysed with three different multi-residue methods, targeting respectively 152 organic pollutants (pesticides, PCBs, bisphenols, PBDEs), 62 polycyclic aromatic hydrocarbons (PAHs) and metabolites, nicotine and cotinine and 36 metals.

RESULTS: From 33 to 70 organic chemicals were detected in each child's hair sample, and from 34 up to 74 in adults. From 7 to 26 PAH were detected per child, and 7 to 21 in adults. Twenty-three to 27 metals were detected per child and 21 to 28 per adult. The highest median concentration were observed for zinc (143 pg/mg in children; 164 pg/mg in adults), bisphenol-A (95.9 pg/mg in children; 64.7 pg/mg in adults) and nicotine (66.4 pg/mg in children; 51.9 pg/mg in adults).

CONCLUSIONS: The present study provides the most comprehensive exposure assessment ever and highlights the simultaneous exposure to multiple classes of pollutants in the general population. The results support the use of multi-residue methods for future studies on exposure-associated effects, to document exposome and better consider the effect of chemical mixtures.

Keywords: Chemical exposures, Endocrine disrupting chemicals, Exposure assessment, Exposome, Mixtures analysis, Multi-pollutant



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 19

Exposure Assessment: Biomarkers

Chair: Douglas Walker, United States & Haotian Wu, United States

O-TO-106

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Assessing the Effects of Metal Mixtures in Urine and Blood on Kidney Function

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BACKGROUND AND AIM: Exposure to metal(oid)s including lead (Pb), cadmium (Cd), and arsenic (As) may impair kidney function individually and in mixtures. However, each metal has unique toxicokinetics reflected in respective biological media (e.g., blood, urine), implying that no single medium is ideal to study multiple metals simultaneously. We hypothesized that multi-media biomarkers (MMBs), integrated exposure indices that combine information across biomarkers into a common metric are informative of adverse kidney function.

METHODS: Levels of Pb, Cd, and As were quantified in blood and urine in 300 4-6 year-old Mexican children in the PROGRESS longitudinal cohort study. MMBs were constructed for the metals using weighted quantile sum regression (WQS) and the two media. We estimated the joint effects of the Pb-Cd-As metal mixture on cystatin C-based estimated glomerular filtration rate (eGFR) and serum creatinine (SCR) assessed at 8-10 years of age, adjusted for covariates.

RESULTS: Quartile increases in the WQS urine metal index and the WQS index across urine and blood (MMBs) were associated with increased eGFR (2.5%, 95%CI [0.1, 5.0]) and (3.0%, 95%CI [0.2, 5.7]), respectively. Additionally, all three—blood, urine, and MMBs—indices predicted decreased SCR: blood (-0.18 mg/L, 95%CI [-0.33, -0.04]), urine (-0.12 mg/L, 95%CI [-0.23, -0.01]), and MMBs (-0.20 mg/L, 95%CI [-0.35, -0.06]). Regardless of medium, weights indicate that Cd contributed most to the associations with eGFR, while Pb contributed most to the associations with SCR.

CONCLUSIONS: We observed associations between metal mixtures, in two media, and hyperfiltration, an early indicator of potential kidney function decline.

Keywords: Exposure assessment-biomarkers of exposure, Mixtures, Mixtures analysis, Heavy metals



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 20

Exposures Mixtures: An Exposome Approach

Chairs: Lida Chatzi, United States & Lea Maitre, Spain

O-TO-107

Exposome » Internal exposome

Non-linear and non-additive associations between the pregnancy exposome and birthweight

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BACKGROUND AND AIM: Birthweight is an indicator of fetal growth and environmental-related alterations of birthweight have been linked with multiple disorders and conditions progressing into adulthood. Although a few studies have assessed the association between birthweight and the totality of exogenous exposures and their downstream molecular responses in maternal urine and cord blood; no prior research has considered a) the maternal serum prenatal metabolome, which is enriched for hormones, and b) non-linear and synergistic associations among exposures.

METHODS: We measured the maternal serum metabolome during pregnancy using an untargeted metabolomics approach and birthweight for gestational age (BWGA) z-score in 410 mother-child dyads enrolled in the PRogramming of Intergenerational Stress Mechanisms (PRISM) cohort. We leveraged a Bayesian factor analysis for interaction to select the most important metabolites associated with BWGA z-score and to evaluate their linear, non-linear and non-additive associations. We also assessed the primary biological functions of the identified proteins using the MetaboAnalyst, a centralized repository of curated functional information. We compared our findings with those of a traditional metabolite-wide association study (MWAS) in which metabolites are individually associated with BWGA z-score.

RESULTS: Among 1110 metabolites, 46 showed evidence of U-shape associations with BWGA z-score. Most of the identified metabolites (85%) were lipids primarily enriched for pathways central to energy production, immune function, and androgen and estrogen metabolism, which are essential for pregnancy and parturition processes. Metabolites within the same class, i.e. steroids and phospholipids, showed synergistic relationships with each other.

CONCLUSIONS: Our results support that the aspects of the maternal metabolome during pregnancy contribute linearly, non-linearly and synergistically to variation in newborn birthweight.

Keywords: Exposome, Birth outcomes, Mixtures analysis, Metabolomics, Big data



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 20

Exposures Mixtures: An Exposome Approach

Chairs: Lida Chatzi, United States & Lea Maitre, Spain

O-TO-108

Exposures » Multi-pollutant/Multi-media

Urban environment and childhood obesity outcomes and weight-related behaviours in primary school children

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BACKGROUND AND AIM: Urban environments are characterised by many factors that may influence children's lifestyle and increase the risk of childhood obesity, but multiple urban exposure patterns have scarcely been studied. We evaluated the association between multiple urban exposures and childhood obesity outcomes and weight-related behaviours.

METHODS: We conducted a cross-sectional study including 2213 children aged 9-12 years in Sabadell, Spain. We estimated air pollution, green spaces, built/food environment, traffic and noise at residential addresses through a total of 28 exposure variables. Childhood obesity outcomes included body mass index (BMI), waist circumference and body fat. Weight-related behaviours included diet (fast food and sugar-sweetened beverage consumption), physical activity, sedentary behaviour, sleep duration and well-being. Associations between exposures and outcomes were estimated in single and multiple-exposure regression models and in a hierarchical clustering on principal components analysis.

RESULTS: Forty percent of children were overweight or obese. In single exposure models, very few associations were observed between the urban exposures and obesity outcomes or weight-related behaviours. In multiple exposure models, associations between increased access to unhealthy food environment and higher obesity outcomes became statistically significant (e.g. OR (overweight/obesity status) = 1.20 [95% CI: 1.01; 1.44]). Cluster analysis identified 5 clusters of urban exposures. Compared to the most neutral cluster, children in the a priori most harmful cluster (high air pollution, road traffic, and road noise) had a higher BMI and higher odds of overweight/obesity (β (zBMI) = 0.17, [95% CI: 0.01, 0.17]; OR (overweight/obesity) = 1.36, [95% CI: 0.99, 1.85]); the clusters were not associated with the weight-related behaviours.



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ABSTRACT E-BOOK

CONCLUSIONS: This study suggests that an urban environment with higher levels of ambient air pollution, traffic and noise is associated with increased childhood obesity risk, but not with weight-related behaviours. A holistic approach capturing urban exposures patterns to evaluate multiple urban exposures is important for future studies

Keywords: External exposome, Multi-pollutant/Multi-media, Obesity and metabolic disorders, Children's environmental health



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 20

Exposures Mixtures: An Exposome Approach

Chairs: Lida Chatzi, United States & Lea Maitre, Spain

O-TO-109

Chemical exposures » Mixtures

Prenatal exposure to lipophilic endocrine-disrupting chemicals and liver injury in children using chemical mixture approaches

Vishal Midya¹, Elena Colicino¹, David Conti², Kiros Berhane³, Erika Garcia², Nikos Stratakis², Sandra Andrusaityte⁴, Xavier Basagana⁵, Regina Grazuleviciene⁴, Line Småstuen Haug⁶, Barbara Heude⁷, Eleni Papadopoulou⁶, Rosemary McEachan⁸, Theano Roumeliotaki⁹, Rémy Slama¹⁰, Jose Urquiza⁵, Marina Vafeiadi⁹, Nerea Varo¹¹, Miriam B. Vos¹², John Wright⁸, Maribel Casas⁵, Rob McConnell², Martine Vrijheid⁵, Lida Chatzi², Damaskini Valvi¹

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BACKGROUND AND AIM: Exposure to Endocrine Disrupting Chemicals (EDC) may increase liver injury, but few studies have examined these associations in children and most focused on a single chemical group. We evaluated the associations between a wide range of prenatal EDC exposures and child liver injury.

METHODS: We studied 1108 healthy children from the Human Early-Life Exposome (HELIX) project, a collaborative network of six established longitudinal population-based birth cohort studies in Europe. Thirty lipophilic EDCs (including 3 organochlorine pesticides, 5 polychlorinated-biphenyl, 2 polybrominated-diphenyl-ethers [PBDEs], 5 high molecular weight phthalates (HMWP), 5 low molecular weight phthalates, 6 phenols and 4 organophosphate pesticides) were measured in maternal pregnancy blood or urine. Alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT) and cytokeratin 18 (CK18) were measured in child serum at follow-up between age 6-11 years. Liver injury was defined as having any liver enzyme (ALT, AST or GGT) above the 90th percentile.



ABSTRACT E-BOOK

We used Bayesian generalized linear mixed regressions (Bglmr) to estimate associations of individual chemicals, Bayesian Weighted Quantile Sum (BWQS) and Bayesian Kernel Machine Regression (BKMR) to assess the overall association of each chemical group with liver injury and CK18, adjusting for confounders.

RESULTS: BWQS results indicated that organochlorine pesticides and PBDEs were associated with increased odds of liver injury (OR[95%CI] by chemical mixture quartile increase=1.44[1.23, 1.72] and 1.59[1.37, 1.90], respectively); whereas HMWP were associated with decreased odds of liver injury (OR[95%CI]=0.71[0.59, 0.85]). A quartile increase of PBDEs was positively associated with CK18 (Estimate[95%CI]=5.33 Units/Liter [2.52,8.16]). Bglmr and BKMR showed associations in same direction as the BWQS results. There was evidence of effect heterogeneity by sex for organochlorine pesticides and HMWPs with liver injury status.

CONCLUSIONS: Using multiple chemical mixture approaches we found that prenatal exposures to persistent pollutants, especially to organochlorine compounds, and PBDEs, may be associated with increased risk for liver injury in childhood.

Keywords: Chemical exposures, Endocrine disrupting chemicals, Mixtures analysis, Modeling, Environmental epidemiology



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 20

Exposures Mixtures: An Exposome Approach

Chairs: Lida Chatzi, United States & Lea Maitre, Spain

O-TO-110

Exposome » Internal exposome

Phenols, phthalates and thyroid hormone levels during pregnancy; relying on toxicological data and Adverse Outcome Pathways to inform epidemiological analysis

Dorothy Nakiwala¹, Pamela D. Noyes⁵, Patrice Faure³, Benoît Chovelon³, Christelle Corne³, Anne Sophie Gauchez³, Dorra Guergour³, Sarah Lyon Caen¹, Amrit K Sakhi², Azemira Sabaredzovic², Cathrine Thomsen², Isabelle Pin⁴, Rémy Slama¹, [Claire Philippat](#)¹

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BACKGROUND AND AIM: Results of studies characterizing associations between exposure to phenols, phthalates and thyroid hormone concentrations during pregnancy are inconsistent. Given the high number of exposures and outcomes usually considered, we hypothesized that part of the inconsistency results from chance findings.

METHODS: We included 437 pregnant women from the SEPAGES cohort with thyroid stimulating hormone (TSH), protein-bound and free thyroxine (T4) and triiodothyronine (T3) quantified in maternal sera. We assessed 12 phenols, 13 phthalate and two 1,2-cyclohexane dicarboxylic acid diisononyl ester (DINCH) metabolites in a pool of 21 spot urine samples collected during pregnancy. We relied on an existing thyroid adverse outcome pathway (AOP) network and in vitro high-throughput screening results from the ToxCast database to select assayed chemicals interacting with well-known and putative molecular initiating events relevant to thyroid hormone disruption (e.g., thyroperoxidase inhibition). We then employed adjusted linear regressions to study associations between these selected chemicals, and hormone concentrations.

RESULTS: Compared to agnostic approaches, our a priori selection allowed to reduce the number of tests performed by 20%. Among the selected chemicals, three (mono-6-hydroxy-propylheptyl phthalate (OH-MPHP), di-2-ethylhexyl phthalate (Σ DEHP), bisphenol A) were negatively associated with TSH (p -values ≤ 0.09). The associations observed with bisphenol A and Σ DEHP were modified by maternal iodine status. We also observed a U-shape association between triclosan and TSH and negative associations between propylparaben (-1.4% (95%CI: -2.7; 0.0) for each doubling in urinary concentrations), monobenzyl phthalate (5.3% (95%CI: -10.12; -0.14) and the T3/T4 ratio.



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ABSTRACT E-BOOK

CONCLUSIONS: Relying on repeated urine samples, we highlighted negative associations between several phenols and phthalate metabolites and TSH, as well as with the T3/T4 ratio. This hypothesis driven methodology incorporating molecular pathway tools provides a promising approach for exposome studies where there are often large numbers of substances and for which agnostic statistical approaches increase the likelihood of false positive findings.

Keywords: Phenols, phthalates, DiNCH, thyroid hormones, pregnancy



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 20

Exposures Mixtures: An Exposome Approach

Chairs: Lida Chatzi, United States & Lea Maitre, Spain

O-TO-111

Chemical exposures » Mixtures

Associations of prenatal exposure to a mixture of EDCs with child social responsiveness in a pooled cohort study

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BACKGROUND AND AIM: Prenatal exposure to Endocrine Disrupting Chemicals (EDCs) may hinder neurodevelopment by disrupting hormonal pathways. We leveraged prenatal measurements of multiple, correlated EDCs in two prospective pregnancy cohort studies to assess independent effects of EDCs with Social Responsiveness Scale (SRS) scores.

METHODS: We harmonized data from 373 mother-child pairs in the Early Autism Risk Longitudinal Investigation Study, a cohort with enriched-risk for autism spectrum disorders (ASD), and the Health Outcomes and Measures of the Environment Study, a general population cohort. We estimated the associations between 2 persistent and 13 non-persistent EDCs, measured in maternal serum and urine, and SRS scores in children from 3 to 8 years old using Bayesian Kernel Machine Regression (BKMR). We graphically examined exposure-response surfaces of each EDC. Highly correlated EDCs within classes were represented by a single compound for their class (ex: polychlorinated biphenyl [PCB]-153 for all PCBs). Models were adjusted for income, maternal age and education, prenatal vitamin use, pre-pregnancy body mass index, study, and child sex and race/ethnicity.

RESULTS: Crude and adjusted models indicated similar relationships between EDCs and SRS scores, but exposure response surfaces were less statistically precise in adjusted models than those for crude models. Associations with individual EDCs and SRS scores varied in the suggested direction of effect. We saw increases in SRS scores with higher levels of polybrominated diphenyl ether-47, 2,4-dichlorophenol, and mono-n-butyl phthalate, and decreases in SRS scores with higher levels of PCB-153, mono-benzyl phthalate, mono-carboxypropyl phthalate, and polybrominated biphenyl.

CONCLUSIONS: Results of these mixture analyses suggest that a subset of EDCs are associated with children's autistic behaviors. However, exposure-response surfaces indicated statistical imprecision, likely resulting from a smaller sample size and high dimensional exposure matrix. Future work in larger studies is needed.

Keywords: endocrine disrupting compounds, exposure mixtures, Neurodevelopment



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 20

Exposures Mixtures: An Exposome Approach

Chairs: Lida Chatzi, United States & Lea Maitre, Spain

O-TO-112

Exposome » Internal exposome

Environmental chemicals and cross-sectional cognition among adults in the National Health and Nutrition Examination Survey

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BACKGROUND AND AIM: Cognitive impairment among older adults is a growing public health challenge and environmental chemicals may be modifiable risk factors. A wide array of chemicals has not been tested for association with cognition in an environment-wide association framework.

METHODS: In the US National Health and Nutrition Examination Survey (NHANES) 1999-2002 and 2011-2014 cross-sectional cycles, cognition was assessed using the Digit Symbol Substitution Test (DSST, scores 0-117) among participants 60 years of age and older. Concentrations of environmental chemicals were measured in blood or urine. Chemicals with at least 50% of measures greater than the limit of detection were included (nchemicals=124, nclasses=16). We tested for differences in cognition by natural log transformed concentration of each chemical using parallel multivariable linear regression models accounting for age, sex, race/ethnicity, and educational attainment. We calculated false discovery rates (FDR).

RESULTS: Participants with complete cognition/demographic measures and at least one chemical measure (n=5,670) were mean age 70.3 years, 51% female, 43.7% college educated, and 53.2% non-Hispanic White. The mean DSST score was 43.6 (18.1 standard deviation) and 24.2% were cognitively impaired (DSST<28). In adjusted analyses, 75% higher lipid adjusted blood concentration of the pesticide DDT was associated with 1.4 points lower DSST score (95% Confidence interval (CI):-2.1,-0.7, FDR:0.0001). Similarly, 75% higher heptachlor concentration was associated with 0.9 points lower DSST score (95%CI:-1.6,-0.1, FDR:0.02). For metals, we observed 75% higher blood cadmium levels were associated with 0.7 points lower DSST score (95%CI:-1.1,-0.4, FDR:5*10⁻⁵) and 75% higher blood lead levels were associated with 0.6 points lower DSST score (95%CI:-0.9,-0.2, FRD:0.002). Among perfluoroalkyl substances, 75% higher urinary concentration of perfluoroundecanoic acid was associated with 0.5 points lower DSST score (95%CI:-1.0,0.07, FDR: 0.09).

CONCLUSIONS: Exposure to environmental chemicals, particularly pesticides and metals, may be modifiable factors for reduced cognition among older adults.

Keywords: cognition, exposome, environment-wide association study, dementia



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 21

Environmental Exposure Impacts on Respiratory Outcomes and Allergies

Chairs: Kate Weinberger, Canada & Radhika Dhingra, United States

O-TO-113

Respiratory and Allergic Outcomes » Asthma

Measuring the Association Between Thunderstorms in the Presence of High Pollen and Risk of Severe Asthma

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BACKGROUND AND AIM: Studies have shown an acute association between the occurrence of thunderstorm conditions in the presence of high pollen and severe asthma, but minimal work has studied these events over a multi-year time series, using detailed measurements of storms and pollen.

METHODS: We estimate the change in risk between thunderstorm asthma events and asthma-related emergency room visits in the Minneapolis-St. Paul metropolitan area for the years 2007-2018. We defined thunderstorm asthma events as daily occurrence of 2 or more lightning strikes during periods of high pollen, interpolated using weather and pollen monitor data and modeled lightning counts. Daily counts of asthma-related emergency department visits were acquired from the Minnesota Hospital Association. We use a 2-stage approach combining zip code level quasi-Poisson time-series regressions in a meta-analysis to estimate an overall relative risk of hospitalizations during thunderstorm asthma events.

RESULTS: We observed a 4.4% (RR = 1.044; 95% CI (1.013,1.076), increase in asthma emergency department visits on the day of thunderstorm asthma event and a 3.2% (RR 1.032; 95% CI (1.003,1.062) increase on the day after the storm event. Our findings were robust to adjustment for temperature, humidity, wind, precipitation, ozone, PM2.5, day of week, and natural splines for seasonal variation in asthma cases. Occurrence of lightning alone or pollen alone shows no association with risk of severe asthma.

CONCLUSIONS: Our results support an association between co-occurrence of lightning and pollen and risk of asthma hospitalization. This model, while previously described with specific epidemic events, has not been well studied in a time series model to evaluate long-term risk, using measurement of both lightning and pollen, and never using unique small area exposure assignment and outcome counts. Our findings indicate that thunderstorm asthma may be an unidentified environmental risk factor for severe asthma.

Keywords: asthma, pollen, thunderstorms, climate



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 21

Environmental Exposure Impacts on Respiratory Outcomes and Allergies

Chairs: Kate Weinberger, Canada & Radhika Dhingra, United States

O-TO-114

Respiratory and Allergic Outcomes » Asthma

Association of blood trihalomethane concentrations with asthma among U.S. Children: NHANES 2005-2012

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BACKGROUND AND AIM: Population studies show that use of swimming pools is associated with risk of asthma and allergic diseases among children. However, few studies have examined exposure to disinfection by-products (DBP) from water chlorination with risk of asthma. To explore the associations between blood trihalomethane (THM) concentrations (a biomarker of DBP) and asthma among U.S. children and assess to what extent the association is modified by tobacco smoke exposure.

METHODS: We included 2,359 children aged 12-19 years with measured blood concentrations of four THMs at baseline: chloroform (TCM), bromodichloromethane (BDCM), dibromochloromethane (DBCM), and bromoform (TBM) from the National Health and Nutrition Examination Surveys 2005-2012. Logistic regression models were fitted to assess the odds ratios (ORs) and 95% confidence intervals (CIs) for the association of THM concentrations (three or four categories) with the risk of self-reported lifetime and current asthma.

RESULTS: After adjusting for potential confounders, blood BDCM concentration was associated with a greater risk of ever asthma among all children (OR=1.54; 95% CI: 1.07, 2.21, comparing the extreme exposure categories). The relation was stronger among children exposed to tobacco smoke (OR=3.96; 95% CI: 1.89, 8.30, comparing the extreme exposure categories). We also found positive relationships between Br-THMs and risk of ever asthma (OR=3.28; 95% CI: 1.43, 7.53, comparing the extreme quartiles of exposure) and between BDCM and Br-THMs and risk of current asthma among children with tobacco smoke exposure (OR=3.72; 95% CI: 1.40, 9.89 and 3.79; 95% CI: 1.22, 11.79, respectively, comparing the extreme exposure categories).

CONCLUSIONS: Our findings provide novel evidence that exposure to disinfection by-products is associated with a greater risk of asthma in children, particularly among those exposed to tobacco smoke.

Keywords: Biomarkers of exposure, Water quality, Respiratory outcomes, Asthma, Environmental epidemiology



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TRADITIONAL ORAL SESSION 21

Environmental Exposure Impacts on Respiratory Outcomes and Allergies

Chairs: Kate Weinberger, Canada & Radhika Dhingra, United States

O-TO-115

Respiratory and Allergic Outcomes » Asthma

Cockroach exposure and perceived stress interact to predict clinical outcomes in childhood asthma

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BACKGROUND AND AIM: Nonpharmacologic interventions for asthma management rely on identification and mitigation of important asthma triggers. Cockroach exposure is strongly associated with asthma morbidity. It is also associated with stress, another risk factor for asthma. Despite high prevalence of both in vulnerable populations, the impact of joint exposure has not been examined.

METHODS: Participants included 173 children with asthma in New Orleans, Louisiana. Cockroach exposure was based on visual inspection using standard protocols. Caregiver stress was measured using Cohen's 4-item Perceived Stress Scale. Outcomes included unscheduled clinic or emergency department (ED) visits, hospitalization, and pulmonary function. Multivariable logistic regression was performed to assess independent effects of the exposure on the outcome and effect modification was examined in stratified analysis based on stress. Path analysis to explore the mediation effect by stress was performed using a probit link with parameters based on Bayes' method with non-informative priors.

RESULTS: Adjusting for stress and other covariates, cockroach exposure was associated with unscheduled clinic/ED visits (aOR=6.2; 95% CI 1.8, 21.7). Positive associations were also found for hospitalization and FEV1 < 80%. High stress modified the relationship with unscheduled clinic/ED visits (high aOR= 7.7 95% CI 1.0, 60.2, versus normal aOR= 4.1 95% CI 0.8, 21.9). Path models identified direct and indirect effects (p = 0.05) indicating that a majority of the total effect on unscheduled clinic/ED visits is attributed directly to cockroach exposure.

CONCLUSIONS: The strong association between cockroach exposure and asthma morbidity is not due to uncontrolled confounding by stress. The combination of cockroach exposure and high stress, common in urban homes, are modifiable factors associated with poor asthma outcomes.

Keywords: children's environmental health, asthma, environmental disparities, environmental epidemiology, respiratory outcomes



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TRADITIONAL ORAL SESSION 21

Environmental Exposure Impacts on Respiratory Outcomes and Allergies

Chairs: Kate Weinberger, Canada & Radhika Dhingra, United States

O-TO-116

Respiratory and Allergic Outcomes » Asthma

The influence of the urban forest on the association between fine particulate air pollution and onset of childhood asthma

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BACKGROUND AND AIM: Fine particles (PM_{2.5}) have been associated with childhood asthma onset. Trees have been suggested to reduce PM_{2.5} levels in urban settings. However, the influence of the urban forest on asthma onset is unclear as trees can reduce air pollution but also emit pollen and biogenic organic compounds. We aim to characterize the influence of the residential tree canopy on the association between PM_{2.5} and asthma onset in children.

METHODS: We used an open cohort of all children born in Montreal (Canada) between 2000 and 2015 created from linked administrative databases; children were followed up to 12 years. New asthma cases were defined with a validated algorithm. Yearly PM_{2.5} levels estimated from satellite images and a chemical transport model were attributed to children during their follow up through linkage with their residential six-digit postal code. Crown areas (i.e. canopy) of all trees in buffers around the postal codes of the children for the leafy and the pollen seasons were estimated based on LiDAR point cloud data. Cox models for PM_{2.5} and asthma onset, adjusted or not for crown areas and with an interaction term with PM_{2.5} levels were developed. Age was the time axis of the models which were stratified for sex, year, health region, and adjusted for material deprivation.

RESULTS: 352,966 children were followed for a total of 1,701,797 person-years; 30,752 children developed asthma. Mean PM_{2.5} exposure was 9.01 ± 1.119 (IQR:0.733) $\mu\text{g}/\text{m}^3$. PM_{2.5} levels were not correlated with the deciduous tree canopy. The association between PM_{2.5} and asthma onset was 1.03 (95%CI: 1.02-1.04) per IQR; it was 1.04 per IQR (95%CI: 0.96-1.03) with the tree canopy included; no effect modification was detected.



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ABSTRACT E-BOOK

CONCLUSIONS: Results suggest that the residential urban forest does not influence positively nor negatively, the association between regional PM_{2.5} and childhood asthma onset.

Keywords: Green space, Asthma, Particulate matter, Children's environmental health



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Statue of Liberty Hall (Hall 1)

TRADITIONAL ORAL SESSION 21

Environmental Exposure Impacts on Respiratory Outcomes and Allergies

Chairs: Kate Weinberger, Canada & Radhika Dhingra, United States

O-TO-117

Climate » Natural disasters

Changes in asthma and general health after Hurricane Harvey: A natural experiment utilizing an asthma clinical trial, Harris County, TX

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BACKGROUND AND AIM: On August 25, 2017, roughly two-thirds through a clinical trial (HIITBAC1) targeting low-income African-American adults with poorly controlled asthma, Hurricane Harvey made landfall along the Gulf coast. Of the 263 HIITBAC1 enrollees, we re-enrolled 75 of 107 who had exited HIITBAC1 during the 12 months before Harvey to assess their health and resilience before and after the disaster. Here we report on the change observed in several key measures.

METHODS: Data collected before and after Harvey were largely the same, and included clinical measures, Asthma Control Test (ACT), Asthma Quality of Life Questionnaire (MiniAQLQ), PROMIS global health, PROMIS emotional support, an exposure history, healthcare utilization, and (in most pre- and all post-Harvey enrollees) an in-home assessment of environmental hazards. In addition, we obtained blood samples; information about their Harvey experience, including trauma scores; and exhaled nitric oxide and airborne mold samples from the post-Harvey enrollees. A linear mixed model was used to assess pre- versus post-Harvey changes in health outcomes and the association with flooding damage, and quantile regression to assess eNO association with spore count. Analyses controlled for potential confounders.

RESULTS: The average age was 55 years (83% female) and 57% of participants had a household income < \$15,000. Compared to pre-Harvey, post-Harvey scores on key health outcomes (i.e., ACT, MiniAQLQ, global physical health, global mental health) decreased significantly. Post Harvey, global physical health was significantly lower for those who flooded, compared with those who did not, whereas global mental health was lower for those reporting Harvey-related home damage. Neither flooding nor Harvey-related home damage were associated with ACT and MiniAQLQ after adjusting for pre-disaster characteristics. Post Harvey, no statistically significant association between eNO and spore counts was found.

CONCLUSIONS: Our initial analyses suggest that Hurricane Harvey adversely affected health in this vulnerable population.

Keywords: Asthma, Environmental disparities, Environmental epidemiology, Exposure assessment, Natural disaster



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 21

Environmental Exposure Impacts on Respiratory Outcomes and Allergies

Chairs: Kate Weinberger, Canada & Radhika Dhingra, United States

O-TO-118

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Impact of vehicular pollution on carboxyhemoglobin levels and respiratory response in urban cyclists

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BACKGROUND AND AIM: The present case-crossover study evaluated changes in carboxyhemoglobin (COHb) levels and spirometry values of 37 volunteers caused by vehicular pollution on a bike path parallel to a road with a high vehicular flow in two exposure scenarios (high exposure on weekdays and low exposure on Sundays) in the city of Bogotá, Colombia

METHODS: For each scenario, ultrafine particles (UFP), carbon monoxide (CO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and carbon black concentrations were measured, as well as vehicular flow and speed at two points on the road of interest, to explore the possible associations among these variables and exposure to each pollutant.

RESULTS: Significant differences were obtained for UFP, CO, NO₂, and SO₂ concentrations between the high- and low-exposure scenarios, and between the estimated exposure doses (EED) of UFP, CO, and SO₂. A strong correlation was found between the EED of CO and the percentage change in COHb before and after each bike ride ($r=0.7571$). Concerning UFP, a greater weight of background pollution was found in the high exposure scenario, followed by the impact of meteorological variables, and emission sources along the road under study.

CONCLUSIONS: To explain the variability of respiratory parameters, the only statistically significant model was obtained for peak expiratory flow (25-75%) of the forced expiratory maneuver (MMEF25-75%), having EED of CO and average UFP size as explanatory variables. Cyclists arrived at the endpoint of the ride with high COHb levels due to exposure to air pollutants along the route they used to arrive at the study site.

Keywords: Air pollution, Mixtures, Biomarkers of exposure, Respiratory outcomes, Short-term exposure



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 22

Traffic-related Air Pollution and Adverse Health Outcomes

Chairs: Perry Hystad, United States & Masna Rai, Germany

O-TO-119

Air pollution » Particulate matter

Long-term exposure to air pollution, road traffic noise, and heart failure incidence: the Danish Nurse Cohort

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BACKGROUND AND AIM: Air pollution has been recognized as a risk factor for ischemic and coronary cardiovascular disease, while evidence on heart failure (HF) is more limited and novel. Moreover, no studies considered possible combined effects of co-exposure to air pollution and noise on HF, as high exposure to one pollutant may make the body more susceptible to the hazardous effects of another pollutant. We examined the association of long-term exposure to air pollution and road traffic noise with incident HF.

METHODS: Using data on female nurses from the Danish Nurse Cohort (> 44 years), we investigated associations between 3-year mean exposures to air pollution and road traffic noise and incident HF using Cox regression models, adjusting for relevant confounders. Incidence of HF was defined as the first hospital contact (inpatient, outpatient, or emergency) between cohort baseline (1993 or 1999) and December 31, 2014, based on the Danish National Patient Register. Annual mean levels of particulate matter with a diameter < 2.5 µm (PM_{2.5}) since 1990, and nitrogen dioxide (NO₂) and road traffic noise (Lden) since 1970 were estimated at participants' residences.

RESULTS: Of the 22,189 nurses, 484 developed HF. We detected associations with all three pollutants, with hazard ratios (HR) and 95% confidence intervals (95% CI) of 1.35 (1.09-1.67), 1.09 (0.98-1.22), and 1.11 (0.99-1.26) per increase of 5.1 µg/m³ in PM_{2.5}, 8.6 µg/m³ in NO₂ and 9.3 dB in Lden, respectively. In mutually adjusted models, associations with PM_{2.5} remained most robust. Combination of exposure



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to high levels (>75th vs. ≤75th percentile) of all three pollutants led to enhanced associations with HF incidence, with an HR of 1.46 (1.03-2.07). Former smokers and nurses with hypertension showed the strongest associations with PM_{2.5}.

CONCLUSIONS: We found that long-term exposures to air pollution and road traffic noise were independently and synergistically associated with HF.

Keywords: air pollution, cohort study, heart failure, morbidity, road traffic noise



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 22

Traffic-related Air Pollution and Adverse Health Outcomes

Chairs: Perry Hystad, United States & Masna Rai, Germany

O-TO-120

Air pollution » Traffic-related

Environmental Exposure to Traffic Pollution and Motor Function in Adolescence

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BACKGROUND AND AIM: Evidence supports the neurotoxic effects of air pollution on cognitive deficits, mental health, and behavioral outcomes in children. While heavy metal exposure has been associated with poor motor function, it is unclear whether traffic-related air pollution (TRAP) has a similar relationship.

METHODS: Participants (n=332) were part of the Cincinnati Childhood Allergy and Air Pollution Study (CCAAPS). Elemental carbon attributable to traffic (ECAT), a marker of TRAP, was estimated at birth, age 12 years (current), and average exposure throughout childhood, using a validated land use regression model. Motor function was assessed with the Grooved Pegboard (GPB) test including time required to complete the task for dominant and non-dominant hand and number of dropped pegs. Associations between TRAP exposure and motor outcomes were estimated using linear (i.e., seconds to completion) and logistic (i.e, drops) regression; sex-specific effects were examined. Primary models controlled for child's IQ, neighborhood deprivation, and total household income; secondary models included blood metals (i.e., lead, cadmium, mercury) collected at the age 12 visit.

RESULTS: Children exposed to elevated current ECAT levels took on average 18 seconds longer to complete the GPB task with their non-dominant hand (95% CI 4.77, 31.14, p=0.008); ECAT was not associated with dominant hand completion. We did not observe a main effect of ECAT at any time point on probability of dropped pegs; however, girls exposed to higher childhood ECAT levels were more likely to drop pegs with their dominant hand during the GPB task (Psex*childhood ECAT = 0.03). Additionally controlling for heavy metal exposure did not alter the results.

CONCLUSIONS: Higher TRAP exposure was associated with poorer motor function, and girls may be at increased risk for adverse outcomes. These findings, as well as others, suggest that air pollution is quickly becoming one of the leading threats to a child's neurodevelopment.

Keywords: Children's environmental health, Neurodevelopmental outcomes, Traffic-related, Air pollution



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 22

Traffic-related Air Pollution and Adverse Health Outcomes

Chairs: Perry Hystad, United States & Masna Rai, Germany

O-TO-121

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Prenatal exposure to near-roadway air pollution and autism spectrum disorders in children

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BACKGROUND AND AIM: Previous studies have reported associations between *in-utero* exposure to regional air pollution and autism spectrum disorders (ASD). *In-utero* nitrogen oxide (NO_x) exposure has been linked to adverse neurodevelopment in animals and cardiovascular conditions in humans, but few studies have investigated pregnancy exposure to near-roadway air pollution (NRAP) and ASD risk.

METHODS: This retrospective birth cohort included 311,617 mother-child pairs of singletons born between 2001-2014 at Kaiser Permanente Southern California (KPSC) hospitals. Maternal and child data were extracted from KPSC electronic medical records. Children were followed until: clinical diagnosis of ASD, non-KPSC membership, death, or December 31, 2019, whichever came first. Exposure to the complex NRAP mixture during pregnancy was estimated by monthly California line-source dispersion models (CALINE4) for both near-roadway (freeway; non-freeway) and total NO_x, using maternal addresses during pregnancy. Cox proportional-hazard models were used to estimate hazard ratios (HR) of ASD associated with NRAP during pregnancy, adjusted for covariates. Nonfreeway NRAP was analyzed using quintile distribution due to nonlinear associations with ASD.

RESULTS: A total of 6,291 children (5,114 boys, 1,177 girls) were diagnosed with ASD. Prenatal exposure to total NRAP was associated with ASD diagnosis [HR (95% CI): 1.03 (1.00,1.06) per 10 ppb increase in NO_x]. Nonfreeway NRAP was associated with ASD diagnosis; however, freeway NRAP was not. The HR (95% CI) comparing the highest quintile of nonfreeway NRAP exposure (>3.8 ppb NO_x) to the lowest quintile (<0.89 ppb) or to the lower 4 quintiles (≤3.8 ppb) were 1.20 (1.08, 1.33) and 1.20 (1.13, 1.27) respectively. The HR (95% CI) associated with high nonfreeway NO_x (>3.8 vs ≤3.8 ppb) were significant in boys [1.20 (1.10, 1.26)] and girls [1.23 (1.06,1.39)], and robust to adjustment for PM_{2.5}.

CONCLUSIONS: Prenatal exposure to near-roadway air pollution, particularly from nonfreeway sources, may be associated with ASD risk in boys and girls

Keywords: oxides of nitrogen, neurodevelopmental, children's environmental health



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TRADITIONAL ORAL SESSION 22

Traffic-related Air Pollution and Adverse Health Outcomes

Chairs: Perry Hystad, United States & Masna Rai, Germany

O-TO-122

Air pollution » Traffic-related

Traffic-related air pollution and olfactory impairment among women in a nationwide US cohort

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BACKGROUND AND AIM: Olfactory impairment (OI), or loss of sense of smell, is a prodromal symptom of Parkinson's disease, Alzheimer's disease, and dementia. There is some evidence linking traffic-related air pollution (TRAP), which includes neurotoxins, with olfactory impairment and neurodegenerative conditions. We aimed to estimate associations between TRAP exposure and self-reported OI in the Sister Study.

METHODS: We linked 2005 census tract-level annual estimates of two primary constituents of TRAP, diesel particulate matter and polycyclic aromatic hydrocarbons/polycyclic organic matter (PAHPOM), to baseline (2003-2009) residential locations for 42,356 eligible Sister Study participants. We also determined the distance from each participant's residence to the nearest roadways as an indicator of potential TRAP exposure. OI was ascertained from detailed follow-up questionnaires (2008-2016). Multivariable log-binomial regression was used to estimate adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for OI associated with exposure to diesel, PAHPOM, and proximity to roadways. We assessed heterogeneity by urbanicity, age, smoking, race, socioeconomic status, and region.

RESULTS: In this cohort, 8% reported OI. While the highest quartile of diesel was inversely associated with OI (PR=0.89, 95% CI: 0.80-0.99), we observed a positive association between diesel levels above the 95th percentile (PR=1.13, 95% CI: 1.00-1.28). Living within 100 meters of major roadways (PR=1.12, 95% CI: 1.03-1.21), particularly interstates (PR=1.62, 95% CI: 1.31-2.02), was also associated with increased prevalence of OI. PAHPOM was not associated with OI. In subgroup analyses, we observed stronger relationships between TRAP and increased prevalence of OI in urban areas and among women aged 55 and older.

CONCLUSIONS: In this study, poor olfaction was associated with the highest diesel exposure levels and residential proximity to roads, but not with PAHPOM levels. Ambient TRAP, particularly in urban areas and near interstates, may impair olfactory function. Studies using objective measures of OI can potentially clarify these associations by mitigating outcome under-reporting and misclassification.

Keywords: air pollution, traffic-related, neurodegenerative outcomes, environmental epidemiology



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TRADITIONAL ORAL SESSION 22

Traffic-related Air Pollution and Adverse Health Outcomes

Chairs: Perry Hystad, United States & Masna Rai, Germany

O-TO-123

Cancer and Cancer-Precursors » Incidence

Roadway Proximity and Lung Cancer Risk in NIH-AARP Diet and Health Study Participants

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BACKGROUND AND AIM: Studies have demonstrated an increased risk of lung cancer with proximity to roadways; traffic-related pollutants are a suspected cause. Few studies have evaluated risks by histologic subtype, which may provide etiologic insight.

METHODS: We generated exposure proxies for 499,237 participants in the six states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and two metropolitan areas (Atlanta, Georgia, and Detroit, Michigan) of the NIH-AARP Diet and Health Study cohort using the residential address at enrollment (1995-1996) and U.S. Census TIGER/Line[®] files. Metrics reflected distance (m) from the residence to the nearest roadway and type (limited access highways, other major highways, secondary roads, neighborhood/local roads). We used Cox regression to estimate hazard ratios (HR) and 95% confidence intervals (CI) for risk of incident lung cancer overall and by histologic subtype in relation to categorized distance (0-49m, 50-199m, and ≥ 200 m). Models were adjusted for age, sex, race/ethnicity, smoking status and intensity, education, family history of cancer, 2010 U.S. Census rurality, and state/metropolitan area.

RESULTS: There were 15,639 lung cancers diagnosed in follow-up through 2011. We observed an increased risk of lung cancer for individuals residing ≤ 49 or 50-199m of any roadway versus ≥ 200 m, with associations slightly stronger for those in closest proximity (HR[≤ 49 m]=1.44, CI:1.11-1.85; HR[50-199m]=1.35, CI:1.05-1.75). Associations appeared driven by proximity to neighborhood/local roads; participants within ≤ 49 m of any roadway were more often close to a neighborhood/local road 94.4% (n=446,223) than a highway or secondary road (5.6%; n=26,642). By histologic subtype, we observed a positive association for adenocarcinoma (HR[≤ 49 m]=1.76, CI:1.13-2.73; HR[50-199m]=1.64, CI:1.05-2.58) and a non-significant association with squamous cell carcinoma (HR[≤ 49 m]=1.39, CI:0.81-2.41; HR[50-199m]=1.26, CI:0.72-2.22).

CONCLUSIONS: From this large U.S. study, overall lung cancer risk increases with proximity to roadways, particularly for adenocarcinoma and possibly squamous cell carcinoma.

Keywords: Cancer and cancer precursors, Incidence, Environmental Epidemiology, Air pollution, Traffic-related



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 22

Traffic-related Air Pollution and Adverse Health Outcomes

Chairs: Perry Hystad, United States & Masna Rai, Germany

O-TO-124

Policy » Policy research

Urban Policy Interventions to Reduce Traffic Emissions and Traffic-Related Air Pollution: A Systematic Evidence Map

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BACKGROUND AND AIM: Cities are the world's engines of economic growth, innovation and social development. They are also hot spots for human exposure to air pollution, mainly originating from traffic. As the urban population grows rapidly, a greater number of people risk exposure to traffic-related air pollution (TRAP) and its adverse, costly health effects. In many cities, there is scope for air quality improvement through targeted policy interventions. This systematic evidence map (SEM) examines and characterizes peer-reviewed evidence on urban-level policy interventions to reduce traffic emissions and/or TRAP from on-road mobile sources, thus potentially reducing human exposures and adverse health effects.

METHODS: A previously published protocol details the methods utilized in this SEM, including literature search strategy, eligibility criteria, article screening, data extraction and coding, data visualization, synthesis, and database description (Sanchez et al., 2020).

RESULTS: We identified and screened 7528 unique articles from database searches and included 378 articles, published between January 1, 2000 to June 1, 2020, in the final SEM. Data was recorded for various policy interventions implemented across the globe. Documented data includes study characteristics, population characteristics, policy intervention category, study area, pollutants studied, if the effect on traffic emissions and/or TRAP was studied and its direction, if human exposures and health effects were studied, and enablers, barriers, and co-benefits. The evidence recorded for each



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ABSTRACT E-BOOK

intervention will be hosted in an open-access, queryable database available on the CARTEEH Data Hub (<https://carteehdata.org/>). Data visualizations will be created in Tableau Public based on the final database, and a demonstration of these will be delivered during the conference presentation.

CONCLUSIONS: This is the first peer-reviewed SEM compiling international evidence on urban-level policy interventions to reduce traffic emissions and/or TRAP in the context of human exposure and health effects in cities. The open-access database is a valuable resource for policymakers and researchers.

Keywords: air pollution, policy, policy and practice, exposures, health co-benefits, traffic-related



ABSTRACT E-BOOK

August 26, 2021 / 07:30 - 09:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 23

Ultrafine Particles and Health

Chairs: Scott Weichenthal, Dimitris Evangelopoulos, United Kingdom

O-TO-125

Air pollution » Short-term exposure

Transcriptomics reveals the mechanisms of population susceptibility to blood glucose associated with short-term exposure to ambient fine and ultrafine particles

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BACKGROUND AND AIM: Chronic obstructive pulmonary disease (COPD) and air pollution are both the leading causes of death in China. However, their interactive effects and underlying mechanisms remain largely unknown. This study aims to examine whether air pollutant-associated blood glucose differs between COPD patients and healthy participants, and provide the underlying biological mechanisms based on transcriptome.

METHODS: Based on a panel study named COPDB (COPD in Beijing), blood glucose and whole blood transcriptome were repeatedly measured in 53 COPD patients and 82 healthy participants at up to four clinical visits. Ambient concentrations of fine particulate matter (PM_{2.5}), ultrafine particles (UFPs), temperature, and relative humidity were continuously monitored at a monitoring station. Linear mixed-effects models were used to compare the associations between ln-transformed blood glucose and average 1–14 d concentrations of air pollutants before the clinical visits. Mediating effect models were used to identify transcripts with significant associations between air pollutant and blood glucose. MetaCore was used to conduct the pathway enrichment analyses.

RESULTS: Blood glucose was positively associated with interquartile range (IQR) increases in average concentrations of UFPs in all participants. UFPs-associated blood glucose elevations were consistently higher in COPD patients than in healthy participants. Some transcripts were identified to mediate the associations between exposure to UFPs and blood glucose levels. Pathway analyses showed that these transcripts were enriched in negative regulation of hypoxia inducible factor-1 (HIF1A) function and immune response related pathways.

CONCLUSIONS: COPD patients are more susceptible to elevated blood glucose associated with UFPs exposure than healthy participants.

Keywords: Air pollution, Short-term exposure, Omics technologies, Particulate matter, Molecular epidemiology, Causal inference



ABSTRACT E-BOOK

August 26, 2021 / 07:30 - 09:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 23

Ultrafine Particles and Health

Chairs: Scott Weichenthal, Dimitris Evangelopoulos, United Kingdom

O-TO-126

Respiratory and Allergic Outcomes » Respiratory outcomes

Associations between Short-Term Exposure to Particulate Matter and Ultrafine Particles with Lung Function in Schoolchildren from the German CorPuScula Study

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BACKGROUND AND AIM: Short-term exposure to particulate matter (PM) has been associated with impaired lung function, but exposure to ultrafine particles (UFP) has been less well examined in children.

METHODS: We analyzed data from 50 schoolchildren (ages 6-10) at an elementary school from the German CorPuScula study conducted from 2001 to 2002. Spirometry (VC, FEV₁, MEF₂₅₋₇₅) and body plethysmography (specific airway resistance) were performed to assess lung function. PM exposure (diameter $\leq 10 \mu\text{m}$; $\mu\text{g}/\text{m}^3$ (PM₁₀), diameter $\leq 2.5 \mu\text{m}$; $\mu\text{g}/\text{m}^3$ (PM_{2.5})) was measured at school over the full study period, and UFP exposure was measured for six months. Mean exposures during the day of examination (9-21h) as well as one- and two-day lags were assessed. Further, individual mean UFP (1- and 3-h), and PM₁₀ (3-, 12- and 24-h) exposures before examination were calculated. Associations between short-term air pollution and lung function were assessed using generalized estimating equation models with an autoregressive correlation matrix, adjusted for day of the week, study day and physiological equivalent temperature index using splines. Two-pollutant models adjusted for centrally-monitored NO₂ were performed.

RESULTS: For PM, median PM₁₀ levels were $17.4 \mu\text{g}/\text{m}^3$ (nobs=961, average of 20 tests/child). For UFP, median UFP concentration was 21,826 particles/mL (nobs=421, average of 8 tests/child). PM and UFP showed mixed associations with spirometry outcomes. For PM, we observed weak positive associations with airway resistance for 12-h and 24-h PM₁₀ (e.g. 7.4 % [95% CI: 1.9%; 13.3%] increase in airway resistance per $24.9 \mu\text{g}/\text{m}^3$ increase in 12-h PM₁₀) and weak inverse associations for the two-day lag. While results for 12-h and 24h PM₁₀ before testing were robust to NO₂ adjustment, inverse associations for two-day lags disappeared. For UFP, no associations with airway resistance were visible.

CONCLUSIONS: We observed mixed results for spirometry outcomes. PM₁₀ was associated with increased airway resistance. No associations were visible for UFPs.

Keywords: Short-term exposure, Particulate matter, Respiratory outcomes



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August 26, 2021 / 07:30 - 09:00 / Times Square Hall (Hall 3)

TRADITIONAL ORAL SESSION 23

Ultrafine Particles and Health

Chairs: Scott Weichenthal, Dimitris Evangelopoulos, United Kingdom

O-TO-127

Air pollution » Particulate matter

Short-term risk effects of exposure to ultrafine particles on emergency department visits of renal diseases in New York State, 2013-2017

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BACKGROUND AND AIM: Although concerns of particulate matters (PMs) on health were well-reported, PMs studies, especially ultrafine particles (UFPs) in relation to renal diseases are still limited. This study aimed to investigate the effects of UFPs on emergency department (ED) visits of renal diseases.

METHODS: This study used a time stratified case-crossover study design with conditional logistic regression. Geocoded ED visits with principal diagnosis of renal diseases (ICD-9 codes: 580-593; ICD-10 codes: N00-19, N25-N29) from 2013-2017 were obtained from New York State Discharge Data. Daily exposure of UFPs and other air pollutants (as confounders) were obtained from a validated chemical transport model with size-resolved particle microphysics.

RESULTS: Among a total of 426,541 ED visits, the strongest excess risks (ER) of UFPs on renal diseases occurred on lag 0-3 days (For each IQR increase, ERIQR (95% confidence interval (CI)) = 0.7 (0.3, 1.0)) after controlling for holidays, PM_{2.5}, NH₃, O₃, relative humidity, and temperature. Specifically, on lag 0-3 days, the ER increased for older adults (> 65 yrs) (ERIQR = 1.2, 95% CI: 0.7, 1.6), and the non-African American (ERIQR = 0.6, 95% CI: 0.3, 1.0). Comparing with Non-Hispanics and male, Hispanics and female had the higher ERs (Hispanics: ERIQR (95% CI) = 0.7 (0.1, 1.2); Female: ERIQR (95% CI) = 0.7 (0.3, 1.0)) respectively. The risk effects of UFPs were also increased in fall (ERIQR = 0.9, 95% CI: 0.3, 1.4); or under the extreme temperature (>90th, ERIQR = 1.2, 95% CI: 0.8, 1.6).:Relative humidity (>90th) had higher but not significant ERs.

CONCLUSIONS: These findings suggested a short-term association between ED visits of renal diseases and elevated UFPs, especially among the elderly, non-black, Hispanics, and female. Temperature, relative humidity, and seasonality may jointly impact renal diseases with UFPs.

Keywords: Ultrafine Particles, Renal Diseases, Chemical Transport Model, Emergency Department Visit



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 23

Ultrafine Particles and Health

Chairs: Scott Weichenthal, Dimitris Evangelopoulos, United Kingdom

O-TO-128

Air pollution » Short-term exposure

Short-Term Particulate Matter, Ultrafine Particles, and Blood Pressure among Children of the CorPuScula Study in Munich, Germany

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BACKGROUND AND AIM: Short-term changes in particulate matter (PM) have been linked to blood pressure, but limited evidence exists on effects among children and for ultrafine particle (UFP) exposures.

METHODS: We used data from 50 children (ages 6-10) in the German CorPuScula study, in which children attended up to 30 school health examinations in 2001 and 2002. Systolic and diastolic blood pressure (SBP and DBP, respectively; mmHg) were collected at each examination after children had rested for at least 5 minutes. PM₁₀ (diameter $\leq 10 \mu\text{m}$; $\mu\text{g}/\text{m}^3$) and PM_{2.5} (diameter $\leq 2.5 \mu\text{m}$; $\mu\text{g}/\text{m}^3$) levels were measured at school using a low volume sampler for the entire study period, and UFPs (n/mL) were measured for six months using a particle counter. All exposures were evaluated for same-day working-hours (9:00-21:00) as well as one- and two-day lags, with UFPs also assessed for the 1-, 3-, 12-, and 24-hours prior to examination. Associations between air pollutants and blood pressure were evaluated using mixed linear regression models with a random participant intercept and adjusted for weekday as well as study day and physiological equivalent temperature index using natural cubic splines. Multipollutant models were conducted adjusting for centrally-monitored NO₂.

RESULTS: For the PM data (nobs=1,079; average 22 observations/child), median daily PM_{2.5} levels were 12.7 $\mu\text{g}/\text{m}^3$. In the UFP data (nobs=420; average 8 observations/child), median daily UFP exposures were 21,544 particles/mL. We observed positive associations between PM and SBP that attenuated slightly upon adjustment for NO₂, with strongest associations for 2-day lags (e.g., 1.45 mmHg [95% Confidence Interval: 0.78, 2.11] increase in SBP per 13.4 $\mu\text{g}/\text{m}^3$ increase in PM_{2.5}). PM₁₀ was weakly inversely associated with DBP. No associations between UFP exposures and either outcome were apparent.

CONCLUSIONS: While positive associations were observed between PM and SBP, we observed no evidence that UFP exposure influences blood pressure in children.

Keywords: Children's environmental health, Short-term exposure, Air pollution, Cardiovascular diseases, Multi-pollutant



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TRADITIONAL ORAL SESSION 23

Ultrafine Particles and Health

Chairs: Scott Weichenthal, Dimitris Evangelopoulos, United Kingdom

O-TO-129

Exposure Assessment Methods » Exposure assessment-air pollution

Predicting Within-City Variations in Ultrafine Particle and Black Carbon Concentrations in Bucaramanga, Columbia Using Open Source Data and Images

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BACKGROUND AND AIM: Outdoor ultrafine particles (UFP; <100 nm) and black carbon (BC) vary greatly within cities and may have adverse impacts on human health such as cardiovascular mortality and brain tumour incidence. Traditional regression methods for estimating spatial distributions of ambient air pollution depend on extensive, curated geospatial information system databases. This has resulted in a disparity wherein little is known about local air pollution in the data-sparse settings of low- and middle- income countries. We used a hybrid approach to develop new models to estimate within-city spatial variations in outdoor UFP and BC concentrations across Bucaramanga, Colombia.

METHODS: We conducted a large-scale mobile monitoring campaign over twenty days in 2019. Land use regression (LUR) models were developed using land use parameters from curated and open-source databases. Convolutional Neural Network (CNN) models were developed using Google Maps satellite view and street view images. Combined models were developed by combining predictions from the LUR and CNN models. After training in the training and validation sets, predictions were generated in the test set and compared to measured values.

RESULTS: The combined UFP model ($R^2=0.54$) outperformed the CNN ($R^2=0.47$) and land use regression (LUR) models ($R^2=0.47$) on their own. Similarly, the combined BC model also outperformed the CNN and LUR BC models ($R^2 = 0.51$ vs 0.43 and 0.45 respectively). Spatial variations in model performance were more stable for the CNN and combined models compared to the LUR models suggesting that the combined approach may be less likely to contribute to differential exposure measurement error in epidemiological studies.

CONCLUSIONS: Estimates from these models can then be applied to population-based cohorts in order to evaluate population health risks. Additionally, our findings demonstrated that satellite and street-level images can be combined with a traditional LUR modelling approach to improve predictions of within-city spatial variations in outdoor UFP and BC concentrations.

Keywords: Ultrafine particles, Black Carbon, Deep learning, Images, Land use regression



ABSTRACT E-BOOK

August 26, 2021 / 07:30 - 09:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 24

Urban Living and Ageing and Longevity

Chairs: Payam Dadvand, Spain & Cuicui Wang, United States

O-TO-130

Built environment » General

Developing robust indicators of age-friendly neighborhood environments across urban-rural and socioeconomic gradients in 20 countries from five continents

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BACKGROUND AND AIM: By 2050, the older-adult population (60+) will reach 2.1 billion, surging fastest in low- and middle-income countries (LMIC). In response, the World Health Organization (WHO) has developed a framework and indicators of age-friendly urban environments, but these criteria have been challenging to apply in rural areas and LMIC. This study fills this gap by adapting these indicators to such settings and assessing variation by country-level income and community-level urban-rural status.

METHODS: First, a narrative review identified and described existing healthy-aging audit tools. Next, data were drawn from the Prospective Urban and Rural Epidemiology (PURE) study's environmental-exposure assessment tools, which relied on systematic social observation and ecometrics to develop objective and subjective indicators relevant to cardiovascular disease. Following a multitrait, multimethod (MTMM) approach to assess convergent and discriminant validity, we specified a set of 23 indicators aligned with WHO's framework and calculated their values across 496 communities in 20 countries, including 382 communities (77%) located in LMIC.

RESULTS: Among the WHO's eight environmental domains, six were represented in PURE's environmental data. Overall, 91% of communities had access to parks/recreation and street lighting, while 45% had traffic lights. In addition, 85% of communities offered a public medical clinic, but only 15% a public hospital. Communities in high-income countries rated highest overall, although bus-transit connections were most common in low-income countries (95%). The greatest amount of variation by urbanness was seen in the number of streetscape-greenery elements (55.2 in rural areas vs. 32.5 in urban); traffic lights (17.8% vs. 67.1%); access to universities (32.9% vs. 90.3%); and home-internet availability (24.7% vs. 53.8%).

CONCLUSIONS: This study indicates the extent to which environmental supports for healthy aging may be less readily available to older adults residing in rural areas and LMIC, highlighting a critical aspect of equity that is increasingly important to address in an aging world.

Keywords: Green space, Walkability, Healthy aging, Methodological study design, International collaboration



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 24

Urban Living and Ageing and Longevity

Chairs: Payam Dadvand, Spain & Cuicui Wang, United States

O-TO-131

Built environment » Walkability

Urban active living environments and cardiovascular disease mortality: a Canadian national cohort study

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BACKGROUND AND AIM: Neighbourhoods conducive to utilitarian walking and active living are associated with higher physical activity and lower cardiovascular risk factors. Most evidence, however, has been drawn from ecological studies. Our aim was to investigate longitudinal associations between neighbourhood walkability and cardiovascular mortality in a large population-based cohort of Canadian adults.

METHODS: We analyzed data from the 2001 Canadian Census Health and Environment Cohort (CanCHEC). These data were obtained from the mandatory 2001 long-form census, which includes a random sample of roughly 20% of the Canadian population. Individual-level data from the 2001 census were linked to income tax files to provide annual residential postal codes, while mortality was ascertained by linkage to the Canadian Vital Statistics Death Database between 2001 and 2016. The main exposure was the Canadian Active Living Environments (Can-ALE), a national quintile index that summarizes features of the built environment related to active living and walkability. We restricted our analysis to those 19 years of age and older at baseline who lived in large city areas (population $\geq 100,000$), allowing individual person-years to move in and out of the analytical sample. Cox proportional hazard models were fit to estimate hazard ratios for Can-ALE categories and cardiovascular mortality while adjusting for many individual and contextual covariates.

RESULTS: A total of 26,875,875 person-years (53% female) and 266,740 deaths were included in the model. Living in a highly walkable neighbourhood (Can-ALE 5 [high] vs 1 [low]) was significantly associated with a 6% reduced hazard of cardiovascular mortality (aHR: 0.94, 95%CI: 0.90, 0.98), 11% reduced hazard of cerebrovascular mortality (aHR: 0.89, 95%CI: 0.81, 0.98), and a 7% reduced hazard of ischemic heart disease mortality (aHR: 0.93, 95%CI: 0.88, 0.99).

CONCLUSIONS: Living in an urban neighbourhood or community supportive of utilitarian walking and active living may contribute to lower mortality from cardiovascular disease in adults.

Keywords: Built environment, walkability, cardiovascular diseases, mortality



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Urban Living and Ageing and Longevity

Chairs: Payam Dadvand, Spain & Cuicui Wang, United States

O-TO-132

Air pollution » Long-term exposure

Exposure to air pollution, blue and green spaces and cause-specific mortality in Greece: An ecological study

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BACKGROUND AND AIM: Previous studies have documented the effects of long-term exposure to ambient particulate pollution on mortality outcomes, while recently there is growing interest in the effects of green and blue spaces and their possible synergistic effects. We investigated the association of exposure to air pollution, green and blue spaces with cause-specific mortality in Greece using an ecological study design.

METHODS: We collected socioeconomic and cause-specific mortality data for 1,035 Municipal Units (MU) from the 2011 Census. Annual fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), black carbon (BC) and ozone (O₃) concentrations for 2010 were predicted at 100x100m grids by hybrid LUR models and a weighted average based on the built-up area percentage of each MU was estimated. The normalized difference vegetation index (NDVI) and the percentage of water bodies were used to assess exposure to green and blue spaces. We applied single and two-exposure Poisson regression models on standardized mortality rates accounting for spatial autocorrelation.

RESULTS: PM_{2.5} was associated with increased mortality from cardiovascular and respiratory causes (Relative Risk (RR): 1.10 and 1.11, per 3.34 µg/m³ respectively), ischemic heart disease (RR: 1.05), cerebrovascular diseases (RR: 1.14) and also from diseases of the nervous system (RR: 1.14). Both BC and NO₂ were associated with cardiovascular and cerebrovascular mortality. No associations with O₃ were found. NDVI was associated with lower cause-specific mortality (RR: 0.90; 0.92; 0.91 per 0.16 for chronic obstructive pulmonary disease, respiratory mortality and mortality from diseases of the nervous system, respectively), while we did not find any association between exposure to blue spaces and mortality. Estimates were mostly robust to co-exposure adjustment.

CONCLUSIONS: Our results support independent associations of air pollution and greenness with mortality. Further research is needed to investigate the role of blue spaces and the possible complex interactions between components of the physical environment.

Keywords: Air pollution, Blue space, Green space, Long-term exposure, Mortality



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Urban Living and Ageing and Longevity

Chairs: Payam Dadvand, Spain & Cuicui Wang, United States

O-TO-133

Climate » Temperature

Effect of heatwaves and greenness on mortality among Chinese elderly people

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BACKGROUND AND AIM: Both heatwaves and greenness have been shown to affect health, but the evidence on their joint effects is needed to be better elucidated. We aim to assess the associations of the combined exposure to greenness and heatwaves and whether the effect varies between different subgroups.

METHODS: We utilized the Chinese Longitudinal Healthy Longevity Survey (CLHLS), a prospective cohort of older adults aged 65. We used the number of heatwave days in one year before death to estimate individual long-term heatwaves exposure and cumulative Normalized Difference Vegetation Index (NDVI) during follow-up to assess individual greenness exposure. Cox proportional hazards models were used to assess the effects of greenness, heatwaves, and their interaction on mortality, adjusted for a range of covariates. We conducted subgroup analyses by residence, gender, and age.

RESULTS: There were 20,758 participants in our study, totaling 67,312 person-years of follow-up. The mean NDVI was 0.41 (SD 0.13), and the mean number of heatwave days was 8.92 (2.04). In the adjusted model, the mortality hazard ratio (HR) for each 3-day increase in heatwave days was 1.04 (95% CI 1.04,1.05), each 0.1-unit decrease in cumulative NDVI was 1.06 (1.05,1.07). In the adjusted model with an interaction term, the HR for the interaction term was 1.01 (1.01,1.02) with a p-value less than 0.001. In our subgroup analyses, the HR for each 3-day increase in heatwave days was higher in urban areas than in rural areas (1.06 vs. 1.03), and the HR for 0.1-unit decrease in NDVI was higher in urban areas than in rural areas (1.08 vs. 1.04).

CONCLUSIONS: Greenness can protect against the effect of heatwaves on mortality, and the number of heatwave days will affect the health effects of greenness. Urban dwellers have a higher response to the detrimental effect of heatwaves and have a higher marginal benefit from greenness exposure.

Keywords: Green space, Temperature, Environmental epidemiology



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Urban Living and Ageing and Longevity

Chairs: Payam Dadvand, Spain & Cuicui Wang, United States

O-TO-134

Built environment » Green space

Green spaces and risk of dementia-related mortality among the elderly in urban areas in Belgium: a 13-year follow-up census-based study

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BACKGROUND AND AIM: Living in greener areas is associated with slower cognitive decline among the elderly, but few studies have explored the link with dementia-related mortality. This study examines the relationship between residential surrounding greenness and dementia-related mortality in the five largest urban areas in Belgium.

METHODS: We used data from the 2001 Belgian census linked to mortality register data during 2001-2014. We included individuals aged 60 years or older and living in the agglomerations of Brussels, Antwerp, Ghent, Charleroi and Liege in 2001. Exposure to residential surrounding greenness was assessed using the Normalised Difference Vegetation Index (NDVI) within 500-m buffer from the residential address registered in 2001. We used ICD-10 codes to identify general dementia-related mortality including any neurodegenerative diseases (F00-F03, G12.2, G20-G22, G30-G31 and G35), and four types of dementia-related mortality: Alzheimer's disease (G30); vascular dementia (F01); unspecified dementia (F03); and Parkinson's disease (G20-G22). To define our cases, we considered any mention to dementia in the death certificate (i.e., as original, immediate, additional or intermediate cause of death). Cox proportional hazard models were conducted to obtain hazard ratios (HR) for dementia-related mortality for an IQR increase in surrounding greenness. Models were adjusted for age, gender, migrant background, education, housing tenure and PM2.5.

RESULTS: In total, 1,089,215 individuals were included at baseline (2001). 6.1% died from neurodegenerative diseases during follow-up (1.9% Alzheimer's disease, 0.5% vascular dementia, 0.4% Parkinson's disease and 2.8% unspecified dementia). Surrounding greenness was inversely associated with all outcomes of dementia-related mortality, excepting Parkinson's disease. These relationships remained significant after adjustment for all the covariates considered, but not with unspecified dementia after including PM2.5. The strongest beneficial association after complete adjustment was found for vascular dementia (HR 0.91, 95%CI: 0.86, 0.96).

CONCLUSIONS: Our findings suggest that living close to green spaces in urban areas might reduce dementia-related mortality risk among the elderly.

Keywords: Green space, Neurodegenerative outcomes, Mortality



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Urban Living and Ageing and Longevity

Chairs: Payam Dadvand, Spain & Cuicui Wang, United States

O-TO-135

Built environment » Green space

Does urban greenspace reduce racial and socioeconomic disparities in mortality in Philadelphia, PA?

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BACKGROUND AND AIM: A small body of research suggests greenspace may reduce socioeconomic health inequalities. Little is known about whether this effect extends to racial health disparities. We investigated if higher amounts of tree canopy cover or perceived park access were linked to smaller disparities in all-cause and cardiovascular (CVD) mortality rates by neighborhood SES or race composition in Philadelphia, PA.

METHODS: We linked census-tract level mortality count data (years 2008-2015) with % living in poverty and % non-Hispanic Black data from the American Community Survey; LiDAR derived % tree canopy measures, and survey derived estimates of % of residents reporting perceived park access. We used age-adjusted negative binomial models, including the natural logarithm of age-specific population counts as an offset, to estimate associations between % non-Hispanic Black and % poverty (categorized in quartiles) with all-cause and CVD mortality. We quantified heterogeneity of associations across quartile-based categories of % tree canopy and perceived park access, by inclusion of interaction terms.

RESULTS: Rates of mortality were higher in tracts with higher % residents living in poverty, and higher % non-Hispanic Black residents (e.g., Relative Rate [RR] of CVD mortality, highest vs. lowest quartile of % non-Hispanic Black: 1.57, 95% CI: 1.44 – 1.70). Disparities in mortality rates across categories of % living in poverty were smaller in areas with more greenspace (RR for high vs. low % poverty census tracts: 1.03 [95% CI: 0.77, 1.36] among tracts with high % residents reporting access to parks; 1.76, [95% CI: 1.33, 2.33] among tracts with low % residents reporting access to parks). By contrast, disparities in mortality across non-Hispanic Black composition categories persisted, regardless of tree canopy cover or park access.

CONCLUSIONS: Our preliminary results suggest that greenspace may reduce socioeconomic, but not racial health disparities. Further research is needed to clarify the reasons underlying these differences.

Keywords: Green space, Environmental disparities, Socio-economic factors (non-chemical stressors), Mortality, Environmental justice



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TRADITIONAL ORAL SESSION 25

Perfluoroalkyl Substances and Health Across the Life Course

Chairs: Atsuko Araki, Japan & Zeyan Liew, United States

O-TO-136

Chemical exposures » PFAS

Perfluoroalkyl and Polyfluoroalkyl Substances and Body Size and Composition Trajectories: the Study of Women's Health Across the Nation 1999-2018

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BACKGROUND AND AIM: Perfluoroalkyl and polyfluoroalkyl substances (PFAS) have been suggested as obesogens but epidemiologic evidence is limited. We examined associations of serum PFAS concentrations with longitudinal trajectories of weight, waist circumference (WC), fat mass and proportion fat in midlife women.

METHODS: This study included 1,381 midlife women, with a total of 15,000 repeated measures from the multi-racial/ethnic Study of Women's Health Across the Nation between 1999 and 2018. The average follow-up was 14.9 (range: 0-18.6) years. Body size (objectively measured weight and WC) and body composition from dual-energy X-ray absorptiometry were assessed at near-annual visits. Linear mixed models with piecewise linear splines were utilized to model non-linear trajectories of body size and composition.

RESULTS: After multivariable adjustment, PFAS concentrations were positively associated with weight, WC, fat mass, and proportion fat at baseline and during follow-up. Comparing the highest to the lowest tertiles of PFAS concentrations, adjusted geometric mean weight was 73.9 kg vs. 69.6 kg for PFOS ($P < 0.0001$), and 74.0 vs. 69.4 kg for linear PFOA ($P < 0.0001$) at baseline. Women with the highest tertile of PFOS had an annual increase rate of 0.33% (95% CI: 0.27%, 0.40%) in weight, compared to the lowest tertile with 0.10% (95% CI: 0.04%, 0.17%) ($P < 0.0001$). PFOS was also significantly related to higher increase rates in WC (difference=0.12% per year, $P = 0.002$) and fat mass (difference=0.25% per year, $P = 0.0002$). EtFOSAA and MeFOSAA showed similar effects to PFOS. Although PFHxS was not related to body size or fat at baseline, PFHxS was significantly associated with accelerated increases in weight ($P < 0.0001$), WC ($P = 0.003$), fat mass ($P < 0.0001$), and proportion fat ($P = 0.0009$). No significant results were found for PFNA.

CONCLUSIONS: Certain PFAS were positively associated with large body size and body fat, and higher increase rates over time. PFAS may be an underappreciated contributing factor to obesity risk.

Keywords: PFAS, Obesity and metabolic disorders



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Perfluoroalkyl Substances and Health Across the Life Course

Chairs: Atsuko Araki, Japan & Zeyan Liew, United States

O-TO-137

Chemical exposures » PFAS

Association between prenatal exposure to perfluoroalkyl substances (PFAS) and acute infectious diseases in infancy in Shandong, China

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BACKGROUND AND AIM: Perfluoroalkyl substances (PFAS) are persistent and bio-accumulative compounds, and animal studies have shown that exposure to PFAS is associated with immunotoxic effects. However, epidemiological studies regarding the impact on infant acute infectious diseases were inconsistent. We aimed to determine if prenatal exposure to PFAS is associated with acute infectious diseases including common cold, tracheitis/pneumonia and diarrhea among 1-year-old infants.

METHODS: Ten selected PFASs including PFOA, PFOS, PFNA, PFDA, PFUA, PFDoA, PFHxS, PFBS, PFHpA and PFOSA were detected in maternal serum from a Chinese birth cohort between 2010 and 2013. Of these infants (n = 235), follow-up questionnaires were completed at 1 year old by parents. The association between prenatal exposure to PFASs and the infections was estimated using logistic regressions model and Poisson regression model with the outcome reported as an odds ratios (OR) and an incidence rate-ratio (IRR), respectively.

RESULTS: Logistic regression analysis found statistically significant positive associations were seen between PFOA (OR = 4.93, 95% CI = 1.83, 13.30), PFNA (OR = 4.67, 95% CI = 1.10, 19.90) and the risk of diarrhea. Poisson regression analysis found that that frequencies of diarrhea increased by 100% - 150% for each 10-fold increase in PFOA, PFOS, PFNA, PFDA and PFUA, and increased by approximately 500% in PFDoA and PFOSA. WQS analyses found that PFAS mixture was positively associated with the occurrence of diarrhea, with PFOA having the highest individual weights. when stratified by exclusively breastfeeding duration (at least 4 months or not), the adverse effects of PFAS exposures on diarrhea were more pronounced among the breastfed infants. There were no significant associations between PFAS and common cold or tracheitis/pneumonia.

CONCLUSIONS: The findings suggest that exposure to specific PFAS is associated with increased occurrence of diarrhea among 12 months infants and indicate a possible role of exclusively breastfeeding in the PFAS-health outcome association.

Keywords: Perfluoroalkyl substances, acute infectious disease, diarrhea, exclusive breastfeeding, infant, China



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Perfluoroalkyl Substances and Health Across the Life Course

Chairs: Atsuko Araki, Japan & Zeyan Liew, United States

O-TO-139

Chemical exposures » PFAS

Perfluoroalkyl substances and risk of myocardial infarction and stroke

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BACKGROUND AND AIM: Perfluoroalkyl substances (PFAS) are widespread persistent pollutants and its exposure in humans relates to elevated cholesterol. However, the potential to impact public health globally by increasing risk of cardiovascular disease remains unexplored. Therefore, we investigated associations of PFAS exposure with risk of myocardial infarction and/or stroke and subsidiary, with baseline blood lipids.

METHODS: A nested case-control study with first incident myocardial infarction and stroke and matched controls from two Swedish cohorts (Swedish Mammography Cohort-Clinical and Cohort of 60-year-olds) was used. Baseline blood sampling occurred during 2003-2009 and 1997-1999 with follow-up through 2017 and 2014 for the cohorts, respectively. Eight plasma PFAS' concentrations were measured using targeted liquid chromatography-triple quadrupole mass spectrometry. Individual values and the standardized sum of five quantifiable PFAS were categorized into tertiles based on the controls. First incident myocardial infarction (n=345) and ischemic stroke (n=354) cases were ascertained via linkage to the National Inpatient Register and the Cause of Death Register. Control individuals, matched for age, sex and sample date, were randomly selected from each cohort. Baseline blood lipids were measured after overnight fasting.

RESULTS: We investigated 1528 case-control subjects with mean [SD] age of 66 [7.7] years, 67% women and PFAS levels around or slightly below established benchmark doses. In multivariable-adjusted analyses, the third tertile of the standardized sum of five PFAS associated with higher total cholesterol and lower triglyceride levels amongst controls at baseline (n=631), but not with increased risk of cardiovascular disease (OR=0.70, 95% CI=0.53, 0.93), myocardial infarction (OR=0.60, 95% CI=0.39, 0.92) or stroke (OR=0.83, 95% CI=0.46-1.50).

CONCLUSIONS: This study indicated that PFAS exposure, although associated with increased cholesterol levels, did not associate with increased risk of myocardial infarction, stroke or their composite endpoint. The findings improve our knowledge on cardiovascular health effects of environmental factors and suggest disturbances in pathways unrelated to cholesterol.

Keywords: Cardiovascular diseases, PFAS, Environmental Epidemiology



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Perfluoroalkyl Substances and Health Across the Life Course

Chairs: Atsuko Araki, Japan & Zeyan Liew, United States

O-TO-140

Chemical exposures » PFAS

Associations between liver PFAS concentrations and plasma extracellular miRNAs in a cohort of adolescents undergoing bariatric surgery

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BACKGROUND AND AIM: Perfluoroalkyl substances (PFAS), the “forever chemicals”, accumulate mainly in the liver and have various adverse health effects. Little is known about the mechanistic pathways of PFAS toxicity, but one likely mechanism is alteration of microRNA (miRNA) profiles that regulate post-transcription gene expression. This study aimed to explore relationships between hepatic PFAS concentrations and extracellular miRNAs in adolescents with severe obesity undergoing bariatric surgery.

METHODS: PFAS concentrations (PFOS, PFOA, PFHxS, PFNA, PFDA, PFUdA, PFHpA, 8:2 FTS, 6:2 FTS, and NMeFOSAA) were assessed in liver biopsy samples (LOD<0.01 ng/g tissue) collected at the time of



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bariatric surgery from 63 participants (mean [SD] age: 16.3 [1.7] years; 73% female) of the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) cohort. HTG EdgeSeq quantified plasma extracellular miRNAs, of which 803 had a coefficient of variation <25% among the control replicates and were used for analysis. Linear regression was performed to examine the pairwise associations between each liver PFAS concentration and each miRNA after adjusting for age, sex, race, pre-surgery weight loss, and BMI. KEGG pathway analysis was used to identify putative biological functions of PFAS-associated miRNAs.

RESULTS: Median (IQR) hepatic PFAS concentrations ranged from 0.9 (0.08-0.13) ng/g liver for 6:2FTS to 6.57 (4.79-9.55) ng/g liver for PFOS. The greatest extent of associations with the expression of individual miRNAs was observed among PFOS and PFHxS, with PFOS being associated with upregulation of 9 miRNAs and PFHxS with downregulation of 15 miRNAs. Putative targets of dysregulated miRNAs associated with PFAS included pathways involved in cell cycle and cancer (e.g., TGF-beta signaling, Wnt signaling, p53 signaling, MAPK signaling), lipid metabolism (e.g., fatty acid biosynthesis, glycerophospholipid metabolism) and glucose metabolism (e.g., insulin signaling).

CONCLUSIONS: Altered miRNA expression might be a mode of action of PFAS toxicity. Findings of this study offer new avenues to explore the mechanistic link between PFAS and disease.

Keywords: liver tissue, PFAS, extracellular miRNAs, adolescents



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Perfluoroalkyl Substances and Health Across the Life Course

Chairs: Atsuko Araki, Japan & Zeyan Liew, United States

O-TO-141

Chemical exposures » PFAS

Longitudinal analysis of DNA methylation in relation to gestational perfluoroalkyl substance exposure: An epigenome-wide association study

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BACKGROUND AND AIM: Alterations to DNA methylation may underlie the association between gestational exposure to perfluoroalkyl substances (PFAS) and adverse health outcomes in children. However, few studies have examined the association between gestational PFAS exposure and DNA methylation, and no studies have repeated DNA methylation data across childhood. We examined associations between gestational PFAS exposure and repeated measures of offspring peripheral leukocyte DNA methylation among 266 mother-child pairs enrolled in the HOME Study (Cincinnati, OH).

METHODS: We quantified serum concentrations of perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoate (PFNA), and perfluorohexane sulfonate (PFHxS) in mothers at ~16 weeks gestation. We measured DNA methylation at delivery (cord blood) and age 12 years using the Illumina HumanMethylation EPIC BeadChip. We analyzed the associations between log₂-transformed PFAS concentrations and repeated DNA methylation measures using generalized estimating equations. Visit by PFAS interaction terms were used to test the stability of these differences across time. We performed Gene Ontology (GO) enrichment analysis to identify significant biological pathways.

RESULTS: A total of 35 loci were significantly associated with PFAS (false discovery rate, $q < 0.05$). Among the 5 loci for PFOS, 10 for PFOA, 7 for PFHxS, and 13 for PFNA ($q < 0.01$), none overlapped. These loci mapped to genes (e.g., AGAP1, HPSE2, HABP2, RNF13, RADIL, and TMEM56) that are associated with cancers, cardiovascular disease, and cognitive function. We found little evidence that



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associations between PFAS and DNA methylation changed over time. The most significant GO pathways included homophilic cell adhesion, cell-cell adhesion and integral component of plasma membrane.

CONCLUSIONS: Using longitudinal data, we identified loci associated with PFAS that have not been reported. Several loci were in genes linked to PFAS-associated health outcomes. Future studies are needed to confirm our findings and examine whether DNA methylation mediates associations between gestational PFAS exposure and offspring health.

Keywords: PFAS, Epigenomics, Biomarkers of exposure, Environmental epidemiology



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TRADITIONAL ORAL SESSION 26

Occupational Exposures and Health

Chairs: Yue-Liang Guo, Australia & Huichu Li, United States

O-TO-142

Cancer and Cancer-Precursors » Other (to be specified with keywords in the keywords section)

Low-level radon exposure and lung cancer in the Pooled Uranium Miners Analysis (PUMA)

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BACKGROUND AND AIM: Radon, a ubiquitous gas, and its progeny are a leading environmental and occupational cause of lung cancer. To better inform radiation protection standards by estimating risk, we assembled an international cohort study of workers employed in uranium mining in Canada, the Czech Republic, France, Germany, and the United States.

METHODS: We focus on miners employed during the more contemporary period of the uranium mining industry when radon exposures tended to be comparatively low, and individual exposure data are available. A cohort of 56,614 male uranium miners first employed in 1960 or later was assembled and followed to ascertain causes of death. Estimates of excess relative rate (ERR) per working level month (WLM) of cumulative radon progeny exposure for mortality from lung cancer were derived by internal Poisson regression.

RESULTS: In the follow-up period a total of 1217 lung cancer deaths occurred, accumulating 1.9 million person-years at risk. The relative rate of lung cancer increased in a linear fashion with cumulative exposure to radon progeny, lagged 5 years (ERR/100 WLM=1.34; 95% CI: 0.89, 1.89). Attained age was a clear modifier of this association, showing a decrease in ERR/WLM with increasing attained age. Further potential modifiers are age at exposure or time since exposure and exposure rate.

CONCLUSIONS: PUMA provides the most precise and informative estimates to-date of the association between low-level exposure to radon progeny and lung cancer mortality. The results strengthen the basis for radiation protection standards for radon and its progeny.

Keywords: Ionizing radiation, Occupational exposures, Risk assessment, International collaboration



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Occupational Exposures and Health

Chairs: Yue-Liang Guo, Australia & Huichu Li, United States

O-TO-143

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

Health Services Use and Health Outcomes among Informal Economy Workers Compared with Formal Economy Workers: A Systematic Review and Meta-Analysis

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BACKGROUND AND AIM: There are approximately two billion informal workers globally. Compared to the formal economy, workers in the informal economy are often marginalised with minimal benefits from occupational health and safety regulations and labour laws as well as decreased access to social protection and health care. Thus these informal economy workers may have higher occupational health risks compared to their formal counterparts. The aim was to systematically review and meta-analyse evidence on health services use and health outcomes among informal economy workers, compared with formal economy workers.

METHODS: We searched for studies between 1999–2020 in March 2020. The eligible population was informal economy workers. The comparator was formal economy workers. The outcomes were: use of general and occupational health services, fatal and non-fatal occupational injuries, HIV, tuberculosis, musculoskeletal disorders, noise induced hearing loss, respiratory infections and depression. Two authors independently screened records, extracted data, and assessed risk of bias and quality of evidence. Inverse variance meta-analyses were conducted with random-effects.

RESULTS: Twelve studies with 1 637 297 participants from seven countries in four WHO regions (Africa, Americas, Eastern Mediterranean and Western Pacific) were included. Compared with formal economy workers, informal economy workers were found to be less likely to use any health services (odds ratio 0.89, 95% confidence interval 0.85–0.94, four studies, 195 667 participants, I² = 89%, low quality of evidence) and more likely to have any common mental disorder (odds ratio 5.02, 95% confidence interval 2.72–9.27, three studies, 26 260 participants, I² = 87%, low quality of evidence). We are uncertain about the other outcomes due to the very low quality of evidence.



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CONCLUSIONS: Informal economy workers are less likely than formal economy workers to use any health services and more likely to have depression. The evidence is uncertain for the other eligible outcomes and warrants further research to strengthen the body of evidence.

Keywords: Occupational exposures, Occupational epidemiology, Outcomes



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Occupational Exposures and Health

Chairs: Yue-Liang Guo, Australia & Huichu Li, United States

O-TO-144

Policy » Policy research

Canadian Aquaculture: Supporting the need to develop sentinel surveillance programs for antimicrobial resistance among Canadian marine aquaculture facilities

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BACKGROUND AND AIM: Marine aquaculture is a rapidly expanding industry globally. Antimicrobial resistance (AMR) stemming from aquaculture is a public and occupational health concern but is poorly understood. Prescribed antibiotics are administered via fish-feed to treat infected fish, which also non-selectively exposes healthy stocks to the agents and increases antibiotic loads in surrounding environments. Consequential selection and amplification of AMR bacteria may create hotspots affecting aquaculture workers and their communities via consumption of contaminated fish and through direct or indirect occupational and environmental exposures to contaminants. Mitigative efforts have purportedly reduced antibiotic use but past and contemporary impacts on AMR exposures are unknown. This case study will identify regulatory and data gaps that currently hinder the implementation of sentinel surveillance strategies in Canada.

METHODS: i) Profile antibiotic use by Canada's marine aquaculture industry from 2016 to 2018 in comparison with other global industry leaders. ii) Comparative analysis of regulatory regime and surveillance differences across aquaculture-practicing leaders.

RESULTS: Public reporting reveals Canadian marine aquaculture's use of antibiotics was higher than reported in Norway, but lower than reported in Chile. There is no standardized monitoring for AMR via aquatic contaminants or identification of potential pathways from those contaminants to aquaculture workers and communities in Canada. This situation is somewhat different in other countries. Current data repositories are insufficient to elucidate the extent of human and environmental risk stemming from AMR emergence from within and around aquaculture sites.

CONCLUSIONS: Canada should develop protective sentinel surveillance programs, but currently lacks the baseline studies required to stimulate evidence-based dialogue. Harmonization of data collection across jurisdictions can help define factors that increase selection pressure for the development of AMR in aquaculture settings. Furthermore, coordinated data management at the public health level can help flag health challenges potentially emerging from environmental exposures to AMR bacteria.

Keywords: Policy and practice, Pharmaceuticals, Occupational exposures



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Chairs: Yue-Liang Guo, Australia & Huichu Li, United States

O-TO-145

Exposures » Occupational exposures

Impact of chronic exposure to naphthalene on physical disorders and neurasthenic symptoms among petrol station workers

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BACKGROUND AND AIM: Petrol station workers (PSW) are highly exposed occupational group in Pakistan but rarely investigated for health risk assessment. To better quantify toxic effects of petroleum hydrocarbon exposure (naphthalene) among petrol station workers (PSW), a study was conducted with an aim to estimate naphthalene body burden as proxy exposure measure.

METHODS: The exposure symptoms of 65 PSW were evaluated by the help of questionnaire. Self-reported health status of each worker was noted. We categorized health disorders into physical (e.g. skin lesions, eye redness, dryness of tongue/lips, appetite loss, and acidity after meals at workplace) and neurasthenic symptoms (e.g. energy loss, fatigue, fainting, twitching, sleeplessness, irritability, and body aches). Blood samples were also collected for analysis of naphthalene concentration by HPLC.

RESULTS: The results showed that mean concentration of blood naphthalene was 122 $\mu\text{g L}^{-1}$ among petrol station workers. There was fairly high significant effect of daily work-hours and employment duration on blood naphthalene levels. Workers exposed to 6 hour per day or more had significantly high prevalence of physical disorders (OR=3.18, 95% CI=1.05–8.08). Neurasthenic symptoms were found in 63% of the subjects and were associated with years of involvement in job. Ten years or more occupational work at petrol stations attributed substantial development of neurasthenic effects (OR=3.45, 95% CI=1.12–8.92).

CONCLUSIONS: We conclude that subjects associating disturbances in physical and neurological behavior with petrol related occupation rated their overall health and functional capacity significantly poorer than that of urban area general population. Hence our study may prove helpful in the implementation of human biomonitoring as an instrument for health risk assessment for those who have occupational exposure to naphthalene

Keywords: Biomonitoring, PAH, Occupational Exposure, Petroleum hydrocarbons, Epidemiology, Health Risk Analysis



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Occupational Exposures and Health

Chairs: Yue-Liang Guo, Australia & Huichu Li, United States

O-TO-146

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

SARS-CoV-2 pandemic among Mexico's private sector workforce: using short-term disability claims to analyze impact and response

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BACKGROUND AND AIM: The COVID-19 pandemic has affected workforces around the world, on both the individual and business levels. This impact has not yet been described adequately. **AIM:** To analyze the impact of COVID-19 among workers and businesses using short term disability claims (STDC).

METHODS: Our analysis is derived from the national data base STDC submitted to the Mexican Institute of Social Security (the largest health care and benefits provider) by private-sector workers and eligible government-owned companies. We analyzed absenteeism trends evaluated through respiratory diseases-STDC (RD-STDC) among the different occupational sectors for 19,112,620 workers registered up to December 31, 2020.

RESULTS: A total of 1,543,600 workers claimed at least one RD-STDC. Up to year week 53, 1.7 million RD-STDC were reported, with an estimated cumulative incidence of 8.0%. The mean age of workers was 35.2 years (Interquartile Range [IQR] = 26- 43 years); 53.4% were male. The average duration of the STD granted was 10.1 days [IQR= 3 - 14 days]. Higher RD-STD-attack rates were observed in Trade (9.9%) and Manufacturing (9.8%). Health care-related subsectors had RD-STDC attack rates of 15.1% for private health care workers. During 2020, 16.9 million total workdays were lost. Real symptomatic COVID-19 attack rates could be 3 or 4 times higher.

CONCLUSIONS: Our findings point to the necessity of establishing an integrated surveillance system in which STDC can help geo-localize chains of contagion that would otherwise proliferate undetected. Information provided by this system will complement surveillance systems for monitoring epidemics and informing decision-making of by health authorities.

Keywords: Short term disability claims, COVID-19, occupational, Mexico



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Links between Air Pollution and Children's and Reproductive Outcomes

Chairs: Marie Pedersen, Denmark & Carmen Messerlian, United States

O-TO-147

Birth and Pregnancy Outcomes » Pregnancy outcomes

Association between ambient air pollution prior to initiation of in vitro fertilization and fertilization rates, pregnancy, and live birth

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BACKGROUND AND AIM: There is a growing body of evidence that pre-pregnancy exposure to ambient air pollution is associated with fecundity and pregnancy, however much existing evidence depends on poorly quantified exposure measures. This study uses highly resolved exposure predictions for ambient air pollution in biologically critical pre-pregnancy windows in a population undergoing in vitro fertilization (IVF) to estimate if air pollutants are associated with adverse IVF outcomes.

METHODS: This study includes individuals initiating a first IVF cycle from 2012-2013 at one of four clinics. Participant characteristics and cycle outcomes were extracted from medical records. PM_{2.5}, NO₂, and NO_x were estimated using a highly resolved city-specific spatiotemporal prediction models. Exposures were estimated for 2 and 8-week periods prior to cycle initiation representing biologically critical time periods. Outcomes evaluated included percent oocytes fertilized, embryo grade, clinical pregnancy, and live birth. Poisson and linear regression were used to evaluate binary and continuous outcomes, respectively.

RESULTS: There were 4,756 eligible participants with a mean age of 35. Mean 2-week exposures were 9.5 µg/m³ for PM_{2.5}, 9.6 ppb for NO₂, and 14.5 ppb for NO_x. We did not detect associations between any exposure and embryo quality, pregnancy, and live birth. Across pollutants, exposure was associated with a small but consistently lower fertilization rate. We found 0.13% (95% CI: -0.24, -0.02), 0.04% (95% CI: -0.07, -0.01), and 0.01% (95% CI: -0.02, -0.01) lower percent oocytes fertilized with a 2 µg/m³ PM_{2.5}, 6ppb NO₂, and 11ppb NO_x 2-week average exposure, respectively. Results for an 8-week exposure were similar.



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CONCLUSIONS: These findings support recent studies which indicate a link between air pollution, fertility, and fecundity. The results of this study indicate that recent exposure to ambient air pollution may be related fecundity, though the effects seen here are not clinically relevant. Further work in characterizing this early time period is necessary.

Keywords: fecundity, fertility, pregnancy, air pollution



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Links between Air Pollution and Children's and Reproductive Outcomes

Chairs: Marie Pedersen, Denmark & Carmen Messerlian, United States

O-TO-148

Air pollution » General

Ambient air pollution exposure during pregnancy and cardio-metabolic markers in cord blood: The Healthy Start study

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BACKGROUND AND AIM: Prenatal air pollution exposure has been associated with adverse cardiometabolic outcomes in childhood. It is unknown whether evidence of metabolic disruption associated with air pollution may be identified at birth. We estimated associations between maternal residential exposure to air pollution during pregnancy and metabolic and lipid biomarkers in cord blood collected at delivery.

METHODS: This study included 812 mother-infant pairs enrolled in the prospective, Colorado-based Healthy Start study (2009-2014). Using inverse-distance-weighted interpolation of data obtained from stationary monitors, we estimated daily particulate matter ≤ 2.5 micrometers (PM_{2.5}) and ozone (O₃) concentrations at participant residences. Daily estimates were averaged by trimester, full pregnancy, and the 7- and 30- days prior to delivery. Outcomes were cord blood concentrations of glucose, insulin, leptin, total and high-density lipoprotein cholesterol, free fatty acids, and triglycerides. Glucose-insulin ratio was calculated as an indirect measure of insulin sensitivity. We used multiple linear regression to estimate associations between PM_{2.5} and O₃ and cord blood metabolic and lipid biomarkers. Covariates included maternal, infant, and meteorological characteristics.



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RESULTS: Higher O₃ exposure, during both recent and longer-term exposure periods during pregnancy, was consistently associated with higher insulin and lower glucose-insulin ratio in cord blood. For example, an interquartile range increase in full pregnancy O₃ (6.3 ppb) was associated with a 0.12 log- μ U/ml (95% confidence interval: 0.03, 0.21) increase in cord blood insulin, after adjusting for covariates. There was limited evidence supporting positive associations between PM_{2.5} and leptin and O₃ and total cholesterol. There were inverse associations between PM_{2.5} and triglycerides, during certain periods of pregnancy.

CONCLUSIONS: Prenatal air pollution exposure was associated with cardiometabolic biomarkers in cord blood, most notably for O₃ and insulin. Future studies should examine whether these changes persist into childhood and their implications on offspring health.

Keywords: prenatal exposure, air pollution, lipids, metabolism, neonate



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Links between Air Pollution and Children's and Reproductive Outcomes

Chairs: Marie Pedersen, Denmark & Carmen Messerlian, United States

O-TO-149

Air pollution » Mixtures

Combined Effects of Air pollutants on Gestational Diabetes Mellitus: a Prospective Cohort Study

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BACKGROUND AND AIM: Maternal exposure to air pollutants increases the risk of gestational diabetes mellitus (GDM). Still, the associations between exposure to air pollutants before pregnancy and GDM are unclear, as well as their combined effects. We aimed to identify exposure to air pollutants before pregnancy associated with GDM risk and to determine any combined effect of these components.

METHODS: This study included 20113 participants from the Born in Guangzhou Cohort Study (BIGCS). The inverse distance-weighted models were used to estimate individual air pollutant exposure, namely ozone (O₃), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), particulate matter less than 10 microns in diameter (PM₁₀), and less than 2.5 microns in diameter (PM_{2.5}). We used generalized estimating equations to examine the stage-specific associations of air pollutants with the risk of GDM.

RESULTS: Of the 20113 participants, 3440 women were diagnosed with GDM. In adjusted models, O₃ exposures in 3-6 months before pregnancy and in the first trimester were significantly positively associated with the risk of GDM, adjusted relative risks (95% confidence intervals) [RRs (95%CI)] were 1.05 (1.00, 1.09) and 1.05 (1.01, 1.10), respectively. SO₂ concentrations in 3-6 months before pregnancy and PM₁₀ concentrations in the first trimester were related to an increased risk of GDM, RRs (95% CI) were 1.21 (1.04, 1.40) and 1.07 (1.02, 1.12), respectively. The RR in groups with high concentrations of two air pollutants was higher than that in groups with one high concentration pollutant only.

CONCLUSIONS: This large study provided evidence on the positive association between exposure to air pollutants six months before pregnancy period to the first trimester and the risk of GDM. The effects of combined exposure to multiple air pollutants were higher than that of single exposure. These findings suggested that public health strategies were needed to reduce the adverse effects of air pollution exposure on pregnant women.

Keywords: air pollution, gestational diabetes mellitus, maternal exposure, cohort study



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Links between Air Pollution and Children's and Reproductive Outcomes

Chairs: Marie Pedersen, Denmark & Carmen Messerlian, United States

O-TO-150

Air pollution » General

Prenatal air pollution exposure and adverse birth outcomes: windows of susceptibility and socio-economic inequalities

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BACKGROUND AND AIM: Air pollution exposure has been associated with adverse birth outcomes. However, few studies have investigated potential gestational windows of susceptibility. Further, the extent to which this association differs across socioeconomic status (SES) is underexplored. Therefore, the aim of this study is to investigate windows of susceptibility and explore potential social inequalities in the association between prenatal air pollution exposure and adverse birth outcomes.

METHODS: We used a Spanish national-wide birth registry study which includes all newborns born between 2009 and 2010 (n=353,750) and whose mothers resided in the peninsula or the Balearic Islands. Maternal exposures to particulate matter with an aerodynamic diameter of <10 µm (PM10), <2.5 µm (PM2.5), and 2.5-10µm (PMcoarse) were estimated at the residential address throughout pregnancy on a daily basis using spatiotemporal land use machine-learning models. Birth outcomes (i.e., birth weight, gestational age, prematurity, and small or large for gestational age) and SES characteristics of the parents (i.e., education, occupation, ethnicity, area-level deprivation index) were obtained from the registry. Confounder adjusted associations between pollutant concentrations and birth outcomes, windows of susceptibility, and SES disparities were examined using regression models.

RESULTS: Higher air pollution concentrations were associated with lower birth weight and increased prematurity [e.g., 20 gram decrease in birth weight (95%CI -25.3, -15.2) per each 10µg/m³ increase in PM10]. Results revealed that exposure during the third trimester were driving these associations and that effect on birth weight and prematurity was greater in magnitude for children from low SES families. Air pollution exposure was not associated with being small or large for gestational age.



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CONCLUSIONS: Exposure to air pollution during pregnancy was associated with adverse birth outcomes, with the third trimester of pregnancy being the most susceptible window. A pattern of social inequality was observed in this association, with a greater impact on newborns from families with fewer resources.

Keywords: Air pollution, birth outcomes, socio-economic inequalities, windows of susceptibility, pregnancy



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Links between Air Pollution and Children's and Reproductive Outcomes

Chairs: Marie Pedersen, Denmark & Carmen Messerlian, United States

O-TO-151

Birth and Pregnancy Outcomes » Pregnancy outcomes

Exposure to PM_{2.5} during pregnancy and ultrasound parameters of fetal growth in Massachusetts, USA

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BACKGROUND AND AIM: Prior studies have examined the association between particulate matter less than 2.5 μm (PM_{2.5}) and fetal growth with inconsistent results. In this study, we examined the association between PM_{2.5} exposure in the first 16 weeks of pregnancy and fetal growth in a pregnancy cohort using routine ultrasound measurements and spatiotemporally resolved PM_{2.5} in Massachusetts, USA.

METHODS: We used prenatal and obstetric data from 8,811 pregnancies that delivered at Beth Israel Deaconess Medical Center from 2011-2016. There were 21,874, 21,788, 21,776, and 21,738 ultrasound measurements for biparietal diameter (BPD), head circumference (HC), femur length (FL), and abdominal circumference (AC), respectively. We used generalized additive mixed models to examine the exposure-response relationship between PM_{2.5} in the first 16 weeks of pregnancy and fetal ultrasound parameters in distinct developmental windows (weeks 14-20, weeks 21-26, weeks 27-32, weeks 33+) adjusted for sociodemographic characteristics, maternal comorbidities, season, and temperature.

RESULTS: For all fetal ultrasound parameters, we observed a nonlinear exposure-response relationship in gestational weeks 14-20. Below 7 $\mu\text{g}/\text{m}^3$, higher PM_{2.5} exposure was associated with reduced ultrasound measurements, while at higher concentrations, it was either not associated with fetal growth (BPD and AC) or associated with larger ultrasound measurements (HC and FL).



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After week 27, PM_{2.5} exposure was linearly associated with reduced BPD and AC, but these associations were weaker than those earlier in pregnancy. For example, an increase in PM_{2.5} from 0 to 7 µg/m³ was associated with BPD z-score reductions of 0.3, 0.2, and 0.1 in weeks 14-20, 27-32, and 33+, respectively.

CONCLUSIONS: Gestational exposure to PM_{2.5} was associated with impaired fetal growth at levels below the current national standards, where early pregnancy appears to be a particularly sensitive window of development during which a fetus is susceptible. Nonlinearities in the exposure-response relationship in weeks 14-20 could potentially be attributed to live-birth bias.

Keywords: air pollution, causal inference, particulate matter, pregnancy outcomes



ABSTRACT E-BOOK

August 26, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 27

Links between Air Pollution and Children's and Reproductive Outcomes

Chairs: Marie Pedersen, Denmark & Carmen Messerlian, United States

O-TO-152

Birth and Pregnancy Outcomes » Birth outcomes

Association between prenatal exposures to ambient air pollutants and preterm birth in the Atlanta African American Mother-Child Cohort

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BACKGROUND AND AIM: Exposures to air pollution during pregnancy have been associated with preterm birth (PTB). Communities of color, especially African American (AA), are disproportionately exposed to high levels of air pollution and experience elevated occurrences of PTB, warranting investigation into the attributable risk of PTB among AA women associated with prenatal exposure to ambient air pollution.

METHODS: This study was conducted in the Atlanta AA Maternal-Child cohort. We linked ambient PM_{2.5}, NO₂, and O₃ concentrations at 1-km resolution to 293 participants who delivered between 2014 and 2016. We used both single- and multi-pollutant logistic models with adjustment for potential confounders (i.e., sociodemographic, socioeconomic status, behavioral risk factors, season of conception, and meteorology) to examine associations between pollutant exposures (during each trimester, entire pregnancy, and 3 years before pregnancy) and PTB (< 37 weeks) and early-term birth (37-38 weeks) vs. full term birth.

RESULTS: PM_{2.5} concentrations (in both single- and 3-pollutant models) and NO₂ (single pollutant model) during the three years before pregnancy were associated with increased odds of PTB. In the 3-pollutant model, the odd ratio (OR) for PTB was 1.66 (95% CI: 1.01-2.73) per interquartile range (IQR) increase in NO₂ throughout pregnancy. Both single- and 3-pollutant models showed NO₂ levels during the 1st and 2nd trimesters, and during the entire pregnancy were significantly associated with increased odds of early-term birth; corresponding ORs for per IQR increment were 1.78, 1.63, and 1.52, respectively. PM_{2.5} during the 3rd trimester was also associated with elevated risk for early term birth in a single pollutant model (OR 1.95, 1.08-3.50).

CONCLUSIONS: Long-term exposures to PM_{2.5} and NO₂ before and during pregnancy were associated with preterm and early-term birth in the Atlanta AA birth cohort. This study supports targeted interventions to protect pregnant women from air pollution, especially AA populations who have a higher PTB rate.

Keywords: Air pollution, Multi-pollutant, Birth outcome



ABSTRACT E-BOOK

August 26, 2021 / 11:30 - 13:00 / Grand Central Hall (Hall 5)

TRADITIONAL ORAL SESSION 28

Environmental Metabolomics

Chairs: Donghai Liang, United States & Zhanghua Chen, United States

O-TO-153

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Untargeted Metabolomics Reveals that Multiple Reproductive Toxicants are Present in the Endometrium

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BACKGROUND AND AIM: Recent epidemiological research focused on the effects of environmental chemicals on the female reproductive system shows mixed results, which may be partially due to differences in exposure assessment, residual confounding from diet or lifestyle factors, or co-exposures to other chemicals. These challenges highlight the need for more precise exposure assessment at the end-organ of interest to accurately understand the adverse reproductive effects of environmental exposures. Our aim was to perform untargeted metabolomic analysis of menstrual blood, a novel biospecimen, to identify environmental toxins present in the endometrium.

METHODS: Whole menstrual effluent samples were collected from four women using a menstrual cup. To evaluate the effect of sample processing times, one portion of menstrual effluent was immediately frozen at -20°C for 24hrs and the second portion was kept at 4°C for 24hrs; both samples were then stored at -80°C. Samples were analyzed using untargeted liquid chromatography with high-resolution mass spectrometry (LC-HRMS). To survey the presence of environmental exposures, LC-HRMS chemical profiles were matched to the ToxCast chemical database, which includes 4,557 commonly used commercial chemicals. Select compounds were confirmed using MS/MS and comparison to reference standards. Principal component analysis (PCA) was used to identify differences within and between individuals' menstrual blood metabolomic profiles, and the influence of the sample processing method.

RESULTS: We identified 261 high confidence matches to environmental chemicals, including suspected reproductive toxicants such as phenols, parabens, phthalates, and organochlorides. PCA showed analysis of menstrual blood samples was highly reproducible, with much higher variability between participants than between an individual's analytical replicates.

CONCLUSIONS: Our results show chemical exposures linked to reproductive toxicity and endocrine disruption are present in the endometrium. In addition, our results demonstrate that menstrual blood can be successfully collected and provides a suitable biofluid for untargeted profiling to assess environmental exposures associated with potential adverse reproductive outcomes.

Keywords: metabolomics, exposome, biomarkers of exposure, endocrine disrupting chemicals, reproductive outcomes



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TRADITIONAL ORAL SESSION 28

Environmental Metabolomics

Chairs: Donghai Liang, United States & Zhanghua Chen, United States

O-TO-154

Omics Technologies » Metabolomics

High-resolution metabolomics of exposure to tobacco smoke during pregnancy and adverse birth outcomes in the Atlanta African American Maternal-Child cohort

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BACKGROUND AND AIM: Exposure to tobacco smoke during pregnancy has been associated with a series of adverse reproductive outcomes; however, the underlying molecular mechanisms are not well-established. In this analysis, we measured urinary cotinine, a widely used biomarker of tobacco exposure, and conducted high-resolution metabolomics (HRM) to identify biological perturbations associated with prenatal tobacco smoke exposures and adverse birth outcomes.

METHODS: We collected early and late pregnancy urine samples for cotinine measurement and serum samples for HRM profiling from 105 pregnant women from the Atlanta African American Maternal-Child cohort (2014-2016). Using an untargeted HRM workflow, we investigated how the biological perturbations in maternal metabolome mediate the association between prenatal smoke exposures and adverse birth outcomes (preterm birth, early term birth vs. full term birth; gestational age at birth) using a meet-in-the-middle approach.

RESULTS: The median maternal urinary cotinine level was 4.77 ug/g creatinine, with 29 subjects higher than 100 ug/g creatinine. In total, 16,481 and 13,043 metabolic features were extracted from serum samples using hilic and c18 columns, respectively. Thirteen metabolic pathways were found to be associated with cotinine level and adverse birth outcomes during early and late pregnancy, including tryptophan, histidine, urea cycle, arginine, and proline metabolism. We confirmed 47 metabolites associated with cotinine exposure, preterm birth, and shorter gestational length, which include glutamate, serine, choline, and taurine; these metabolites are closely involved in endogenous inflammation, vascular reactivity, and lipid peroxidation processes.

CONCLUSIONS: The metabolic perturbations associated with cotinine exposure were closely connected within a metabolic network related to inflammation, oxidative stress, placental vascularization, and insulin action, which could contribute to shorter gestations. The findings support the future development of targeted interventions to reduce adverse birth outcomes associated with



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ABSTRACT E-BOOK

tobacco smoke exposure, especially among African American who are disproportionately exposed to high tobacco smoke and experience higher rates of adverse birth outcomes.

Keywords: Tobacco Smoke Exposures, Metabolomics, Birth Outcomes, Preterm Birth



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Environmental Metabolomics

Chairs: Donghai Liang, United States & Zhanghua Chen, United States

O-TO-155

Chemical exposures » General

Using non-targeted screening and silicone wristbands to investigate geographic differences in pollution exposures among maternal and cord sera

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BACKGROUND AND AIM: Differential risk for adverse pregnancy outcomes in the Fresno and San Francisco regions of California may be influenced by chemical exposures in pregnant women that are not fully captured by traditional biomonitoring approaches. We compared multiple exposure assessment approaches and evaluated differences in chemical exposures among a cohort of pregnant women between the two locations.

METHODS: We recruited 300 San Francisco and 75 Fresno mothers and collected maternal and cord sera which we screened for over 2,420 chemicals using high-resolution mass spectrometry using liquid chromatography – quadrupole time-of-flight mass spectrometry (LC-QTOF/MS). 26 of the Fresno participants wore silicone wristbands, which were screened for over 1,500 chemicals using targeted chemical analysis. We matched 75 San Francisco participants to the Fresno participants and used Fisher's exact test to compare detection frequencies of chemicals in maternal and cord sera between the two locations. We also evaluated whether mothers living in Census tracts with high levels of pollution or pesticides according to CalEnviroScreen had significantly higher numbers of chemicals detected in their sera using Spearman's rank correlation.

RESULTS: We detected 2,167 features across the maternal and cord sera samples by the non-targeted approach. The numbers of suspect chemical features detected were not significantly different between San Francisco and Fresno. A higher number of chemicals tentatively identified as cosmetics or fragrances were significantly differentially detected among the Fresno participants ($p < 0.05$). The



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silicone wristbands also showed high levels of several chemicals used in fragrances, including ethylene brassylate, benzyl salicylate, tonalide, beta-ionone, and linal. Fresno participants living in tracts with higher pesticide scores had significantly higher numbers of suspect pesticides in their sera ($p < 0.05$). **CONCLUSIONS:** Multiple exposure assessment approaches demonstrate the broad array of chemicals women are exposed to during pregnancy. Many of these chemicals have not been well-studied in terms of their effects on human health.

Keywords: exposome, reproductive outcomes, environmental disparities



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Environmental Metabolomics

Chairs: Donghai Liang, United States & Zhanghua Chen, United States

O-TO-156

Chemical exposures » PFAS

Gestational Perfluorooctanoate Exposure and Childhood Metabolome at Age 8 Years

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BACKGROUND AND AIM: Gestational exposure to perfluorooctanoate (PFOA) is associated with excess adiposity and increased cardiometabolic risk in children. To identify potential mechanisms underlying these associations, we characterized metabolic alterations and pathways associated with gestational PFOA exposure in 8-year-old children using a metabolome-wide association study (MWAS).

METHODS: We performed untargeted, high-resolution metabolomic profiling of serum samples collected at age 8-years from 106 children enrolled in the HOME study (Cincinnati, OH) using high-resolution liquid chromatography mass spectrometry (LC-MS). During pregnancy, we quantified PFOA concentrations in serum collected from their mothers using LC-MS methods. Associations between maternal PFOA concentrations during pregnancy and annotated metabolites detected in child serum samples were evaluated using multivariable linear regression adjusted for child age, sex, and race with a false discovery rate <20%. Pathway level changes were determined by characterizing metabolite networks; enriched pathways were determined using Mummichog.

RESULTS: Maternal PFOA concentrations during pregnancy (median: 5.2 ng/mL, 25th-75th percentile: 3.6-7.3 ng/mL) were associated with alterations in the child metabolome at age 8 years. Associations that met FDR<20% included 203 metabolites, of which 144 were negatively associated with PFOA concentrations. Annotation of metabolites included a range of lipids and dietary factors, while pathway enrichment identified alterations in amino acid metabolism, lipid pathways, oxidative stress, de novo fatty acid biosynthesis and catabolism.

CONCLUSIONS: This is the first study to examine gestational PFOA in association with childhood metabolome using untargeted approach. In this study, maternal PFOA concentrations at pregnancy were associated with systemic alterations in metabolic pathways related to energy production, oxidative stress and catabolism in serum collected from 8-year-old children.

These results highlight the importance of early life exposure, and suggest that PFOA-related metabolic alterations manifest early in life. Future studies should examine how these PFOA-related alterations contribute to increased risk for childhood adiposity and cardiometabolic risk.

Keywords: PFAS, Metabolomics, Children's environmental health



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Environmental Metabolomics

Chairs: Donghai Liang, United States & Zhanghua Chen, United States

O-TO-157

Omics Technologies » Metabolomics

Trace elements and plasma metabolomics in a general population from Spain: The Hortega Study

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BACKGROUND AND AIM: Limited studies have evaluated the joint influence of trace elements on metabolic pathways. We analyzed the association of 12 trace elements with 54 plasma metabolites in 1144 participants from the Hortega Study, a population-based sample from Spain.

METHODS: Urine antimony (Sb), arsenic (As), As adjusted by arsenobetaine (Asb), barium (Ba), cadmium (Cd), chromium (Cr), cobalt (Co), molybdenum (Mo) and vanadium (V); and plasma copper (Cu), selenium (Se) and zinc (Zn) were measured with ICP-MS and AAS, respectively. Serum metabolomic profiles, including lipoprotein subclasses, were assessed by NMR-spectrometry. We jointly correlated metabolites by principal component (PC) analysis. Bayesian Kernel Machine Regression (BKMR) allowed to evaluate the influence of trace element mixtures on metabolomic profiles.

RESULTS: The geometric means of trace element exposure biomarker levels were, 0.07, 68.69, 6.53, 62.03, 0.37, 3.55, 0.25, 26.09 and 2.08 µg/g for urine Sb, As, As adjusted by Asb, Ba, Cd, Cr, Co, Mo and V, and 93.88, 83.73 and 77.13 µg/L, for plasma Cu, Se and Zn. Cu was inversely associated with metabolic principal component (mPC) 1 (reflecting increasing non-essential and essential branch-chained aminoacids and bacterial co-metabolism versus decreasing VLDL lipoproteins subclasses); Se and Zn were inversely associated with mPC 2 (reflecting increasing essential aromatic aminoacids and bacterial co-metabolism); The corresponding associations for mPC 3 (reflecting increasing LDL lipoprotein subclasses) were positive for plasma Cu, Se and Zn and inverse for urine Co. Plasma Zn was inversely associated with mPC 4 (reflecting increasing HDL lipoprotein subclasses). These associations remained after multiple-trace element adjustment. BKMR to assess joint trace element exposure was confirmatory.



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CONCLUSIONS: Excessive exposure to Co, Cu, Se, and Zn was associated with metabolite profiles traditionally linked to cardiometabolic risk and bacterial co-metabolism. While our findings should be confirmed in other studies, interventions to prevent uncontrolled exposure to these trace elements may be needed.

Keywords: Microbiome, Mixtures, Metabolomics, Biomarkers of exposure



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Environmental Metabolomics

Chairs: Donghai Liang, United States & Zhanghua Chen, United States

O-TO-158

Omics Technologies » The exposome

Metabolomics and gene expression profiles in association with air pollution exposure mixtures among young adults with asthma

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BACKGROUND AND AIM: Air pollution exposure has been shown to increase severity of various disease outcomes including asthma control, however, the underlying biological mechanisms are not well established. In this study, we aim to leverage transcriptomics and metabolomics to identify biological mechanisms of air pollutants exposure.

METHODS: In this cross-sectional study, 102 young adults with childhood asthma history, who were participants of Southern California Children's Health Study, were enrolled in 2012. Whole blood gene expression data was measured with Illumina HumanHT-12 v4 Expression BeadChip, with 20,869 expression signatures included in the analysis. Serum untargeted metabolomics were analyzed using the Metabolon UPLC-MS/MS, and 937 metabolites were confirmed for all samples. Participants' regional (NO₂, O₃, PM₁₀, PM_{2.5}) and near-roadway air pollution exposure were based on nearby central monitoring and modelling during one-month and one-year before the study visit. Multi-omics network analysis (R package 'xMWAS') was conducted to identify subnetworks that link metabolomics and transcriptomics to specific air pollutants exposure. Joint-pathway analysis based on MetaboAnalyst (McGill University) was performed to identify pathways associated with air pollutants in each subnetwork. Key covariates such as SES, ethnicity, sex, and smoking were adjusted in all analyses.

RESULTS: Network analysis found that 357 gene markers, 92 metabolites, and one-year and one-month exposures to 8 air pollutants were clustered into 9 subnetworks. For the subnetwork including PM₁₀ and one-month O₃, gene expression markers were enriched in pathways for insulin secretion, antigen processing and presentation. Another subnetwork including PM_{2.5} and NO₂ exposures was linked to altered metabolism of amino acids such as arginine, serine, and aspartic acid. One-year O₃ exposure was clustered with metabolites and genes involved in glycerophospholipid metabolism and N-Glycan biosynthesis.

CONCLUSIONS: This study demonstrates that exposure to various air pollutants may induce changes in gene expression and metabolomics in individuals with asthma, potentially affecting disease prognosis.

Keywords: Air Pollution, Metabolomics, Transcriptomics, Network Analysis, Pathway Analysis



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TRADITIONAL ORAL SESSION 29

Environmental Policy-relevant Research

Chairs: Martin Tondel, Sweden & Melissa Fiffer, United States

O-TO-159

Air pollution » General

Economic cost of local attributable burden disease to PM_{2.5} ambient air pollution in Medellín, Colombia, 2010-2016

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BACKGROUND AND AIM: The health impacts of air pollutant particulate matter with a diameter of 2.5 microns (PM_{2.5}) have been widely documented around the world. However, in Latin America there are few studies on the epidemiology of air pollution. Medellín is the second largest city in Colombia and one of the most polluted in the region; here, we have recently carried out different research on the subject, such as time series studies and the estimation of the local burden of disease attributed to ambient PM_{2.5} pollution (LBDPM_{2.5}). The aim of this research is to determine the economic costs of LBDPM_{2.5} in Medellín for the period 2010-2016

METHODS: For this study, the disease cost approach and the human capital approach were taken into account. These include direct medical costs and indirect costs due to loss of productivity, as a way to approximate the calculation of the economic burden. The groups of health events in which the costs were estimated were those that had information on the population attributable fraction for PM_{2.5} in Colombia, according to the studies of the global burden of disease carried out by the Institute of Health Metrics and Evaluation.

RESULTS: The economic costs of LBDPM_{2.5} had a cost of \$ 281.2 million USD, \$ 40.2 million USD annually, which represented 0.091% of the Gross Domestic Product of Colombia and 0.627 % of the department of Antioquia. The costs of premature mortality accounted for 80% of the total cost of the LBDPM_{2.5}. These costs register an increasing gradient as the age of men and women advances, reaching exceptional levels in the elderly population.

CONCLUSIONS: Our results do not differ from national and international reports and found a higher economic cost of LBDPM_{2.5} due to premature mortality. This is one of the few reports that estimates the cost of morbidity attributable to PM_{2.5}.

Keywords: Air pollution, Cost of Disease, Particulate Matter, Colombia



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TRADITIONAL ORAL SESSION 29

Environmental Policy-relevant Research

Chairs: Martin Tondel, Sweden & Melissa Fiffer, United States

O-TO-160

Air pollution » Wildfires

Health Burden Attributable to Increased PM_{2.5} Exposures and Potential Exposure Reductions during the 2020 Washington State Wildfire Smoke Episode

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BACKGROUND AND AIM: Major wildfires in 2020 along the west coast of the U.S. have made PM_{2.5} concentrations in this region rank among the highest in the world. The study aims to estimate the magnitude and disproportionate spatial impacts of increased PM_{2.5} concentrations attributable to these wildfires on population health, and to assess the potential reduction in mortality burden if avoiding elevated PM_{2.5} exposures in Washington.

METHODS: Daily PM_{2.5} concentrations for each county before and during the 2020 Washington wildfire episode (Sep. 7th-19th) were obtained from regulatory air monitors. Utilizing previously established concentration-response functions (CRFs) of PM_{2.5} (CRF of total PM_{2.5}) and odds ratio (OR) of wildfire smoke days (OR of wildfire smoke days) for mortality, we estimated excess mortality attributable to the increased PM_{2.5} concentrations and examined avoided all-cause mortality under plausible reduced PM_{2.5} exposures.

RESULTS: Elevated PM_{2.5} levels were estimated to place a heavy mortality burden on counties in Western Washington, while counties in Central and Eastern Washington were estimated to have higher per-capita mortality during the wildfire smoke episode. With CRFs for total PM_{2.5}, the 13-day exposure to wildfire smoke was estimated to lead to 92.2 (95% CI: 0.0, 178.7) more all-cause mortality cases; with OR of wildfire smoke days, 38.4 (95% CI: 0.0, 93.3) increased all-cause mortality cases and 15.1 (95% CI: 0.0, 27.9) increased respiratory mortality cases were attributable to the wildfire smoke episode. As a hypothetical example that a future wildfire intervention policy recognizing populations living below the poverty level, avoiding 40% of PM_{2.5} exposure for people below the federal poverty level can potentially reduce 4.1 (95% CI: 0.0, 8.2) all-cause mortality.

CONCLUSIONS: Because wildfire smoke episodes are likely to impact the Pacific Northwest in future years, continued preparedness and mitigations to reduce exposures to wildfire smoke are necessary to avoid excess health burden.

Keywords: wildfires, particulate matter, mortality, environmental disparities



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Environmental Policy-relevant Research

Chairs: Martin Tondel, Sweden & Melissa Fiffer, United States

O-TO-161

Air pollution » Long-term exposure

Health Effects of Hydrogen Sulfide Exposures: A Review of the Evidence Pertaining to Low Level Exposures

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BACKGROUND AND AIM: Hydrogen sulfide (H₂S) is a toxic gas well-known for its acute health risks in occupational settings and long considered a nuisance in community settings. Less is known about the health effects of chronic, low-level exposures (<10 ppm). We review the health effects of chronic exposure to H₂S at low concentrations that are relevant in community, and often occupational, settings.

METHODS: We focus on the peer-reviewed epidemiological literature since 2004. Taking an interdisciplinary approach, we contextualize epidemiological studies with peer-reviewed toxicological, experimental, and exposure assessment studies as well as agency guidelines and standards. We examine all sources of H₂S emissions, geothermal and industrial, yet limit the exposure route of interest to inhalation.

RESULTS: Chronic exposure to H₂S at levels below 10 ppm was associated with odor aversion, irritation, and harmful ocular, nasal, respiratory, and neurological effects. Exposure to an annual mean concentration between 7 and 27 ppb was associated with an increased prevalence of harmful neurological effects. Among people exposed to mean concentrations as low as 0.3 ppb, a slight increase of H₂S as little as 1 ppb may be associated with increased eye irritation, nasal irritation, and respiratory effects. Few studies considered vulnerable and susceptible populations. In epidemiological studies, the strength of association between low-level H₂S exposure and adverse health effects was primarily limited by exposure measurement error and confounding by co-pollutants.

CONCLUSIONS: Long-term, community-based epidemiological studies with robust objective exposure assessment are needed. Still, the evidence linking chronic exposure to H₂S in the ppb range with negative health effects, especially considering potential effects on sensitive populations, suggests that more stringent guidelines and standards are needed to protect communities.

Keywords: air pollution, long-term exposure, environmental epidemiology, exposure assessment



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 29

Environmental Policy-relevant Research

Chairs: Martin Tondel, Sweden & Melissa Fiffer, United States

O-TO-162

Exposures » Occupational exposures

GFR decline and prior dysuria among Nicaraguan sugarcane workers

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BACKGROUND AND AIM: Nicaraguan sugarcane workers have an elevated prevalence of chronic kidney disease of unknown origin, referred to as Mesoamerican Nephropathy (MeN). Work in the sugarcane industry involves exposure to climatic heat and strenuous physical labor, suspected contributors to the development of MeN. These same factors may increase the risk of dysuria, thought due to crystalluria, which in other disease states has been associated with acute kidney injury. In a longitudinal study of sugarcane workers, we examined whether experiencing dysuria was associated with subsequent reduced kidney function.

METHODS: At a sugarcane company in Nicaragua, we abstracted employment and medical records for 190 male workers (1997–2010). Dates worked, jobs held, and medical data were collected. Estimated glomerular filtration rate (eGFR) was categorized as a binary outcome, first analyzed as <90 (includes mild and moderate eGFR reduction) and then analyzed as <60 (focused on moderate eGFR reduction) mL/min/1.73m². To examine the association between prior dysuria diagnosis (ever/never) and reduced eGFR, logistic regression based on generalized estimating equations for repeated events was used to estimate the odds ratio (OR) and the 95% confidence interval (CI), controlling for age, cumulative harvest seasons worked, proportion seasons worked as cane cutter, and period of the harvest season.

RESULTS: A total of 1,676 eGFR measurements were available for 190 workers. There were 134 workers with at least one dysuria diagnosis, and 72% of eGFR measures were preceded by a dysuria diagnosis. eGFR < 90 [adjusted OR=2.27 (95% CI 1.40, 3.67)] and eGFR < 60 [adjusted OR=3.87 (95% CI 1.81, 8.25)] were both associated with having a prior dysuria episode.

CONCLUSIONS: Experiencing dysuria was associated with an increased risk of reduced eGFR. These findings suggest that crystalluria may contribute to subsequent transient changes in kidney function, though more research is warranted.

Keywords: Temperature, Occupational Epidemiology, Cardiovascular diseases, International collaboration, Climate



ABSTRACT E-BOOK

August 26, 2021 / 13:30 - 15:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 29

Environmental Policy-relevant Research

Chairs: Martin Tondel, Sweden & Melissa Fiffer, United States

O-TO-163

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

The global distribution of pesticide poisoning: Implications for vulnerable populations, environmental health and equality in a shifting global policy climate

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BACKGROUND AND AIM: Human poisoning by pesticides has long been seen as a severe public health problem. As early as 1990, a task force of the World Health Organization (WHO) estimated that about one million unintentional pesticide poisonings occur annually, leading to approximately 20,000 deaths. Thirty years on there is no up-to-date picture of global pesticide poisoning despite an increase in global pesticide use. Our aim was to systematically review the prevalence of unintentional, acute pesticide poisoning (UAPP), and to estimate the annual global number of UAPP.

METHODS: We carried out a systematic review of the scientific literature published between 2006 and 2018, supplemented by mortality data from WHO. We extracted data from 157 publications and the WHO cause-of-death database, then performed country-wise synopses, and arrived at annual numbers of national UAPP. World-wide UAPP was estimated based on national figures and population data for regions defined by the Food and Agriculture Organization (FAO).

RESULTS: In total 141 countries were covered, including 58 by the 157 articles and an additional 83 by data from the WHO Mortality Database. Approximately 740,000 annual cases of UAPP were reported by the extracted publications resulting from 7,446 fatalities and 733,921 non-fatal cases. On this basis, we estimated that about 385 million cases of UAPP occur annually world-wide including around 11,000 fatalities. Based on a worldwide farming population of approximately 860 million this means that about 44% of farmers are poisoned by pesticides every year.

CONCLUSIONS: Our study updates outdated figures on world-wide UAPP. Along with other estimates, robust evidence is presented that acute pesticide poisoning is an ongoing major global public health challenge. There is a need to recognize the high burden of non-fatal UAPP, particularly on farmers and farmworkers, and that the current focus solely on fatalities hampers international efforts in risk assessment and prevention of poisoning.

Keywords: Pesticide, Poisoning, Occupational, Farmer, Farmworker, Agriculture



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 30

Temperature and Health

Chairs: Antonio Gasparini, & Robbie Parks, United States

O-TO-164

Climate » Temperature

Ambient warming and human sleep duration and timing: a worldwide case-crossover study using big data from wearable devices

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BACKGROUND AND AIM: Only limited self-report evidence links outdoor temperatures with alterations in sleep. We aimed to assess the attributable impact of nighttime minimum temperature on objectively recorded sleep outcomes.

METHODS: In a global natural experiment, we linked over 10 billion minute-level sleep measurements comprising 7.41 million nightly sleep records (n=47,628) from accelerometer-based wristbands to daily meteorological data across 68 countries between 2015 and 2017. We used person-level longitudinal panel fixed effects models to isolate the within-person sleep impact attributable to nighttime temperature. The primary endpoints were sleep timing and total time asleep.

RESULTS: Controlling for potential device-specific, person-specific, location-specific, and temporal confounds, warmer temperatures were associated with reduced sleep duration across the observed temperature distribution. Within-person sleep duration declined by 6.11 minutes per every 10°C increase when nighttime minimum temperatures exceeded 10°C. During nights over 25°C, sleep onset was delayed by 5.92 minutes, sleep offset advanced by 2.51 minutes and the probability of short <7hr sleep increased by 3.50 percentage points compared to the median temperature reference range of 5-10°C. The negative relationship between a 1°C increase in ambient temperature and sleep duration was more acute for the elderly compared to middle aged adults, for females compared to males, and residents of lower income countries compared to residents of high income countries. There was no evidence for short term acclimatization or intraday sleep substitution with daytime rest.

CONCLUSIONS: Warmer nighttime ambient temperatures were associated with reduced and delayed sleep. This evidence suggests a plausibly causal pathway through which rising temperatures may contribute to global health inequalities if unmitigated climate change continues. Employing 21 global climate models, we project that climate change may cumulatively erode adult sleep by 23.40 hours (warmest regions) to 5.40 hours (coldest regions) annually under a high emissions scenario, barring further adaptation.

Keywords: Climate, Big Data, Mental health outcomes, Causal inference, Sleep



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 30

Temperature and Health

Chairs: Antonio Gasparrini, & Robbie Parks, United States

O-TO-165

Climate » Temperature

Urbanization and Heat-mortality risk in Korea and Japan

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BACKGROUND AND AIM: The complex role of urbanisation in heat-mortality risk has not been fully studied. Korea and Japan have experienced a rapid population densification in metropolitan areas and the resultant disparities between metropolitan and non-metropolitan areas have intensified. We investigated the multi-dimensional effects urbanization on heat-mortality risk using nationwide data.

METHODS: We collected time-series data for mortality and weather variables for all 229 districts in Korea (2011-2017) and 47 prefectures in Japan (1980–2015). We used a distributed lag nonlinear model to calculate the heat-mortality risk. Population density and population size were used as indicators of urbanization level. We also examined neighborhood characteristics that can be related to the spatial heterogeneity in heat-mortality risk.

RESULTS: In Korea, we found a U-shaped association between population density and heat-mortality risk with the highest risk for rural populations; in urban areas, risk increases with increasing population density. Higher heat-mortality risk was associated with a lower number of hospital beds per person and higher % people requiring recuperation. In Japan, population growth has intensified in the metropolitan areas since the 2000s, and the highest heat-mortality risk was observed in the metropolitan areas at the same period. Higher apartment % and lower forest area and medical services were associated with higher heat-mortality risk in Japan.

CONCLUSIONS: Our findings indicate that the association between urbanization and heat-mortality risk is different in Korea and Japan; however, in both countries, people living in metropolitan areas showed higher vulnerability to heat than people living in non-metropolitan urban areas, and the limited accessibility to medical services was associated with the higher heat risk in metropolitan areas.

Keywords: Urbanization, Urban-Rural Disparity, Heat-Mortality Risk, Urban Development, Heat Action Policies



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 30

Temperature and Health

Chairs: Antonio Gasparrini, & Robbie Parks, United States

O-TO-166

Climate » Temperature

Vulnerability factors driving differential patterns in the heat-related mortality between rural and urban areas in Switzerland

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BACKGROUND AND AIM: Heat-mortality association has shown to be highly variable across geographies suggesting potential disparities in adaptive capacity or vulnerability of populations between and within countries. Understanding these factors can help us clarify potential adaptive mechanisms and help design tailored public health interventions to protect vulnerable populations from climate change. Here we performed a high-resolution nationwide epidemiological assessment to identify spatial patterns in the heat-related vulnerability and assess whether urban and rural districts share similar vulnerability factors.

METHODS: We modelled the heat-mortality association using distributed lag non-linear models over daily temperature-mortality series between May-September 1990-2017 in each municipality in Switzerland. We performed a multivariate meta-regression using a wealth of demographic, socioeconomic, topographic, climatic, land use and other environmental data available for each geographic unit. We ran stratified analyses by urban and rural areas and assessed differential patterns through interaction models between urban/rural areas and the various vulnerability factors.

RESULTS: In this nationwide analysis, we found slightly larger heat-mortality risks in urban areas (RR=1.37(95%CI:1.28-1.46)) vs rural(1.26(95%CI:1.16-1.36)), defined as the risk at the 99th percentile vs. the temperature of minimum mortality. However, our preliminary findings suggest similar patterns in meta-predictors explaining vulnerability to heat across urban and rural regions(i.e.interaction terms were not statistically significant). Overall, we found larger heat-mortality risks associated with higher levels of PM2.5, percentage of foreign population, proportion of impervious surfaces, average temperature, population density and limited access to health care.



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ABSTRACT E-BOOK

CONCLUSIONS: Our preliminary findings suggest that population living in urban areas in Switzerland may be more vulnerable to heat, compared to rural locations, and within each type of region similar vulnerability factors may play a role. This would suggest that (1) there would not be large polarizations in risks and vulnerability factors across regions in Switzerland, and (2) even in rural locations factors associated with more urbanized environment may exacerbate the risks.

Keywords: heat, adaptation, mortality, climate change



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 30

Temperature and Health

Chairs: Antonio Gasparini, & Robbie Parks, United States

O-TO-167

Climate » Temperature

Effects of long-term average temperature and temperature variability on cardiovascular disease hospitalizations in the US Medicare population

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BACKGROUND AND AIM: Numerous studies have shown short-term exposure to extreme temperature is associated with increased mortality and morbidity. Less is known about effects of long-term exposure to warm or cold temperatures. Our aim was to evaluate associations of long-term temperature exposure and temperature variability with cardiovascular disease (CVD) hospitalizations.

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 used data from the 4km Gridded Surface Meteorological dataset to assess the annual (January-December), summer (June-August), and winter (December-February) average temperature and temperature variability (standard deviation) for each year for each zip code. Cox-equivalent Poisson models were used to estimate associations with first CVD, coronary heart disease (CHD) or cerebrovascular disease (CBV) hospitalization, after adjustment for potential confounders (including individual and area-level SES indicators).

RESULTS: Higher annual average and summer average temperatures were associated with an increased risk of CVD, CHD and CBV hospitalization. Lower winter average temperatures were associated with an increased risk of CVD and CHD hospitalization, but a decreased risk of CBV hospitalization. For CVD hospitalization, we found a HR of 1.07 (95%CI: 1.06, 1.07) per IQR increase (8.1°C) for annual average temperature, a HR of 1.03 (95%CI: 1.03, 1.04) per IQR increase (5.2°C) for summer average temperature, and a HR of 0.97 (95%CI: 0.97, 0.98) per IQR increase (11.7°C) for winter average temperature.



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Higher annual and winter temperature variability and lower summer temperature variability were associated with an increased risk for all outcomes. Associations were modified by age, race, air pollution and greenness.

CONCLUSIONS: Warmer annual and summer average temperatures and cooler winter average temperatures were associated with an increased risk of CVD hospitalizations. Higher annual and winter temperature variability and lower summer temperature variability were also associated with increased risk.

Keywords: temperature, temperature variability, Cardiovascular diseases



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 30

Temperature and Health

Chairs: Antonio Gasparini, & Robbie Parks, United States

O-TO-168

Climate » Temperature extremes and variability

Adapting to the heat? Extreme temperature and birth outcomes over time in Spain, 1985-2016

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BACKGROUND AND AIM: Extreme temperatures affect women's birth outcomes increasing the likelihood of low birth weight and preterm birth. Moreover, the relationship appears particularly pronounced when looking at extreme heat, raising concerns in light of future global warming. Nevertheless, humans actively adapt to the local weather and to changes in the climate through technological and behavioral responses. Until now, research on pregnant women's adaptation to temperature is lacking. Here, we aim to understand how the risks of Low Birth Weight (LBW) related to extreme temperature changed over time in Spain.

METHODS: We collected administrative data on 5 million urban singleton births between 1985 and 2016 and we combined them with precise meteorological information provided by local meteorological stations. We measure exposure to temperature by trimester of pregnancy and run two main analysis using linear probability models. With the first model we assess the risk of LBW for the whole period of analysis. In the second model, we stratify the effect of temperature per three time periods 1985-1995, 1996-2005 and 2006-2016.

RESULTS: The pooled results do not show any substantive increase in the risks of LBW with extreme temperatures. However, when looking at the association between temperature and birth outcomes by period we observe an increase in the risk of LBW with exposure to days with mean temperature >30°C in the decade 1985-1995 but not subsequently. Moreover, the increase in LBW is mostly concentrated in the first trimester of pregnancy.

CONCLUSIONS: Finally, the results suggest adaptation to extreme temperature over time in the Spanish population of pregnant women.

Keywords: temperature, temperature extremes, birth outcomes.



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

TRADITIONAL ORAL SESSION 30

Temperature and Health

Chairs: Antonio Gasparini, & Robbie Parks, United States

O-TO-169

Climate » Temperature

Changing heat impacts on mortality and implications for mitigation planning in New York City

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New York City Department of Health and Mental Hygiene

BACKGROUND AND AIM: Heat mitigation planning requires careful characterization of the adverse impacts of temperature on health outcomes. New York City (NYC) has used observed temperature-mortality relationships to revise the city's heat advisory trigger threshold, but such assessment must be ongoing as temperatures rise.

METHODS: We analyzed 5-year rolling periods of weather and mortality data for May-September, 1997-2017 in NYC to estimate changes in cumulative relative risks (CRR) with up to 3-day lag and attributable deaths over time using both the extreme heat event (EHE) day indicator (0/1) for NYC's heat advisory threshold ($\geq 35^{\circ}\text{C}$ for two days or $\geq 38^{\circ}\text{C}$ for any duration) and a continuous daily maximum heat index (or maximum temperature when heat index was unavailable), or MAX, using quasi-Poisson distributed lag non-linear models. For MAX, we used the median for the entire period (28°C) as reference, estimated CRRs at 37°C (median temperature of days above 35°C), compared to EHE CRR, and estimated attributable deaths for all days above 28°C .

RESULTS: CRRs for both EHE and MAX have been comparable and stable (~ 1.08) in the recent decade and lower than in earlier periods (~ 1.10). The number of EHE days were stable over the study period (~ 10 days/year), while non-EHE summer days (28°C to less than 35°C) have been increasing (57 days in 1997-2001 vs. 74 days in 2013-2017). The estimated attributable deaths for MAX mirror the warming climate, increasing since 1997, and surpassing those for EHE in recent years (267 MAX vs 94 EHE for 2013-2017).

CONCLUSIONS: Estimated excess deaths due to non-EHE days are larger than those for EHE days and increasing. In NYC, where the overall air conditioning prevalence is greater than 90%, near-term heat mitigation should focus on addressing inequities in air conditioning and energy insecurity in the most-impacted communities along with other structural heat mitigation strategies beyond emergency response.

Keywords: temperature, mortality, extreme heat, attributable deaths, heat mitigation



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 31

Exposure to Metals and Adverse Health Outcomes

Chairs: Tiffany Sanchez, United States & Meghan Tipre, United States

O-TO-170

Chemical exposures » Heavy metals

Association between prenatal metals exposure and childhood lung function

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BACKGROUND AND AIM: Previous cross-sectional research has shown metals are associated with decreases in lung function in children. The influence of prenatal metals exposure on childhood lung function remains understudied. This study aimed to determine if prenatal metals exposure predicts childhood lung function, and assess effect modification by child sex.

METHODS: We assessed 217 mother-child dyads enrolled in the Programming Research in Obesity, Growth, Environment, and Social Stressors birth cohort in Mexico City. Maternal blood samples were measured for lead, arsenic, and manganese in pregnant women during their 2nd trimester using plasma-mass spectrometry. Between 8-11 years of age, lung function was tested by pre- and post-bronchodilator spirometry. Outcomes included z-scores for forced expiratory volume in one second (FEV1), forced vital capacity (FVC), FEV1/FVC and forced expiratory flow at 25-75% of the pulmonary volume (FEF25-75) in separate models. We conducted multiple linear regression to evaluate the association between prenatal metals and post-bronchodilator childhood lung function adjusting for maternal age, education, and environmental tobacco smoke exposure and mutually adjusting for other metals. Models were then stratified by child sex to assess effect modification.

RESULTS: Prenatal blood lead (1.13±0.60) was marginally associated with lower FEV1 (β -0.20, 95% CI: -0.43, -0.03), and lower FVC (β : -0.20, 95% CI: -0.42, 0.03). We did not find significant main effects of arsenic or manganese on lung function outcomes. When stratified by sex, lead was associated with lower FEF25-75% (β : -0.27, 95% CI: -0.53, -0.02) among boys but not in girls (β : 0.07, 95% CI: -0.32, 0.46).



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ABSTRACT E-BOOK

CONCLUSIONS: Prenatal lead was marginally associated with decreased lung function in childhood and appeared to be modified by child sex. These findings underscore the need to consider prenatal metal effects on childhood lung function.

Keywords: children's environmental health, heavy metals, pediatric lung function



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 31

Exposure to Metals and Adverse Health Outcomes

Chairs: Tiffany Sanchez, United States & Meghan Tipre, United States

O-TO-171

Exposures » Multi-pollutant/Multi-media

Metal co-exposures and telomere length in Bangladeshi children

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BACKGROUND AND AIM: Telomeres are non-coding DNA sequences that protect the ends of chromosomes and preserve genetic material during cell division. Telomere length is associated with the occurrence and progression of common chronic diseases. In younger populations, telomere length may represent a biomarker of disease susceptibility. Growing evidence suggests that environmental factors, such as metals, can substantially impact the mechanisms that control telomere length.

METHODS: We investigated the association between a panel of metals measured in toenail samples by inductively-coupled plasma mass spectrometry and leukocyte relative telomere length (RTL) measured by Luminex assay, among 472 five- to seven-year-old children enrolled in the Bangladesh Environmental Research in Children's Health (BiRCH) cohort.

RESULTS: Of the 18 metals tested, statistically significant correlations with RTL were observed with toenail arsenic (tAs) and mercury (tHg). In linear regression models adjusted for child age, sex, and father's age at child's birth, a doubling of log₂-transformed tAs was associated with a -0.022 (95% CI: -0.033, -0.011; p=0.0001) decrease in RTL. Similarly, a doubling of log₂-transformed tHg was associated with a -0.020 (95% CI: -0.032, -0.007; p=0.002) decrease in RTL. Similar associations were observed using co-exposure regression models including both tAs and tHg, adjusted for covariates. In this model, we observed independent, negative associations of both log₂-transformed tAs and tHg with RTL, such that a doubling of tAs was associated with a -0.019 (95% CI: -0.031, -0.007; p=0.003) decrease in RTL and a doubling of tHg was associated with a -0.015 (95% CI: -0.028, -0.002; p=0.02) decrease in RTL.

CONCLUSIONS: Our study suggests that both As and Hg may independently influence RTL, with detectable associations in early- to mid-childhood. Further studies are needed to confirm our findings and investigate the potential long-term impacts of As- and Hg- exposure associated telomere shortening in childhood on health outcomes in adult life.

Keywords: metals, telomeres, toenails, Bangladesh, children



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TRADITIONAL ORAL SESSION 31

Exposure to Metals and Adverse Health Outcomes

Chairs: Tiffany Sanchez, United States & Meghan Tipre, United States

O-TO-172

Chemical exposures » Mixtures

Prenatal Exposure to Toxic Metal Mixtures and Risk of Bacterial Sepsis in Extremely Low Gestational Age Newborns

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BACKGROUND AND AIM: Prenatal exposures to toxic metals (and metalloids) have been linked to altered immune function in animal studies, but few epidemiologic studies have investigated immunological effects in humans. We evaluated the risk of bacterial sepsis – an extreme immune response to bacterial infection – in relation to prenatal toxic metal exposures, individually and jointly, among a US-based cohort of infants born extremely preterm.

METHODS: We analyzed 237 participants enrolled in the ELGAN cohort, which recruited infants delivered before 28 weeks gestation from 14 hospitals during 2002-2004. The infants were followed from birth to postnatal day 28 with bacterial culture results reported weekly. Arsenic, cadmium, lead, and mercury concentrations were measured in umbilical cord tissue samples using inductively coupled plasma tandem mass spectrometry. We fit discrete-time hazard models to estimate associations between the sepsis incidence and individual metal quartiles, as well as a weighted quantile sum regression model for metal mixtures.

RESULTS: Seventy (32%) of the extremely preterm infants developed sepsis during the follow-up period (median follow-up time: 2 weeks). After adjustment for maternal age, educational attainment, public health insurance status (a proxy for income), and smoking during pregnancy, only cadmium was individually associated with sepsis risk. Comparing the highest to lowest quartile, the hazard ratio (HR) for cadmium was 1.97 (95% CI: 1.00-3.99). The weighted quantile sum index was also associated with a higher incidence of sepsis (HR=1.36, 95% CI: 1.06-1.74); consistent with analyses of individual metals, the metal that was most highly weighted in the index was cadmium.

CONCLUSIONS: Prenatal exposures to toxic metals, particularly cadmium, were prospectively associated with an increased risk of bacterial sepsis among infants born extremely preterm. Future research should examine whether increasing intakes of essential trace elements (e.g., zinc) during pregnancy or after delivery could counteract the apparent immunotoxicity of prenatal toxic metal exposures.

Keywords: Mixtures, Heavy metals, Infectious diseases, Birth outcomes, Environmental epidemiology



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 31

Exposure to Metals and Adverse Health Outcomes

Chairs: Tiffany Sanchez, United States & Meghan Tipre, United States

O-TO-173

Chemical exposures » Heavy metals

Urinary Metal Mixtures and Incident Metabolic Syndrome in Midlife Women: the Study of Women's Health Across the Nation (SWAN)

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BACKGROUND AND AIM: Exposure to metals may contribute to the development of metabolic syndrome (MetS); however, evidence from midlife women who are at greater risk of cardiometabolic disease is limited. We prospectively examined the associations of 15 urinary metal concentrations with incident MetS in the Study of Women's Health Across the Nation Multi-Pollutant Study.

METHODS: The sample included 947 White, Black, Chinese and Japanese women from 5 study sites in the United States, aged 45-56 years and free of MetS at baseline (1999-2000), followed through 2017. Urinary concentrations of 15 metals, including arsenic, barium, cadmium, cobalt, cesium, copper, mercury, manganese, molybdenum, nickel, lead, antimony, tin, thallium, and zinc, were quantified at baseline. Incident MetS was identified annually as the presence of at least 3 of the following 5 components: high blood pressure, impaired fasting glucose, abdominal obesity, high triglycerides, and low high-density lipoprotein cholesterol.

RESULTS: After adjustment for potential confounders, the hazard ratios (HR) (95% confidence interval (CI)) for MetS associated with each doubling of urinary metal concentration was 1.14 (1.08, 1.23) for arsenic, 1.14 (1.01, 1.29) for cobalt, and 1.20 (1.06, 1.37) for zinc, in Cox proportional hazards models. Positive associations of urinary arsenic with high blood pressure and impaired fasting glucose, positive associations of urinary cobalt with high blood pressure and abdominal obesity, and positive associations of urinary zinc with high blood pressure, impaired fasting glucose, abdominal obesity, and high triglyceride were observed. In the quantile-based g-computation assessing the joint effect of metal mixtures, increasing urinary arsenic, cobalt, and zinc concentrations by one quartile was associated with a higher incidence of MetS (HR=1.73, 95% CI: 1.21, 2.48).

CONCLUSIONS: Higher urinary arsenic, cobalt, and zinc concentrations were associated with an elevated incidence of MetS in midlife women. Future studies should confirm these findings and further investigate the underlying mechanisms.

Keywords: Metals, mixtures, metabolic syndrome, women, cohort study.



ABSTRACT E-BOOK

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Exposure to Metals and Adverse Health Outcomes

Chairs: Tiffany Sanchez, United States & Meghan Tipre, United States

O-TO-174

Exposures » Multi-pollutant/Multi-media

Environmental metals and metal mixtures and renal disease in an adult population from Spain: the Aragon Workers Health Study

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BACKGROUND AND AIM: Disproportionally high exposures to arsenic (As), cadmium (Cd) and lead are nephrotoxic. However, epidemiological studies evaluating low-chronic exposure, especially for other metals, are limited. We assessed the cross-sectional and prospective associations of a panel of metals, individually and as mixtures, with albuminuria and estimated glomerular filtration rate (eGFR), two well-established markers of renal function.

METHODS: 1519 participants from the Aragon Worker's Health Study had available cobalt (Co), copper (Cu), molybdenum (Mo), zinc (Zn), As, barium (Ba), Cd, chromium (Cr), antimony (Sb), titanium (Ti), uranium (U), vanadium (V) and tungsten (W) urinary measurements. In a subset of 707 participants with available follow-up, we estimated annual-average increase of urine albumin and eGFR. The joint association of metals were evaluated implementing Bayesian Kernel Machine Regression (BKMR) methods.



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RESULTS: Median metal levels were 0.24, 7.0, 18.6, 295, 3.1, 1.9, 0.25, 0.99, 0.20, 9.7, 0.03, 0.50, 0.22 $\mu\text{g/g}$ creatinine for Co, Cu, Mo, Zn, As, Ba, Cd, Cr, Sb, Ti, U, V and W, respectively. Increased urinary Co, Cu, Zn, As, Cr, Ti, U and W were associated with higher odds of albuminuria ≥ 30 mg/g. In BKMR analysis, these associations seemed to be driven by W, As and Zn. In prospective analyses, increased Cu, As and Cr were also related with higher odds of annual-increase albumin excretion $\geq 20\%$. For eGFR, the prospective association with annual-eGFR change [mean difference in change (95% confidence interval)] was not statistically significant for most metals except for As [-0.35 (-0.70, -0.001)], Zn [-0.31 (-0.61, -0.01)] and Ba [0.38 (0.09, 0.67)], directionally consistent with and without urine creatinine adjustment.

CONCLUSIONS: We identified W, As, Zn and Cr exposures as potential risk factors of renal dysfunction. Exposure reduction and mitigation interventions of metals may decrease renal disease risk.

Keywords: Heavy metals, Epidemiology, Outcomes



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Exposure to Metals and Adverse Health Outcomes

Chairs: Tiffany Sanchez, United States & Meghan Tipre, United States

O-TO-175

Chemical exposures » Heavy metals

Cadmium and lead exposure and risk of dementia in a Swedish population-based cohort: The Malmö Diet and Cancer Study

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BACKGROUND AND AIM: Elevated cadmium and lead exposure is toxic for the brain, but it is unclear if low-dose exposure increases the risk of dementia. We aim at examining the association between blood cadmium and lead at baseline and risk of dementia after a follow-up period of up to 23 years in a population-based cohort with cadmium and lead exposure comparable to those of most European countries and the U.S.

METHODS: A Swedish population-based cohort (n=4,331, age 46-67 years) was recruited in 1991-1994. All-type dementia diagnoses, Alzheimer's disease, vascular disease and mixed dementia (vascular and Alzheimer's disease) were retrieved through December 2014. Associations with blood cadmium and lead (in quartiles, Q1-4) were analyzed using Cox regression and adjusted for potential confounders and known risk factors for dementia (age, sex, education level, systolic blood pressure, body mass index, diabetes mellitus, statin treatment, hypertension treatment, APOE ε4 and smoking).

RESULTS: Multivariable-adjusted hazard ratios (HR) for all-type dementia were increased among women in the 4th quartile of blood cadmium (median 1.0 µg/L) compared with those in the 1st quartile (HR 1.92, 95% CI 1.12, 3.31) but were not statistically significant when considering all individuals or only men. Hazard ratios were also increased for vascular dementia when considering all individuals (HR 2.38, 95% CI 1.03, 5.49, Q4 of blood cadmium vs Q1) as well as only women (HR 4.7, 95% CI 1.39, 16.3 Q4 of blood cadmium vs Q1), but no associations were found among men. No associations were found for lead nor for cadmium in relation to Alzheimer's disease or mixed dementia.

CONCLUSIONS: Blood cadmium in the highest quartile was associated with an increased risk of all-type dementia and vascular dementia in our population-based samples of Swedish adults. Associations were restricted to women. Our findings strengthen the need of measures to further reduce cadmium exposure in the general population.

Keywords: Heavy metals, environmental epidemiology, neurodegenerative outcomes, chemical exposures.



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Infections (including COVID-19) and the Environment

Chairs: Manolis Kogevinas, Spain & Olayinka Osuolale, Nigeria

O-TO-176

Exposome » External exposome

Applying a multiple exposures framework to explore complex spatial inequalities of Covid-19-related excess mortality in Lombardy region of Northern Italy

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BACKGROUND AND AIM: Spatial inequalities of mortality rates caused by Covid-19 have been observed in many countries, including Italy. While such spatial inequalities may be influenced by a combination of multiple place-based factors, studies thus far have used only conventional multivariable regression approaches to explore spatial determinants of Covid-19-related mortality.

METHODS: We use mortality data from all of 2020 and model excess mortality using the previous 5-year mortality average for each municipality in Italy's Lombardy region. Using Bayesian profile regression (BPR), a non-parametric clustering algorithm, we fit 19 spatial covariates to identify clusters of municipalities with similar 'spatial exposure profiles' and explore which exposure profiles are associated with either a higher or lower adjusted risk of excess mortality during the pandemic year (2020). These 19 spatial covariates include six air pollutants and a variety of socio-demographic factors, land use indicators, and health facility contextual information.

RESULTS: BPR resulted in 23 clusters of exposure profiles. Controlling for spatial autocorrelation and health protective agency, we find that the highest risk cluster, located in the sparsely populated southern sub-region of Pavia province, has the highest proportion of their population 65 years or older and is characterized with elevated ozone and SO₂ air pollutant levels, and has relatively low access to health facilities. Clusters with elevated levels of three or more air pollutants exhibited significantly elevated excess mortality risk only if they were in densely populated urban areas, if the air pollutants appeared to be traffic-related, and if they were located further away from major capital cities of Lombardy provinces.

CONCLUSIONS: Our results suggest a complex web of spatial determinants that interact to influence spatial inequalities of Covid-19-related excess mortality in Italy's Lombardy region. Studies must apply a multiple exposures framework to help unravel the complex and multi-dimensional nature of spatial inequalities of Covid-19 impacts on public health.

Keywords: Covid-19, air pollution, inequalities, exposome



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Infections (including COVID-19) and the Environment

Chairs: Manolis Kogevinas, Spain & Olayinka Osuolale, Nigeria

O-TO-177

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

Ambient air pollution and risk of SARS-CoV-2 infection and of COVID-19 disease in a cohort study in Catalonia (COVICAT Cohort)

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BACKGROUND AND AIM: Air pollution has been associated with a higher risk of COVID-19 in ecological studies. We examined the association of pre-pandemic air pollution with SARS-CoV-2 infection, immunological response, and COVID-19 disease in a general population cohort.

METHODS: 9,605 adult participants from a general population cohort in Catalonia were contacted post-lockdown in June-November 2020 and administered web- or telephone-based questionnaires. We drew blood samples from 4090 participants, and determined IgG, IgM, and IgA antibodies for five viral target antigens (Luminex assay). We defined disease as previous diagnoses or hospital admission with COVID-19, or reporting 4 or more COVID-19 symptoms. We used the ELAPSE model to assess annual pre-pandemic (2010) exposure to particulate matter (PM_{2.5}), NO₂, Black Carbon (BC), and O₃. We calculated log-binomial Relative Risks (RR) adjusting for age, sex, type of questionnaire, individual and area-based socioeconomic status, and lifestyle factors.

RESULTS: Of the 9,605 participants 481 (5.0%) had COVID-19 disease. Among those tested for SARS-CoV-2 antibodies, 743 (18.1%) had been infected. There were no associations between air pollutants and SARS-CoV-2 infection: increases in average annual levels of 5µg/m³ of NO₂ and PM_{2.5} and 1µg/m³ of BC were associated with RRs (95%CI) of 1.02 (0.98-1.06), 1.07 (0.85-1.35) and 1.08 (0.92-1.29) respectively. Among infected participants, increasing air pollutant levels were associated with higher IgG responses. Air-pollutants were associated in the overall population with increased risk of COVID-19 disease with RRs of 1.07 (95%CI 1.02-1.11) for NO₂, 1.45 (1.07-1.97) for PM_{2.5}, and 1.28 (1.02-1.59) for BC. O₃ was associated with a slightly decreased risk (RR=0.98, 0.97-1.00). We observed similar results among those infected. We observed slightly higher risks of COVID-19 disease associated with air-pollutants in obese participants and those with lower socioeconomic position.

CONCLUSIONS: Exposure to pre-pandemic air-pollutants was associated with a higher risk of COVID-19 disease although not associated with a higher risk of SARS-CoV-2 infection.

Keywords: COVID-19, SARS-CoV-2, immunology, air-pollution, cohort



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Infections (including COVID-19) and the Environment

Chairs: Manolis Kogevinas, Spain & Olayinka Osuolale, Nigeria

O-TO-178

Air pollution » Short-term exposure

Impact of the COVID-19 lockdown policies on reducing air pollution levels and related deaths in Europe

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BACKGROUND AND AIM: Previous studies have reported a decrease in air pollution following the enforcement of lockdown measures during the first wave of the COVID-19 pandemic. However, these investigations were mostly based on simple pre-post comparisons using past years as a reference, and did not assess the role of different policy interventions. In this contribution, we quantitatively



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evaluated the association between various lockdown measures and the decrease in NO₂, O₃, PM_{2.5}, and PM₁₀ levels across 47 European cities and the associated short-term mortality in the period of February-July 2020.

METHODS: We used data from several chemical transport models developed by the Copernicus Atmosphere Monitoring Service (CAMS) to define trends in air pollution under business-as-usual and lockdown scenarios, thus removing differences due to weather conditions and other differences affecting pre-post comparisons. We then applied an advanced spatio-temporal Bayesian non-linear mixed effect model to determine the association with stringency indices of individual policy measures, allowing non-linear relationships and geographical correlations.

RESULTS: The findings indicate evidence of non-linear relationships, with a stronger decrease in NO₂ and to a lesser extent PMs under very strict lockdown regimes. The effects of lockdown measures vary geographically, with a stronger decline in pollution in Southern and Central Europe. The comparative analysis of separate lockdown policies suggests important differences across interventions. Specifically, actions linked to school/workplace closure, limitations on gatherings, and stay-at-home requirements had strong effects, while restrictions on internal movement and international travels showed little impact. The observed decrease in pollution potentially resulted in hundreds of avoided deaths across the European cities.

CONCLUSIONS: This study provides important evidence on the differential impacts of various policies implemented during the COVID-19 pandemic in decreasing the level of pollutants in urban areas across Europe.

Keywords: air pollution decline, Covid-19 Government Response, chemical transport model, Bayesian mixed effect model, mortality



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Infections (including COVID-19) and the Environment

Chairs: Manolis Kogevinas, Spain & Olayinka Osuolale, Nigeria

O-TO-179

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

Longer- and Shorter-term Air Pollution Exposure Associated with COVID-19 Severity and Mortality: A Large Cohort Study in Southern California

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BACKGROUND AND AIM: A growing number of ecological studies have suggested that air pollution contributes significantly to the COVID-19 incidence and mortality. To address the limitations of ecological analysis, this study aims to investigate the associations of longer- and shorter-term air pollution exposures with COVID-19 severity and mortality and explore effect modification by social-demographics using individual-level data from a large multi-ethnic cohort.

METHODS: The retrospective cohort includes 75,010 individuals (mean age 42.5 years, 54% female, 66% Hispanic) diagnosed with COVID-19 at Kaiser Permanente Southern California between 3/1/2020-8/31/2020. Ambient air pollutant (PM_{2.5}, NO₂ and O₃) exposures prior to the COVID-19 diagnosis date were estimated based on residential address history using inverse distance-squared weighted averages of central monitor data. Longer-term exposure was defined as 1-year and 4-year averages; shorter-term exposure was defined as 1-week and 1-month averages prior to COVID-19 diagnosis. Primary outcomes were COVID-19 severity defined as COVID-19-related hospitalizations, intensive respiratory support, intensive care unit admissions within 30 days, mortality within 60 days after COVID-19 diagnosis.

RESULTS: Longer-term PM_{2.5} and shorter-term NO₂ exposures were significantly associated with COVID-19 severity and mortality in multi-pollutant models adjusted for confounders. One standard deviation (SD) increase in 1-year PM_{2.5} exposure was associated with a 24-38% (p<.0001) increased odds for severity and a 17% (p<.01) increased hazard for mortality. Prior 4-year PM_{2.5} exposure was also significantly associated with COVID-19 severity. One SD increase in 1-month NO₂ exposure was associated with 12-24% (p<.0001) increased odds for severity and 14% (p<.05) increased hazard for mortality. Prior 1-week NO₂ exposure was also significantly associated with COVID-19 outcomes. No significant interactions with sex or ethnicity were observed; however, significant interaction with 1-month PM_{2.5} exposure was observed for larger associations in individuals age 65+ years.

CONCLUSIONS: Data from this large cohort showed that ambient air pollutants are important factors affecting COVID-19 severity and mortality.

Keywords: PM_{2.5}, NO₂, COVID-19, short-term, long-term, Air Pollution



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Infections (including COVID-19) and the Environment

Chairs: Manolis Kogevinas, Spain & Olayinka Osuolale, Nigeria

O-TO-180

Methods » Environmental epidemiology

Associations between SARS-CoV-2 concentration in wastewater and sludge and measures of COVID-19 cases in three communities

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BACKGROUND AND AIM: COVID-19 is an ongoing public health crisis in the United States, and wastewater-based epidemiology has evolved as a form of surveillance that can capture both symptomatic and asymptomatic cases. The aim of this study is to determine the association among concentrations of SARS-CoV-2 in wastewater and sludge and epidemiological measures of COVID-19.

METHODS: We used data from the Boston, Massachusetts (8/19/2020 to 1/19/2021), Portland, Maine (9/1/2020 to 3/2/2021), and New Haven, Connecticut (3/1/2020 to 7/1/2020) metropolitan areas. Massachusetts (population of approximately 3.1 million) and Maine (population of approximately 77,000) SARS-CoV-2 concentrations were measured from weekly or biweekly 24-hour composite samples of wastewater. The Connecticut SARS-CoV-2 concentrations were measured from daily primary sludge samples (copies/mL) from a facility that serves roughly 200,000 residents. Maine samples were not normalized to population size and values below the limit of detection (0.762 copies/mL) were determined to be half the detection limit. Massachusetts samples were normalized to the population using Pepper mild mottle virus. All samples were quantified using RT-qPCR. We used linear regression to assess the association between SARS-CoV-2 concentration in wastewater and sludge and COVID-19 regional incidence. All analyses were adjusted for day of week, temperature (Fahrenheit), precipitation (inches), and flow rate (millions of gallons per day; Massachusetts and Maine only). SARS-CoV-2 concentrations and COVID-19 cases were log-transformed.

RESULTS: The median (IQR) concentrations of SARS-CoV-2 were 312.0 (74.0, 858.2), 17.4 (5.5, 63.5), and 70996.87 (37911.53, 124461.7) copies/mL in Massachusetts, Maine, and Connecticut, respectively. SARS-CoV-2 concentrations in wastewater and sludge were significantly associated with incidence in Massachusetts ($\beta=0.56$; 95%CI=0.50, 0.63) and Connecticut ($\beta=0.74$; 95%CI=0.34, 1.14) and marginally significant in Maine ($\beta=0.22$; 95%CI=-0.002, 0.44; $p=0.05$).

CONCLUSIONS: SARS-CoV-2 concentrations in wastewater and sludge were associated with incidence in three communities in the Northeast of the United States.

Keywords: SARS-CoV-2, wastewater-based epidemiology, COVID-19, sludge



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Infections (including COVID-19) and the Environment

Chairs: Manolis Kogevinas, Spain & Olayinka Osuolale, Nigeria

O-TO-181

Policy » Research translation to affect policy and practice

Impact of COVID-19 on household energy use in Ghana

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BACKGROUND AND AIM: Different Governments' response to the COVID-19 pandemic is likely to have varying effects on different sectors of the economy including the energy sector. It is unknown how the pandemic and the different government response and control measures impacted on the clean energy landscape in Ghana. The aim of this study was to assess the impact of the COVID 19 pandemic on household access to and sustained use of clean energy for cooking in Ghana and also on the implementation of the government's Cylinder Recirculation Model (CRM).

METHODS: This was a cross-sectional study that employed a mixed-methods approach to data collection. The data collection was conducted in the Kintampo and Obuasi Municipalities of Ghana involving key players in the clean energy sector including households, LPG purveyors, and relevant policymakers and implementers. We adopted the Exploration, Preparation, Implementation and Sustainment (EPIS) implementation framework

RESULTS: Although the pandemic did not halt the implementation of the LPG CRM, it stalled the process in some ways. For instance, the building of large-scale bottling plants was stalled due to challenge with finding private capital to fund the project. Demand for LPG initially increased due to panic buying by households in anticipation of a lockdown. Supply did not change drastically because of measures put in place to allow personnel in the energy sector including LPG to continue to work even during the lockdown. Changes in household's income and expenditure during the pandemic were found to be associated with the choice of current cooking fuels and the use of LPG.

CONCLUSIONS: The findings of the study highlight the mitigating factors in the household energy sector during the pandemic, provide lessons that can improve the resilience of the sector to ensure sustained use of clean fuels and inform the implementation of clean energy programs during pandemics.

Keywords: COVID 19, household clean energy, Cylinder Recirculation Model, Ghana



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Environmental Health Disparities

Chairs: Rachel Morello-Frosch, United States & Kelvin Fong, United States

O-TO-182

Air pollution » Mixtures

Modification by Multiple Social Stressors in Air Pollution-CVD Associations

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BACKGROUND AND AIM: A growing literature explores variation in pollution susceptibility by chronic psychosocial stressors (e.g., poverty, violence). It is less explored, however, whether the confluence of multiple stressors – clustered in minority and lower-income urban communities via segregation processes – may compound susceptibility, or confound observed modification by any one stressor.

METHODS: We examined modification by multiple community stressors on relationships between spatio-temporal pollutant exposures and risk of cardiovascular (CVD) event in New York City, using conditional logistic regression in case-crossover, with time-stratified referent sampling. We used exhaustive data on all inpatient (admitted) CVD events presenting at NYC emergency departments from 2005-2011 (n = 837,523), fine-scale spatial maps for PM_{2.5}, NO₂, SO₂, and O₃ from NYC Community Air Survey, and daily EPA pollution and NOAA weather data. A range of stressor indicators were drawn from Census and administrative databases, examined against focus group and survey data to confirm relevance to residents' stress experience. Due to concern about stressors clustering by race and ethnicity (i.e., non-random assignment into tracts), we adjusted year-round models (NO₂ and PM_{2.5}) for modification by tract composition.

RESULTS: Testing stressors individually, we found significant associations between NO₂ and CVD risk only in communities in the highest quintile of violent crime, felony assault, poverty, or socioeconomic deprivation (SDI); associations in all other quintiles crossed the null, as did associations for all other pollutants. In models including separate interaction terms for violent crime and SDI, NO₂ was associated with significant increases in CVD risk in all quintiles. Associations for NO₂ modestly increased across quintiles of increasing violence, but not SDI.

CONCLUSIONS: Observed patterns of modification differed substantially when including multiple stressors modifiers, increasing observed NO₂-CVD associations overall. These results suggest a need to capture community stress experience more holistically, to reduce confounding across stressors which may dampen observed pollutant-health associations and modification.

Keywords: air pollution, mixtures, psychosocial stressors, segregation, case-crossover, cardiovascular disease (CVD)



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TRADITIONAL ORAL SESSION 33

Environmental Health Disparities

Chairs: Rachel Morello-Frosch, United States & Kelvin Fong, United States

O-TO-183

Climate » Temperature extremes and variability

Characterizing the spatial variability and vulnerability of heatwaves on ambulance callouts in Adelaide

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BACKGROUND AND AIM: High temperatures and heatwaves are associated with increased morbidity/mortality, and pose a substantial public health burden. Understanding the patterns of heatwave vulnerability at a fine spatial scale is essential to better target prevention strategies to areas with heightened vulnerability. This study aimed to investigate heatwave impacts on ambulance callouts in Adelaide at a small geographical level and identify area-level factors that influence the high morbidity risk within Adelaide.

METHODS: Ambulance callouts data during the warm-season (October-March) from 2007 to 2014 were obtained from the South Australian Department for Health and Wellbeing. A time-stratified case-crossover design was used to examine associations between heatwave-severity (defined using Excess Heat Factor) and ambulance callouts at the Statistical Area Level 2 (SA2) spatial unit (representing suburbs). Effect modification by neighbourhood characteristics was examined and city-level estimates were pooled using random-effects meta-analyses. Results are reported as the percent increase in risk according to heatwave-severity (low-intensity, severe/extreme) compared with non-heatwaves, and were then mapped to produce a spatial representation of risk.

RESULTS: A total of 377,125 ambulance callouts were included in the analysis. An exposure-response relationship was observed with ambulance callouts increasing by 5% (95%CI: 3-6%) and 8% (95%CI: 6-11%) during low-intensity and severe/extreme heatwaves, respectively. SA2s in western and southern Adelaide had higher risks during low-intensity heatwaves, while SA2s in southern and central Adelaide had higher risks during severe/extreme heatwaves. Analysis of area-level factors on heatwave and ambulance callouts revealed higher health impacts in areas (SA2s) characterized by high percentages of populations with high heat exposure, low socioeconomic status, poor housing and transport, vulnerable household composition, and poor health status.

CONCLUSIONS: Our results show that ambulance callouts increased during heatwaves, but with a varying magnitude within Adelaide. The identified differential demographic, social, and environmental drivers of heatwave-morbidity calls for place-based prevention and adaptation strategies to reduce heatwave-related health burden.

Keywords: Heatwave, Morbidity, Spatial heterogeneity, Vulnerability, Case-crossover, Neighbourhood



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 33

Environmental Health Disparities

Chairs: Rachel Morello-Frosch, United States & Kelvin Fong, United States

O-TO-184

Birth and Pregnancy Outcomes » Birth outcomes

Immigrant Disparities in Estimated Effects of Fine Particulate Matter on Birth Weight

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BACKGROUND AND AIM: Maternal exposure to fine particulate air pollution (PM_{2.5}) during pregnancy has been linked to lower newborn birth weight, a risk factor for disease and mortality. As little is known about PM_{2.5} effect disparities by immigrant status (i.e., US-born vs. immigrant mother), we estimated PM_{2.5} associations with birth weight by immigrant status overall and within racial/ethnic groups.

METHODS: For full-term live singletons in North Carolina from 2002 to 2014 (n = 1,082,485), we determined maternal exposure to PM_{2.5} during pregnancy using daily PM_{2.5} predictions from the EPA's Fused Air Quality Surfaces Using Downscaling model. We estimated using regression the effect of PM_{2.5} on newborn birth weight, adjusted for maternal race, age, education, smoking, marital status, newborn prenatal care, and mode of delivery.

RESULTS: Immigrant mothers had higher average exposure to PM_{2.5} than US-born mothers (12.1 µg/m³ vs. 11.7 µg/m³). Overall, newborns were 2.33 (95% confidence interval (CI): 0.49, 4.18) grams lighter per interquartile range (IQR) increment in PM_{2.5} (4.05 µg/m³). Estimated PM_{2.5} effects on birth weight were modified by maternal immigrant status (p = 0.02). Those with US-born mothers were 3.15 (95% CI: 1.12, 5.19) grams lighter per PM_{2.5} IQR while those with immigrant mothers were 4.88 (95% CI: 0.48, 9.27) grams heavier. Within racial/ethnic groups, we found similar patterns of disparities. Among non-Hispanic Blacks, those with US-born mothers were 4.47 (95% CI: 0.20, 8.74) grams lighter per PM_{2.5} IQR while those with immigrant mothers were 19.20 (95% CI: 2.03, 36.36) grams heavier. Disparities among those born to non-Hispanic White or Hispanic mothers were smaller in magnitude and not statistically different at the p = 0.05 level. Sensitivity analyses with the outcome small for gestational age showed similar patterns in disparities.

CONCLUSIONS: Our study revealed disparities in associations between maternal exposure to PM_{2.5} during pregnancy and newborn birth weight by immigrant status.

Keywords: Particulate matter, Environmental disparities, Birth outcomes, Environmental justice, Immigrant health



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 33

Environmental Health Disparities

Chairs: Rachel Morello-Frosch, United States & Kelvin Fong, United States

O-TO-185

Air pollution » General

The effects of historical residential redlining on temporal trends of air pollution levels measured near New York City schools

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BACKGROUND AND AIM: In the 1930's the Home Owners' Loan Corporation began categorizing neighborhoods based on racial demographics and perceived risk for mortgage investment. This historical practice of redlining has perpetuated racial segregation, poverty and influenced where major sources of air pollution were placed thus placing some schoolchildren at risk of high exposures. While a declining trend of air pollution was reported in New York City (NYC) between 2001 and 2012, little is known about regional differences in air quality improvement. Our objective was to determine recent temporal trends of air pollution from 2009-2018 near NYC schools and examined if trends differed in historically redlined neighborhoods.

METHODS: We examined annual average street-level concentrations of BC, PM_{2.5}, and NO₂, within a 250-km radius around NYC public schools (2009-2018; N=1828) using NYC Community Air Survey land-use regression models. Neighborhoods were characterized as redlined (N=892) vs. other (N=936). Year of monitoring (interval variable) and historical redlining (binary) were included in linear regression models. To test whether temporal trends of air pollution differ by historical redlining, a multiplicative interaction term was included. Models were further stratified by historical redlining. Annual percent change (APC) in pollutant concentration was calculated.

RESULTS: Overall, there was a decreasing trend of BC (APC=-4.9%), PM_{2.5} (-4.2%), and NO₂ (-3.2%). On average, pollutants were higher in redlined vs. other neighborhoods (BC: 1.12±0.29 vs. 0.99±0.27 µg/m³; PM_{2.5}: 9.47±1.47 vs. 8.93±1.42 µg/m³; NO₂: 23.5±4.2 vs. 21.4±3.75 ppb; p<0.001 for all). A smaller reduction of BC and PM_{2.5} was observed in redlined neighborhoods, compared to others for BC (APC: -4.7% vs. -5.1%; P-interaction<0.001) and PM_{2.5} (-4.1% vs. -4.3%; P-interaction<0.001) but not NO₂.

CONCLUSIONS: Despite significant reductions in recent annual average BC, PM_{2.5}, and NO₂ concentrations across NYC, historically redlined neighborhoods experienced smaller decrease in air pollution compared to others, highlighting a potential ongoing legacy of the discriminatory practice.

Keywords: black carbon, nitrogen dioxide, particulate matter, health equity, environmental justice



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TRADITIONAL ORAL SESSION 33

Environmental Health Disparities

Chairs: Rachel Morello-Frosch, United States & Kelvin Fong, United States

O-TO-186

Chemical exposures » PFAS

Prenatal per- and polyfluoroalkyl substance (PFAS) exposure, metabolomic perturbation, and lower birth weight in African American women: a meet-in-the-middle approach

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BACKGROUND AND AIM: Prenatal exposures to per- and polyfluoroalkyl substances (PFAS) have been linked to restricted fetal growth. Pregnant African American (AA) women are disproportionately exposed to higher levels of select PFAS and experience higher rates of low birth weight than other races/ethnicities. However, the detailed molecular mechanisms underlying these disparities remain largely unknown. The purpose of this study is to investigate biological pathways and intermediate biomarkers underlying association between prenatal PFAS exposure and lower birth weight using high resolution plasma metabolomics among pregnant AA cohort.

METHODS: Serum perfluorohexane sulfonic acid, perfluorooctane sulfonic acid, perfluorooctanoic acid, and perfluorononanoic acid measurements, and untargeted plasma metabolomics profiling were conducted in 312 pregnant AA women in Atlanta, Georgia at 8-14 weeks of gestation using fasting blood samples. We utilized a high-resolution metabolomics workflow, including Metabolome-Wide Association Studies (MWAS), enriched pathway analyses, and chemical annotations, with the 'meet-in-the-middle' approach to identify the potential biological pathways and intermediate biomarkers of the PFAS-birth weight relationship.

RESULTS: Among 25,516 metabolomic features extracted from the polar and nonpolar analytical columns, 320 features were significantly associated with serum PFAS and birth weight in the MWAS. After further validation using online databases or authentic chemical standards in the laboratory, we found 8 confirmed biomarkers including glycine, α -ketoisovalerate, uric acid, monoradylglycerol, and some polyunsaturated fatty acids and steroid hormones. In addition, 17 biological pathways associated with serum PFAS and birth weight were identified, including linoleate, vitamin D3, branched-chain amino acid, and fatty acid metabolism. The significant biomarkers and biological pathways identified were mostly involved in amino acid, lipid, and fatty acid metabolism or inflammation and oxidative stress.



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ABSTRACT E-BOOK

CONCLUSIONS: This study among pregnant AA found several maternal metabolic perturbations associated with serum PFAS concentrations and birth weight. Future studies are warranted to validate these findings and completely apprehend the underlying biological mechanisms.

Keywords: PFAS, metabolomics, birth weight



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 33

Environmental Health Disparities

Chairs: Rachel Morello-Frosch, United States & Kelvin Fong, United States

O-TO-187

Climate » Temperature

Residential segregation, air temperature, and circulatory mortality: Exposure model choice matters for disparities analyses

Daniel Carrión, Johnathan Rush, Elena Colicino, Allan C. Just

Icahn School of Medicine at Mount Sinai

BACKGROUND AND AIM: Growing literature demonstrates racial disparities in land cover and land surface temperature (a proxy for air temperature). Simultaneously many epidemiological studies use coarse air temperature products that may underestimate exposure disparities, potentially manifesting as effect modification by race in health analyses.

METHODS: Hourly air temperature was derived from a new 1km spatiotemporal satellite model (XGBoost-IDW-Synthesis: XIS) and compared to NASA's 12km NLDAS-2. We calculated population-weighted tract-level Cooling Degree Days (CDD: the cumulative hourly exceedance of 18.333°C) for June-August 2019 in 13 US Northeastern States (Maine to Virginia). Tract-level (n=17,732) population-weighted CDD (both XIS and NLDAS-2 derived) was first modeled with %Black 65+ residents using county random slopes and intercepts. Censored Poisson regression was used with county-level (n=433) June-August 2019 total deaths from circulatory diseases among those 65+ by race from CDC WONDER modeled with: county CDDs (from tract CDD averages weighted by racial composition), population density, state, and logged offset of the population 65+.

RESULTS: Temperature exposures vary widely with a median of 383 CDD for all counties (IQR: 286-536) in Summer 2019. Modeling tract CDDs within counties, the XIS-Temperature model found that a 0 to 100% change in %Black is associated with 67.8 CDD (95%CI: 56.1-80.7) and the NLDAS-2-based model found 25.5 CDD (95%CI: 15.8-34.8). Stratified county-level regressions for circulatory deaths scaled per 92 CDDs (~average 1°C higher per day) with XIS exposures for Black 65+ residents found a relative risk (RR) of 1.14 (95%CI: 1.07-1.21) versus the NLDAS-2 exposure model with RR=1.24 (95%CI: 1.15-1.33). For White 65+ residents, both the XIS-based and NLDAS-2 models had RR=1.04 (95%CI: 1.03-1.06).

CONCLUSIONS: Improved exposure models are important tools for understanding environmental health disparities by uncovering exposure disparities and refining epidemiological associations.

Keywords: Exposure disparities, Climate Justice, Exposure assessment, Energy burden, Cardiovascular disease



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Empire State Building Hall (Hall 4)

TRADITIONAL ORAL SESSION 34

Machine Learning and Data Science to Enhance Environmental Health Research

Chairs: Jeanette Stingone, United States & Honghyok Kim, United States

O-TO-188

Exposures » Multi-pollutant/Multi-media

The intersection of climate-related health outcomes and urban environmental characteristics using spatiotemporal data science

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BACKGROUND AND AIM: Cities are home to 80% of Canadians of whom have differential vulnerabilities, in population-specific contexts, to climate change impacts on their health. To identify areas within one city - Edmonton, Alberta - experiencing current climate-susceptible health impacts, we explored spatiotemporal patterns of chronic disease and a combination of urban environmental factors. Identifying areas of convergence may help identify where climate change-related severe weather events and worsened air pollution could magnify cardiovascular, renal, respiratory, neurological, mental health, injury, and pregnancy outcomes.

METHODS: We merged 1.2M records of patients (2013-2018) from the National Ambulatory Care Reporting System and the Discharge Abstract Database and classified the relevant conditions into the above seven health outcomes. All variables were aggregated/assigned to 1,196 dissemination areas (DA); environmental variables were sourced from the National Air Pollution Surveillance, National Pollutant Release Inventory, Alberta Climate Information System, vegetation "greenness," and material-social deprivation indices. We analyzed their respective data distributions accounting for both space and time by transforming the events of each health grouping, using seasonal (3-month) time intervals for each DA, into space-time cubes. Then, we input the space-time cubes into emerging hot spot analysis to calculate statistically significant hot and cold spots.

RESULTS: Geovisualization of 3-dimensional cubes and 2-dimensional maps helped us identify urban areas with extreme or unusual patterns in health outcomes. Each of the seven health groupings revealed different patterns, which typically coincided with demographics. Through spatial overlays and statistics, we associated the spatiotemporal health-exposure intersections to aid in variable selection for a future vulnerability index.

CONCLUSIONS: Our space-time explorations identify where these exposed populations occur and may help target appropriate climate change adaptive capacity interventions. This research is part of a larger project that is generating deeper insight into multiple factors that affect the climate change vulnerabilities and resilience of Alberta populations.

Keywords: Exposures, Multi-pollutant, Air pollution, Temperature extremes and variability, Chronic diseases, Spatial data science



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TRADITIONAL ORAL SESSION 34

Machine Learning and Data Science to Enhance Environmental Health Research

Chairs: Jeanette Stingone, United States & Honghyok Kim, United States

O-TO-189

Exposure Assessment Methods » Exposure assessment-general

Predicting spatiotemporally-resolved air temperature over Sweden from satellite data using an ensemble model

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BACKGROUND AND AIM: Mapping of air temperature (Ta) at high spatiotemporal resolution is critical to reduce exposure assessment errors in epidemiological studies on the health effects of air temperature. We aimed to predict daily Ta at a spatial resolution of 1×1 km² from 2001 to 2019 using an ensemble model based on the satellite-based daily land surface temperature. The results will provide insights in modeling Ta with an ensemble model to reduce exposure measurement error and serve as a foundation for epidemiological studies on the short-term and long-term effects of air temperature on public health at a large geographical scale.

METHODS: The generalized additive model based ensemble model incorporated four base models, including a generalized additive model, a generalized additive mixed model, and two machine learning models (random forest and extreme gradient boosting), and allowed the weights for each model to vary over space, with the best-performing model for each grid cell assigned the highest weight.

RESULTS: The ensemble model showed high performance with an overall R² of 0.98 and a root mean square error of 1.38 °C in the ten-fold cross-validation, and outperformed each of the four base models. Among base models, the two machine learning models outperformed the two regression models. In the machine learning models, Ts was the dominant predictor of Ta, followed by day of year, Normalized Difference Vegetation Index, latitude, elevation, and longitude.

CONCLUSIONS: The GAM-based ensemble model exploited the predictive ability of base models by allowing the weights for each model to vary over space, and provided an improved estimation of air temperature over Sweden that outperformed estimations from each base model. Among the base models, two machine learning methods (RF and XGBoost) exhibited higher predictive power than two linear regression models. The estimations from ensemble models can be applied in epidemiological studies to minimize bias caused by exposure misclassification.

Keywords: random forest, extreme gradient boosting, generalized additive model, ensemble model, air temperature, health exposure



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Machine Learning and Data Science to Enhance Environmental Health Research

Chairs: Jeanette Stingone, United States & Honghyok Kim, United States

O-TO-190

Exposure Assessment Methods » Exposure assessment-general

Predicting residential exposure to allergens in an electronic health record cohort of children with asthma in Massachusetts, USA

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BACKGROUND AND AIM: Children with asthma spend much of their time indoors where they can be exposed to numerous allergens that exacerbate symptoms. Generating systematic knowledge in a clinical setting of whether residential triggers are present can be resource intense (e.g., home visits, surveys). In addition, people's surrounding environments are complex mixtures, making identifying key elements affecting health-related outcomes a challenge. Recent advances in electronic health record (EHR) data use and novel statistical methods provide opportunities to predict allergen presence indoors.

METHODS: We developed prediction models for cockroach, rodent (mice or rats), and mold presence using data from an asthma intake form among $n=1,767$ children with asthma who visited Boston Medical Center from 2004-2015. Multilevel predictors ($p=72$) included individual, housing, and neighborhood factors that were linked to geocoded patient addresses from EHRs and modeled using an ensemble machine learning approach. To estimate effects, we reduced dimensionality by regularized regression and then simulated our resultant ensemble model across exposure levels via G-computation, a causal inference method.

RESULTS: Prediction models had reasonable discrimination in classifying allergen presence by area under the receiver operating curve (AUC: 0.64). For cockroaches, estimated naïve average causal effects (NACE) of tax-exempt parcels consistent with large public or affordable housing were negative (NACE: -0.033; 95%CI: -0.061, -0.004). For rodents, effects were only suggestive of statistically significant relationships. The protective relationship with tax exempt parcels likely captures proxy effects, such as integrated pest management plans commonly implemented at large public and affordable housing complexes.

CONCLUSIONS: Integrating novel clinical and geographical databases with cutting-edge statistical methods, we predicted population-wide allergen presence and identified potentially salient components of surrounding environmental mixtures. This approach can provide clinicians and epidemiologists information on individual environmental exposures for informing potential interventions and epidemiologic EHR-based cohort creation.

Keywords: asthma, allergies, exposure assessment, mixtures



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TRADITIONAL ORAL SESSION 34

Machine Learning and Data Science to Enhance Environmental Health Research

Chairs: Jeanette Stingone, United States & Honghyok Kim, United States

O-TO-191

Air pollution » Mixtures

Use of a LASSO approach to Identify ambient volatile organic compounds associated with emergency admissions for lower respiratory tract infection

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BACKGROUND AND AIM: Existing evidence suggests that ambient volatile organic compounds (VOCs) may be associated with adverse respiratory outcomes, but it is unclear whether specific components may be responsible for triggering respiratory diseases. We aimed to examine which VOCs are associated with emergency admissions for lower respiratory tract infection (LRTI) based on a LASSO approach.

METHODS: We obtained daily concentrations for 98 types of VOCs from two fixed-site monitoring stations located in Beijing. People who resided in Beijing for half a year or more and were hospitalized in local hospitals for the diagnosis of LRTI during the period of 2015 to 2016 were included. We used a LASSO approach to estimate specific VOC effects: (1) including all types of VOCs and fitting generalized linear models with a LASSO penalty function in a time-series framework using quasi-Poisson regression to identify which VOCs may be triggering LRTI; (2) including a specific VOC and fitting classic generalized linear models to estimate the associations with LRTI.

RESULTS: There were 184,865 emergency admissions for LRTI during 2015 to 2016 in Beijing. Total VOC concentration ranged from 12.79ppb to 258.95ppb, of which alkanes account for about 38%, followed by alkenes (14%), and alkynes (7%). For LRTI, acetylene (C₂H₂), acrolein (C₃H₄O), 2,3-dimethylbutane (C₆H₁₄) and bromodichloromethane (CHBrCl₂) were selected by the LASSO penalty function. Per IQR increase, short-term exposure to same-day C₂H₂ and C₆H₁₄ were associated with 1.90% (95%CI: 0.75, 3.07) and 2.07% (95%CI: 0.47, 3.70) change in LRTI, while C₃H₄O and CHBrCl₂ were associated with 1.01% (95%CI: -0.24, 2.28) and -0.03% (95%CI: -0.75, 0.70) change in LRTI, respectively.

CONCLUSIONS: Our study suggests that short-term exposure to C₂H₂ and C₆H₁₄ is associated with increased risk of LRTI emergency admissions. These specific components may reflect the role of traffic emission. Additional research is necessary to examine whether C₃H₄O and CHBrCl₂ may affect LRTI.

Keywords: air pollution, volatile organic compounds, LASSO, respiratory emergency admissions



ABSTRACT E-BOOK

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TRADITIONAL ORAL SESSION 34

Machine Learning and Data Science to Enhance Environmental Health Research

Chairs: Jeanette Stingone, United States & Honghyok Kim, United States

O-TO-192

Air pollution » General

Exposure to ambient air pollution and fetal cerebellar transverse diameter: a longitudinal study

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BACKGROUND AND AIM: Vulnerability to adverse health effects of air pollution begins during the fetal period, as emerging evidence suggests that exposures to fine particulate matter (PM_{2.5}) and nitrogen dioxide (NO₂) are associated with low birth weight and prematurity. We aimed to determine the extent to which PM_{2.5} and NO₂ exposures during the preconception period and early pregnancy are associated with cerebellar development as measured by fetal ultrasound.

METHODS: Participants were 854 mother-fetal pairs enrolled in the NYU Children's Health and Environmental Study (CHES) (New York City, 2016-2019). Clinical data on transverse cerebellar diameter (TCD, mm) from ultrasound examinations of pregnant women were extracted from electronic health records. We used a tree-based machine learning method of random forests and gradient boosting machines to predict daily PM_{2.5} and NO₂ at residential addresses. Average PM_{2.5} and NO₂ exposure during three months pre-conception, as well as first and second trimesters were calculated using daily exposure. Associations between each air pollutant and repeatedly measured TCD were examined using linear mixed models adjusted for time of cerebellar measurement, maternal age, pre-pregnancy body mass index, race/ethnicity, employment, education, depressive symptoms, and parity.

RESULTS: The mean gestational age was 18.31 weeks (SD=1.91) at the time of first TCD measurement and 24.06 weeks (SD=5.45) at second TCD measurement. Exposures to PM_{2.5} during the pre-conception period and the first trimester were associated with a smaller TCD (β per $\mu\text{g}/\text{m}^3$ = -0.15, 95% CI: -0.30, 0.01, and β = -0.30, 95% CI: -0.47, -0.13, respectively). Exposures to NO₂ during the pre-conception period and the first trimester were associated with a smaller TCD (β per ppb = -0.05, 95% CI: -0.08, -0.01, and β = -0.05, 95% CI: -0.09, -0.01, respectively). There were no associations between second trimester exposures and TCD.



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ABSTRACT E-BOOK

CONCLUSIONS: Exposure to PM_{2.5} and NO₂ during the pre-conception period and early pregnancy may influence fetal brain development.

Keywords: Particulate matter, nitrogen dioxide, air pollution, pregnancy, fetal growth, cerebellum



ABSTRACT E-BOOK

August 24, 2021 / 13:45 - 15:15 / Brooklyn Bridge Hall (Hall 2)

PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-001

Built environment » Noise

Cardiovascular disease mortality and transportation noise: relative and absolute excess risk by age and gender

Danielle Vienneau¹, Apolline Saucy¹, Louise Tangermann¹, Benjamin Flückiger¹, Beat Schäffer², Jean Marc Wunderli², Martin Röösli¹

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BACKGROUND AND AIM: Long-term exposure to transportation noise is related to cardiovascular disease (CVD) mortality. Less is reported about potential differential effects by age and sex, an important consideration when calculating health impacts.

METHODS: The Swiss National Cohort, including all resident adults (4.1 million, followed 2001-2015), was used to derive relative and absolute excess risk for all CVD mortality associated with road, railway and aircraft noise – by sex and age (30-64, 65-79, 80+ years). Multipollutant, time-varying Cox regression with age as timescale was applied to evaluate excess RR (from hazard ratios, HR) and 95% confidence intervals per 10dB Lden noise. The model included each noise source, PM2.5 and was adjusted for individual and area-level covariates. Absolute excess risk was calculated from the same population, multiplying the deaths/100,000 person-years (PY) by the excess risk (HR-1) within each group.

RESULTS: For CVD and road traffic noise, the RR decreased with age (8.6% [7.3; 9.9] age 30-64; 2.7% [2.0; 3.4] age 65-79; 0.8% [0.03; 1.6] age 80+ per 10dB) whereas absolute excess risk increased with a respective 8, 41 and 58 deaths/100,000 PY in each age category. The same pattern was found for railway and aircraft noise, though associations with aircraft noise lost significance in the oldest age category. The RR for CVD mortality were higher in males (4.9% [4.2; 5.7] road; 1.8% [1.2; 2.3] railway; -0.1% [-1.1; 0.9] aircraft noise per 10dB) than females (1.1% [0.4; 1.8] road; 0.9% [0.4; 1.4] railway; 0.7% [-0.3; 1.7] aircraft noise per 10dB). Absolute excess risk was also higher in males vs. females due to similar baseline risk.

CONCLUSIONS: Age stratified analysis may be important for health impact assessment as the risk may vary with age. We observed higher relative risks in younger adults, while the absolute excess risk was highest in older adults because of higher baseline cardiovascular mortality risk.

Keywords: transportation noise, CVD, HIA



ABSTRACT E-BOOK

August 24, 2021 / 13:45 - 15:15 / Brooklyn Bridge Hall (Hall 2)

PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-002

Climate » Temperature

Can Weather Help Explain 'Why Now?': The Potential Role of Hourly Temperature as a Stroke

Trigger

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BACKGROUND AND AIM: While evidence suggests that daily ambient temperature exposure influences stroke risk, little is known about the potential triggering role of hourly temperature exposure. We examined the association between hourly temperature and ischemic and hemorrhagic stroke, separately, and assessed effect modification by hypertension in a secondary analysis.

METHODS: We identified primary hospitalizations for ischemic and hemorrhagic stroke among New York State adults, 2000–2015, from the NY Department of Health Statewide Planning and Research Cooperative System, via ICD-9-CM codes. We estimated hourly temperature exposure from North American Land Data Assimilation System-2 estimates based on subject's residential ZIP Code. We conducted a case-crossover study with time-stratified matching. The association between temperature up to 36 hours prior to stroke and stroke risk was estimated via conditional logistic regression adjusted for relative humidity, with a distributed-lag non-linear term for temperature. We assessed effect modification via z-tests.

RESULTS: Among ischemic and hemorrhagic strokes respectively, we observed 578,572 and 164,041 cases; the mean (standard deviation; SD) age was 71.7 (14.6) and 66.7 (17.5) years, with 55% and 49% female. The mean (SD) temperature was 10.9°C (10.3°C), with a range of -29.5–39.2°C. We found evidence of linear exposure-response relationships. Higher temperature was associated with ischemic stroke up to seven hours before the stroke; a 10°C temperature increase over seven hours was associated with 4.9% (95% Confidence Interval [CI]: 3.2, 6.2%) increase in hourly stroke rate. Temperature up to five hours prior was negatively associated with hemorrhagic stroke, with a five-hour cumulative association of -6.0% (95% CI: -8.4, -3.5%). For hemorrhagic stroke we observed suggestive evidence of a larger association among subjects with hypertension.

CONCLUSIONS: In this study, hourly temperature was positively associated with ischemic stroke and negatively associated with hemorrhagic stroke. Our results suggest that ultra short-term weather may trigger stroke, and that hypertension may confer vulnerability.

Keywords: Climate, Temperature, Cardiovascular Disease,



ABSTRACT E-BOOK

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PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-003

Climate » Temperature

Urban heat islands and heat health warning systems in Mediterranean cities. Results from the Life ASTI project

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BACKGROUND AND AIM: In the LIFE ASTI project a forecasting system for estimating the urban heat island intensity (UHI) and defining high resolution heat health watch warning systems was developed in 3 Mediterranean cities, namely Thessaloniki, Rome and Heraklion.

METHODS: Mortality data and temperature data for each city were collected for the period 2013-2018. A city-specific Poisson regression model was fit to define the association between mortality and maximum apparent temperature (Tappmax) considering the following explicative variables: holidays, month (May–August), the interaction between Tappmax and month and the number of consecutive hot days above the cut-off (mean Tappmax value corresponding to all days for which excess mortality was greater than 10%). For each value of Tappmax, the model then estimates the daily excess mortality (difference between observed daily values and a baseline reference) and defines monthly thresholds and warnings levels (1,2,3). Using the LIFE ASTI high-resolution urban forecasting system (spatial resolution 250m and lead time 5 days) a differential warning is issued for each zone within the city.

RESULTS: UHI forecast maps and heat warnings are issued for each city together with specific health advice to users through the Life Asti web APP (<https://app.lifeasti.eu/>). Forecast and observed warnings days for summer 2019-2020 were compared and associated with observed mortality data. Preliminary results on summer 2019-20 showed a slight underestimation of Tappmax values but overall a good accordance of warning days. During heat wave periods increases in mortality were observed in both Rome and Thessaloniki. The model has been adjusted and results for summer 2021 will be presented comparing forecast data with observed data from the LIFE ASTI high resolution monitoring network and mortality data.

CONCLUSIONS: High resolution warnings will help activate differential public health response measures within a city and reduce heat-related effects.

Keywords: climate, temperature, modeling, exposures



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PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-004

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

Climate justice and California's methane super-emitters: An environmental equity assessment of community proximity and exposure intensity

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BACKGROUND AND AIM: Issues of environmental justice exist with respect to toxic waste facilities, concentrated animal feeding operations, and air pollution exposure. For the first time, we aimed to characterize potential disparities in exposure to methane super-emitters in California with respect to race/ethnicity, socioeconomic status, and civic engagement.

METHODS: We obtained location, category (e.g., landfill, refinery), and emissions rate of California methane super-emitters from Next Generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG) flights conducted between 2016–2018. We identified block groups within 2km of super-emitters (exposed) and 5-10km away (unexposed) using dasymetric mapping and assigned level of exposure among block groups within 2km (measured via number of super-emitter categories and total methane emissions). We used generalized additive mixed models with a logit-link to assess the association between block group-level sociodemographic variables and odds of exposure to a super-emitter or, among exposed block groups (those within 2km of a super-emitter), odds of higher intensity exposure to multiple categories of super-emitters. Mixed models included a random intercept for county. We allowed for deviations from linearity using penalized splines.

RESULTS: Analyses included 483 super-emitters. The majority were dairy/manure (n = 213) and oil/gas production sites (n = 127). Results from fully adjusted logistic mixed models were consistent with environmental injustice in methane super-emitter locations. For example, for every 10% increase in non-Hispanic Black residents, the odds of exposure increased by 10% (95% CI: 1.04, 1.17). We observed similar disparities for Hispanics and Native Americans, but not with indicators of socioeconomic status. Among block groups located within 2km, increasing proportions of non-White populations and lower voter turnout were associated with higher super-emitter emission intensity.

CONCLUSIONS: Previously unrecognized racial/ethnic disparities exist in exposure to California methane super-emitters, which future policies should address.

Keywords: Environmental justice, Air pollution, Socio-economic factors (non-chemical stressors), Environmental disparities



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PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-005

Exposures » Environmental disparities

The Environmental Injustice of Beauty: an intersectional analysis of vaginal care products by race/ethnicity and socioeconomic status

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BACKGROUND AND AIM: The environmental injustice of beauty framework links intersectional systems of oppression (e.g. racism, sexism, classism) to racialized beauty practices and poor health outcomes. Historical and ongoing discrimination around vaginal odors especially among women of color can influence menstrual and other vaginal product use, which are a source of exposure to harmful chemical mixtures. The aim of this analysis is to examine differences in vaginal product use by race/ethnicity and socioeconomic status.

METHODS: We combined survey data on vaginal product use from the following two studies focused on the health of Black and Latina reproductive-aged women: a hospital-based study in the Washington, DC area (FORGE) and a community-based study in California (Taking Stock). Vaginal product use was examined at the intersections of race/ethnicity (Black (N=185), Latina (N=156), White (N=71), and Other (N=84) and socioeconomic status (\leq High School (HS) education (N=99) versus >HS (N=391)).

RESULTS: Significant differences exist in the type of vaginal care products used by racial/ethnicity as well as by educational attainment. Tampon and menstrual cup use were more common among White women than Black or Latina women ($p < .001$). Among women of color, tampon and menstrual cup use were greater among more highly educated women. Conversely, less educated women were more likely to use douches, feminine sprays, and scented tampons and pads ($p < .01$). The highest prevalence of most fragranced product use was among Black women with HS education or less.

CONCLUSIONS: White women with some college education have significantly different vaginal product use patterns than Black and Latina women without a college education. Racial/ethnic and socioeconomic patterns in product use may contribute to inequities in environmental exposures and health outcomes. In future analyses, we will examine intersectional patterns across multiple product categories.

Keywords: Environmental disparities, Female, Environmental epidemiology, Chemical exposures



ABSTRACT E-BOOK

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PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-006

Birth and Pregnancy Outcomes » Birth outcomes

Association between county-level coal-fired power plant pollution and racial disparities in preterm births from 2000 to 2018

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BACKGROUND AND AIM: Coal has historically been a primary energy source in the United States. The byproducts of coal combustion, such as fine particulate matter (PM_{2.5}), have increasingly been associated with adverse birth outcomes. Few studies have investigated the relative contribution of air pollution to Black-White disparities in preterm births and none have looked at the potential role of energy transitions in reducing disparities in preterm births. The goal of this study was to leverage the current progressive transition away from coal in the United States (U.S.) to assess whether coal PM_{2.5} is associated with preterm birth rates and whether this association differs by maternal Black/White race/ethnicity.

METHODS: Using a novel dispersion modeling approach, we estimated PM_{2.5} pollution from coal-fired power plants nationwide at the county-level during the study period (2000–2018). We also obtained county-level preterm birth rates for non-Hispanic White and non-Hispanic Black mothers. We used a generalized additive mixed model to estimate the relationship between coal PM_{2.5} and preterm birth rates, overall and stratified by maternal race/ethnicity. We included a natural spline to allow for non-linearity in the concentration–response curve.

RESULTS: On average, the preterm birth rate was higher among non-Hispanic Black women than among non-Hispanic White women (17% compared to 11%). We observed a positive non-linear relationship between coal PM_{2.5} and preterm birth rate, which plateaued at higher levels of pollution. We also observed differential associations by maternal race; the association was stronger for White women, especially at higher levels of coal PM_{2.5} (> 2.0 µg/m³).

CONCLUSIONS: Our findings suggest that the transition away from coal may reduce preterm birth rates in the U.S.

Keywords: Birth outcomes, air pollution, particulate matter, environmental disparities, health co-benefits



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PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-007

Air pollution » General

Air Pollution and environmental justice in Latin America: where are we and how can we move forward?

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BACKGROUND AND AIM: Environmental justice or health inequalities are documented throughout the world. Air pollution in Latin America is a major environmental threat, yet few studies have focused on aspects of environmental justice with regard to air pollution in the region. We examined the scientific literature and describe whether and how these issues have been addressed, identify possible gaps in knowledge, and offer suggestions for future research to contribute to policies that seek greater equity with regard to air pollution impacts in Latin America

METHODS: We searched bibliographic databases with a combination of keywords to identify studies that have examined disparities or differences in vulnerability to air pollution between socioeconomic groups. These were classified into those that examined the unequal pattern of exposure, and those that have studied differential susceptibilities to health effects associated with air pollution

RESULTS: Our search returned 83 studies after filtering for duplicates. Examination of abstracts and full texts provided a final list of 21 studies for in depth inspection. Of these, 7 examined patterns of differential exposure and 13 assessed differential effects according to socioeconomic position (SEP) and one evaluated both dimensions. As expected, Brazil, Mexico and Chile concentrated most publications followed by Colombia, Ecuador and Peru. Except for a study in São Paulo using traffic density as surrogate for air pollution exposure, all other found a clear pattern of higher exposure in socially deprived areas. As for health impacts, results were more mixed but many studies found a clear modification of effect of SEP on the air pollution health effect association, with those in the lower SEP having greater effects

CONCLUSIONS: Health risks (exposure and susceptibility) associated with air pollution are unevenly distributed among Latin American urban populations. Understanding these differential exposures and differential effects is important for priority and target setting in policies to tackle these inequalities.

Keywords: environmental justice, inequalities, air pollution, Latin America



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PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-008

Air pollution » Long-term exposure

The role of long-term air pollution for COVID-19 infection and severity during pregnancy

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BACKGROUND AND AIM: Ambient air pollution may increase risk of infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), but this remains unstudied in a cohort with universal Coronavirus Disease 2019 (COVID-19) testing. We fill this gap using a cohort of pregnant women from Columbia University hospitals, who as of March 13, 2020 all received SARS-CoV-2 nasopharyngeal quantitative polymerase-chain-reaction (PCR) testing and were queried about prior COVID-19 test results and symptoms upon labor unit admission. We aimed to evaluate the association between long-term air pollution exposure and COVID-19 and the role of racial/ethnic and socioeconomic factors in this association.

METHODS: We used electronic health record data on all deliveries at Columbia University Irving Medical Center and Allen Hospital in New York City, that took place between March 13, 2020 and December 31, 2020. Our outcome measures were (1) positive COVID-19 PCR at delivery and (2) ever-testing positive for COVID-19 and being symptomatic. We estimated long-term fine particle (PM_{2.5}) exposure using 300m resolution New York City Community Air Survey predictions at mothers' addresses at the time of delivery. We used logistic regression models controlled for potential confounders including maternal race/ethnicity, delivery hospital, Borough of residence, birthdate, and census tract-level median household income and average household size.

RESULTS: Analyses included 3941 women; 4.7% (n=186) tested positive for COVID-19 at delivery and 15.4% (n=45) of those who ever tested positive for COVID-19 had symptoms. Mean (standard deviation) 2017 residential PM_{2.5} concentrations were 7.5 (0.6) µg/m³. In adjusted models, we observed no association between PM_{2.5} concentrations and testing positive for COVID-19 at delivery (OR = 0.94, 95% CI: 0.64, 1.37) or being symptomatic with COVID-19 (OR = 1.04, 95% CI: 0.56, 1.93).

CONCLUSIONS: Long-term air pollution exposure was not associated with increased risk of COVID-19 among pregnant women in New York City.

Keywords: Long-term exposure, COVID-19, Pregnancy outcomes



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PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-009

Outcomes » Childrens environmental health

A cluster analysis of the social and environmental health impacts of the COVID-19 pandemic among low-income youth

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BACKGROUND AND AIM: School closures during the COVID-19 pandemic disrupted the learning and home environments of youth across the US. It is suspected that the pandemic has both widened the racial gap in educational attainment and exacerbated health disparities. In this cross-sectional study, we examined the social, environmental, and health impacts of the pandemic on low-income youth in the St. Louis metropolitan area, an urban region with longstanding racial and income disparities in education and health outcomes.

METHODS: Study participants were parents or guardians (n=122) of students aged 9-12, from the St. Louis Public School District who participated in remote learning during the Fall semester of 2020. Parents completed a questionnaire adapted from the National Institute of Health's Environmental Influences on Child Health Outcomes COVID-19 Questionnaire-Child Parent-Report Version. The questionnaire included demographic measures and measures of pandemic-related student impacts, such as changes in diet, sleep, physical activity, environment, and/or social connections. K-Means cluster analyses were conducted to evaluate whether multiple negative impacts concentrated in discrete clusters among students.

RESULTS: We identified two distinct cluster profiles: a "dietary and social impact" profile (n=73) and an "environmental and physical" impact profile (n=49). The clusters significantly differed in race and parental relationship status. Black students and students with Single/Divorced/Widowed/Noncohabitating parents or guardians were more likely to have an "environmental and physical" profile than non-Black students and students with Married/Cohabiting parents or guardians who were more likely to have a "dietary and social impact" profile (both p<0.05).

CONCLUSIONS: This study provides initial findings on the social, environmental, and health impacts of the COVID-19 pandemic among low-income, urban youth. The results suggest that the negative impacts caused by the pandemic cluster and these clusters differ by race and family structure. A better understanding of these impacts will help develop strategies to mitigate the negative effects of the pandemic.

Keywords: Community outreach, Environmental disparities, Environmental justice, Socio-economic factors



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PECHA KUCHA SESSION 1

Chair: Ulrike Gehring, Netherlands & Youn-Hee Lim, Denmark

O-PK-010

Birth and Pregnancy Outcomes » Birth outcomes

Association between residential proximity to hydraulically fractured oil and gas wells and adverse birth outcomes in California (2006-2015)

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BACKGROUND AND AIM: Hydraulic fracturing (HF) is a chemically intensive oil and gas extraction method. Although studies indicate exposure to HF during pregnancy may be associated with adverse birth outcomes, no health studies on HF exposure have been conducted in California.

METHODS: We conducted a retrospective cohort study of 979,961 births to mothers in eight California counties with HF wells between 2006-2015 to assess the relationship between prenatal exposure to HF wells and adverse birth outcomes. Exposed individuals were those that had at least 1 HF well within 1 km of their residence throughout their pregnancy and the reference population had no wells within 1 km but at least one oil or gas well within 10 km. We used generalized estimating equations to examine associations between HF well exposure and low birth weight (LBW), preterm birth (PTB), small for gestational age birth (SGA), and term birth weight (tBW). We assessed effect modification by urban/rural communities using stratified models.

RESULTS: Less than one percent of mothers (N=1,192) were exposed to HF during pregnancy. Among rural mothers, prenatal HF exposure was associated with 74% increased odds of LBW (odds ratio [OR] = 1.74 and 95% confidence interval [CI]: 1.10, 2.75), 68% increased odds of SGA (OR = 1.68, 95% CI: 1.42, 2.27), 73 grams lower tBW (mean difference: -73 g, 95% CI: -131, -15) and 17% increased odds of PTB (OR = 1.17, 95% CI: 0.64, 2.12). Among urban mothers, we observed a positive association between HF exposure and SGA (OR = 1.23, 95% CI: 0.98, 1.55) and inverse associations with LBW (OR: 0.83, 95% CI: 0.63, 1.07) and PTB (OR: 0.65, 95% CI: 0.48, 0.87).

CONCLUSIONS: Proximity to HF was associated with adverse birth outcomes among rural women in California. Future research is needed to better characterize specific hazards associated with HF.

Keywords: birth outcomes, oil and gas development, hydraulic fracturing, pregnancy exposure



ABSTRACT E-BOOK

August 23, 2021 / 14:00 - 15:00 / Statue of Liberty Hall (Hall 1)

LIGHTNING TALKS 1

Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-001

Air pollution » General

Ambient air pollution and academic achievements among US children: a panel study

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BACKGROUND AND AIM: Ambient air pollution is an important environmental exposure, and children are especially vulnerable to its neurotoxic effects. Prior studies have associated early childhood exposures to air pollution with poor performances in cognitive and academic tests. No existing study has tested such associations on a nationwide level. We hypothesize that higher ambient air pollution concentrations in a Geographic Schol District (GSD) in the year prior to the state testing window will be associated with lower average academic test scores at the district level.

METHODS: We investigate three prevalent ambient air pollutants: PM_{2.5}, NO₂ and ozone, and their association with the academic test scores of all students in grades 3 to 8 in the United States at the GSD level from 2010 to 2016. We applied multivariate linear regression and controlled for urbanicity, socioeconomic status, student racial compositions, GSD-grade fixed effects and year fixed effects. The two-way fixed effects model resembles a generalized difference-in-difference approach in a panel data setting. The results can be interpreted causally if certain assumptions are met.

RESULTS: We found that a 1 µg/m³ increase in ambient PM_{2.5} was associated with a 0.00246 standard deviation (95% CI: 0.00173, 0.00320) lower average Math test score. Similar associations were found for NO₂ (0.00049 per ppb, 95% CI: 0.00020, 0.00079) and ozone (0.00146 per ppm, 95% CI: 0.00111, 0.00180). For English language/arts (ELA), a 1 µg/m³ (ppb) increase in ambient PM_{2.5} (0.00141, 95% CI: 0.00083, 0.00199) and NO₂ (0.00161, 95% CI: 0.00138, 0.00185) were associated with lower average test scores. The reductions in both Math and ELA test scores were larger for GSDs with higher socioeconomic status.

CONCLUSIONS: Our results show that ambient air pollution is associate with lower academic performances among children. Further improving air quality may benefit children's academic achievements and career in the long run.

Keywords: Air pollution, Neurodevelopmental outcomes, Oxides of nitrogen, Ozone, Particulate matter



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August 23, 2021 / 14:00 - 15:00 / Statue of Liberty Hall (Hall 1)

LIGHTNING TALKS 1

Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-002

Air pollution » General

Associations between chronic air pollution and COVID-19 mortality: A patient-level analysis from New York City

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BACKGROUND AND AIM: Vulnerability factors for COVID-19 mortality may include environmental exposures, such as air pollution. We aimed to perform individual-level analyses to understand whether, amongst adults hospitalized with PCR-confirmed COVID-19, higher chronic air pollution exposure is associated with risk for COVID-19 mortality, intensive care unit (ICU) admission or intubation.

METHODS: We conducted a retrospective analysis of SARS-CoV-2 PCR positive patients admitted to seven New York City hospitals from March 8, 2020 to August 30, 2020. We estimated annual average



ABSTRACT E-BOOK

fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂) and black carbon (BC) exposures at patients' residential address by leveraging the validated, spatiotemporal resolved NYC Community Air Survey. We employed multivariable quasipoisson regression with propensity score weighting to examine associations between chronic PM_{2.5}, NO₂ and BC exposure, considered separately, and COVID-19 outcomes.

RESULTS: Of the 6,542 patients, 41% were female (N=2,936) and aged a median of 65 years (IQR 53, 77). Nearly 60% of the cohort self-identified as a person of color [Hispanic (26%), non-Hispanic Black (26%) or Asian (7%)]. Air pollution exposures by place of residence were generally low. Overall, 31% (N=2,044) of the cohort died, 19% (N=1,237) required ICU admission and 16% (1,051) required intubation and mechanical ventilation. In multivariable models, a 1 μ g/m³ increase in PM_{2.5} exposure was associated with a 11% increase in the risk of mortality (OR 1.11, 95% CI 1.01, 1.21) and 13% increase in the risk (RR 1.13, 95% CI 1.00, 1.29) of ICU admission. BC was positively, but not significantly, associated with COVID-19 outcomes in multivariable analyses.

CONCLUSIONS: Higher chronic PM_{2.5} exposure is associated with increased COVID-19 mortality and ICU admission. Our data support of the urgency of environmental justice efforts in current and future public health pandemic responses.

Keywords: air pollution, COVID-19, mortality



ABSTRACT E-BOOK

August 23, 2021 / 14:00 - 15:00 / Statue of Liberty Hall (Hall 1)

LIGHTNING TALKS 1

Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-003

Air pollution » Long-term exposure

Long-term air pollution exposure and diabetes incidence in two prospective cohorts of U.S. women

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BACKGROUND AND AIM: Global prevalence of type 2 diabetes (T2DM) is increasing. Research has identified links between air pollution exposure and T2DM through metabolic and inflammatory pathways, but more large cohort studies are needed to help disentangle which pollutants are responsible and which individuals are most susceptible. Our aim was to prospectively evaluate the association between long-term exposure to fine particulate matter (PM_{2.5}) and T2DM incidence in the US-based Nurses' Health Study (NHS) and Nurses' Health Study II (NHSII) cohorts.

METHODS: Monthly PM_{2.5} exposures were predicted from spatiotemporal models and linked to participants' residential addresses from 1989-2007. Biennial participant questionnaires provided rich individual level covariate data. Self-reported clinician diagnosis of T2DM was confirmed via a validated supplementary questionnaire. We used Cox proportional hazards models to assess the relationship between time-varying two-year average PM_{2.5} exposure and incident T2DM in each cohort. We adjusted for time-varying covariates including lifestyle factors, menopausal status and hormone use, and markers of individual and neighborhood socioeconomic status (nSES). Results were meta-analyzed and heterogeneity was assessed. We also examined interactions by self-reported physical activity level and nSES.

RESULTS: Over follow-up, there were 10,108 incident T2DM cases during 1,182,400 and 1,574,821 person-years of follow-up among the 96,291 and 112,941 women in NHS and NHSII, respectively. In fully adjusted models, the meta-analysis HR for an interquartile range (4.8 µg/m³) increase in two-year PM_{2.5} exposure was 1.04 (95% CI: 1.01, 1.08) for incident T2DM. Results were similar in models for cumulative exposure. We found suggestive evidence of effect modification by physical activity level, but not by nSES.



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ABSTRACT E-BOOK

The association between $PM_{2.5}$ and T2DM was stronger in more physically active women.

CONCLUSIONS: Our results support the growing evidence of a positive association between air pollution and T2DM.

Keywords: air pollution, particulate matter, long-term exposure, incidence, obesity and metabolic disorders



ABSTRACT E-BOOK

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LIGHTNING TALKS 1

Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-004

Air pollution » Long-term exposure

Long-term exposure to low concentrations of air pollution and cause-specific mortality beyond cardiorespiratory disease: A Danish nationwide cohort study

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BACKGROUND AND AIM: The association between air pollution and mortality from cardiorespiratory disease is well established, yet evidence for other causes is limited. We examined the associations of long-term exposure to air pollution with mortality from lower respiratory infection (LRI), diabetes, dementia, Alzheimer's disease (AD), and psychiatric disease (PD) in a Danish nationwide cohort study.

METHODS: We linked 3,083,227 subjects aged ≥ 30 years in 2000 to the Danish Cause of Death Registry until 2017. Annual mean concentrations of fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), and black carbon (BC) in 2010 at 100x100m resolution were estimated with European-wide hybrid land-use regression models developed within ELAPSE (Effects of Low-Level Air Pollution: A Study in Europe). We applied Cox proportional hazard models with age as time scale, parish as cluster, and adjusting for sex, country of origin, income, education, employment status, marital status, and parish and region-level indicators of income and employment.

RESULTS: During the follow-up, 805,838 subject died: 30,578 from LRI, 20,735 from diabetes, 41,178 from dementia, 11,894 from AD, and 12,801 from PD. Mean levels of PM_{2.5}, NO₂ and BC were 12.4 $\mu\text{g}/\text{m}^3$, 20.3 $\mu\text{g}/\text{m}^3$ and 1.0 $10^{-5}/\text{m}$, respectively. Hazard ratios (95% confidence intervals) for associations of PM_{2.5}, NO₂, and BC with LRI mortality were 1.16 (1.10-1.21) per 5 $\mu\text{g}/\text{m}^3$, 1.07 (1.04-1.09) per 10 $\mu\text{g}/\text{m}^3$, and 1.05 (1.03-1.08) per 0.5 $10^{-5}/\text{m}$, respectively. Corresponding estimates for diabetes mortality were 1.11 (1.04-1.17), 1.03 (1.00-1.05), and 1.00 (0.98-1.03); for dementia mortality were 1.05 (1.00-1.10), 1.05 (1.03-1.07), and 1.03 (1.01-1.05); for AD mortality were 1.24 (1.14-1.36), 1.18 (1.13-1.22), and 1.15 (1.11-1.19); and for PD mortality were 1.39 (1.28-1.51), 1.24 (1.20-1.28), and 1.22 (1.18-1.27).



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ABSTRACT E-BOOK

CONCLUSIONS: Long-term exposures to PM_{2.5}, NO₂, and BC were associated with mortality other than cardiorespiratory diseases, even stronger for mortality from Alzheimer's and psychiatric disease. The indirect adjustment for missing risk factors will be applied.

Keywords: Air pollution, Big data, Long-term exposure, Mortality, Neurodegenerative outcomes



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LIGHTNING TALKS 1

Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-005

Air pollution » Long-term exposure

Long-term exposure to ambient air pollution and bladder cancer incidence in a pooled European cohort: the ELAPSE project

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BACKGROUND AND AIM: The epidemiological evidence on associations between ambient air pollution and bladder cancer is limited. We aimed to evaluate the associations between long-term exposure to ambient air pollution and bladder cancer incidence in a pooled European cohort.

METHODS: We pooled data from six European cohorts enrolled between 1985 and 2005 (N = 302,493). Residential exposure to annual 2010 mean concentrations of fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), Black Carbon (BC), warm season ozone (O₃) and eight PM_{2.5} elemental components (copper, iron, potassium, nickel, sulfur, silicon, vanadium, and zinc) were assessed based on Europe-wide land use regression models at 100 × 100 m spatial scale. We applied Cox proportional hazard models with adjustment for potential confounders at individual- and area-level. We also performed two-pollutant models and sensitivity analyses including using exposures back-extrapolated to baseline years.

RESULTS: During an average of 18.2 years follow-up, 967 bladder cancer cases were diagnosed. In single pollutant models, we observed a positive association between PM_{2.5} and bladder cancer incidence (Hazard Ratio (HR) and 95% confidence interval (CI): HR 1.09; 95% CI: 0.93, 1.27 per 5 µg/m³), which attenuated for PM_{2.5} back-extrapolated to baseline years (HR 1.06; 95% CI: 0.99, 1.14 per 5 µg/m³). Effect estimates for NO₂, BC and O₃ were very close to unity. Regarding elemental



ABSTRACT E-BOOK

composition in PM_{2.5}, we observed a positive association between zinc and bladder cancer incidence (HR 1.08; 95% CI: 1.00, 1.16 per 10 ng/m³). The effect estimates were robust in two-pollutant models and sensitivity analyses.

CONCLUSIONS: There was suggestive evidence of an association between long-term exposure to PM_{2.5} and bladder cancer incidence, especially with zinc in PM_{2.5}, which is primarily associated with industrial emissions. We found no evidence of an association between traffic-related air pollution and bladder cancer.

Keywords: Air pollution, Particulate matter, Particle components, Long-term exposure, Cancer and cancer precursors



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LIGHTNING TALKS 1

Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-006

Neurologic and Mental Health Outcomes » Neurodegenerative outcomes

Long-term air pollution exposure and mortality due to dementia, Parkinson's Disease and psychiatric disorders: the ELAPSE project

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BACKGROUND AND AIM: Ambient air pollution exposure has been linked to neurodegenerative and psychiatric disorders, but evidence remains limited. We examined the association between long-term air pollution exposure and mortality due to dementia, Alzheimer's Disease (AD), Parkinson's Disease (PD), psychiatric disorders and suicides in a pooled analysis of eight European cohorts.

METHODS: Within the project 'Effects of Low-Level Air Pollution: A Study in Europe' (ELAPSE), we pooled data from eight cohorts from six European countries. Annual mean residential concentrations in 2010 for fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), black carbon (BC) and ozone (O₃) were estimated using Europe-wide hybrid land use regression models. We applied stratified Cox proportional hazard models, adjusting for potential confounders, to investigate the associations between air pollution and mortality due to dementia, AD, PD, psychiatric disorders, and suicides.

RESULTS: Of 325,367 participants, 1167 died from dementia (528 from AD), 468 from PD, 995 from psychiatric disorders, and 273 from suicides, during a mean follow-up of 19.5 years. We observed positive associations of NO₂, PM_{2.5} and BC with PD (hazard ratio; 95% confidence intervals: 1.14; 0.98-1.33 per 10 µg/m³ in NO₂, 1.26; 1.03-1.55 per 5 µg/m³ in PM_{2.5}, and 1.09; 0.93-1.27 per 5 10-5m-1 in BC), psychiatric disorders (1.08; 0.98-1.19; 1.21; 1.02-1.43; 1.12; 1.01-1.24) and suicides (1.16; 0.98-1.37; 1.14; 0.79-1.65; 1-10; 0.93-1.31). We found weak negative associations of NO₂, PM_{2.5} and BC with dementia (0.92; 0.84-1.00; 0.92; 0.79-1.07; 0.91; 0.83-1.00) or AD (0.93; 0.82-1.06; 0.85; 0.69-1.03; 0.89; 0.78-1.03).

CONCLUSIONS: Long-term exposures to NO₂, PM_{2.5} and BC may be associated with premature mortality from PD, psychiatric diseases and suicides.

Keywords: air pollution, dementia, Alzheimer's Disease, Parkinson's Disease, psychiatric disorders, suicide



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LIGHTNING TALKS 1

Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-007

Outcomes » Childrens environmental health

Positive attitude, low level of knowledge and inappropriate practices towards air pollution: CAP study in Colombian children and adolescents

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BACKGROUND AND AIM: Children and adolescents increasingly demand more protection from the effects of air pollution and climate change. However, little is known about what they know, feel and do to protect themselves in tropical countries. The aim of this study was to evaluate knowledge, attitudes, and practices (KAP) about the effects of air pollution on health in children and adolescents.

METHODS: Cross-sectional study in eight educational institutions (three private and five public) in Colombia. In 2019 a KAP validated questionnaire was applied and a scale of 0-100 was constructed. The median (IQR: Q1 - Q3) were reported and the factors associated with better KAP were evaluated with Poisson regression and the PR (95% CI) was reported.

RESULTS: 1676 students in grades 6th to 11th were evaluated, 53.8% were female. The level of knowledge about composition, sources and effects was 43.8 (31.3 - 56.3). The 15.1% had high knowledge and the associated factors were positive attitude, good practice, being in 10th to 11th grade, significant school environmental project and private school. The attitude about measures to reduce air pollution was 76.9 (69.2 - 92.3), the 43.9% had a positive attitude and were positively associated with positive attitude, good practice and being a woman; private school decreases positive attitude. The level of practices was 28.6 (28.6 - 42.9), only 6.8% had good practices, 73.6% had never used masks to protect themselves from contamination and only 8.4% consulted the air quality index. The factors associated with the worst practices were being in 8th to 11th grade, significant school environmental project experience, private school, and practicing sports.

CONCLUSIONS: KAP levels on air pollution of children and adolescents in Colombia are not favorable. It is urgent to work on the issue at all educational levels, strengthen the school environmental project and work with parents from home.

Keywords: Air pollution, Children's environmental health, Policy and practice, Particle components, Science communication



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Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-008

Exposures » Environmental disparities

Using Satellite Data for Environmental Justice Efforts in California

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BACKGROUND AND AIM: Air quality management is increasingly focused not only on across-the-board reductions in ambient pollution concentrations, but also on identifying and remediating elevated exposures that often occur in traditionally disadvantaged communities. Remote sensing of ambient air pollution using data derived from satellites has the potential to better inform management decisions that address environmental disparities by providing increased spatial coverage, at high spatial resolutions, compared to air pollution exposure estimates based on ground monitors alone.

METHODS: Daily PM_{2.5} estimates for 2015-2018 were estimated at a 1 km² resolution, derived from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) satellite instrument and the Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm, and compared to federal ground monitors in order to assess the utility of highly-refined spatiotemporal air pollution data in the 13 communities included in the California Community Air Protection Program.

RESULTS: Results suggest that regulatory monitoring networks are unable to identify pollution hotspots within these communities without the addition of high-resolution satellite data. However, day-to-day temporal variability is generally well represented by nearby ground-based monitoring data even in communities with strong spatial gradients in pollutant concentrations.

CONCLUSIONS: These findings can help inform strategies for use of remote sensing data in environmental justice efforts including the screening of locations with air pollution exposures that are not well-represented by existing ground-based air pollution monitors.

Keywords: Air Pollution, Environmental Disparities, Environmental Justice, Exposure Assessment, Particulate Matter



ABSTRACT E-BOOK

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LIGHTNING TALKS 1

Air Pollution and Adverse Health Outcomes

Chairs: Adetoun Mustapha, Nigeria & Imane Sekmoudi, Morocco

O-LT-009

Exposures » Environmental disparities

Developing an air pollution exposure surveillance system in England; a new national vulnerability indicator

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BACKGROUND AND AIM: Air pollution is a serious public health issue and stakeholders (in particular local authorities (LA)) require more detailed information to protect those at risk. Public Health England was tasked to develop enhanced surveillance for air pollution, as part of the Environmental Public Health Tracking programme, and this may include surveillance of hazards (such as air pollution), exposures (concentrations of PM_{2.5} and NO₂) and susceptibility (pre-existing demographic, social and health conditions).

AIMS: 1) To scope and develop feasibility of air pollution exposure surveillance for stakeholders in England, 2) To design, pilot and trial potential new indicators to represent human vulnerabilities to air pollution, to help identify areas with populations who are sensitive, i.e. by age or socio-economic status (SES).

METHODS: Following extensive consultation with stakeholders, vulnerability indicator development was conducted in two stages: 1) choice of exposure data and susceptibility indicator, and 2) linkage of the exposure and susceptibility indicators to produce population vulnerability that can be provided in a useful output format, e.g. map, rating index or indicator. We interviewed pilot LA's to gain feedback on local application.

RESULTS: We focused on susceptibility to ambient air pollution: age, SES and location, and related these to air pollution (PM_{2.5} and NO₂) concentrations. We combined the exposure data and susceptibility to derive the vulnerabilities indicator plotted in a GIS. LA's interpreted the maps for their areas and fed back how the indicator supported local decision-making processes.

CONCLUSIONS: An air pollution exposure surveillance system is piloted for England. LAs welcomed the novel public health application and new datasets. The indicator shows where exposure needs to be tackled to reduce health effects including morbidity associated with exposure to outdoor air pollution. Next, the indicator needs to track the impact of interventions where changes in air pollution occur.

Keywords: Air pollution, Environmental disparities, Policy and Practice, methodological study design, exposures, multi-pollutants.



ABSTRACT E-BOOK

August 23, 2021 / 14:00 - 15:00 / Brooklyn Bridge Hall (Hall 2)

LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-011

Air pollution » Long-term exposure

Long-term air pollution exposure and incident stroke in American elderly population: a national cohort study

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BACKGROUND AND AIM: Literature has linked air pollution and cerebrovascular diseases including stroke. However, evidence is limited for the simultaneous effects of multiple air pollutants on stroke incidence.

METHODS: A nationwide population-based open cohort study was used to estimate the association between long-term exposure to PM_{2.5}, NO₂, ozone, and stroke incidence. The study population included all free-for-service Medicare enrollees (aged ≥65 years) in the contiguous United States from 2000-2017. We estimated the hazard ratios (HRs) for the first diagnosis with stroke using single-, bi-, and tri-pollutant Cox proportional hazards models that controlled for demographic characteristics, Medicaid eligibility, and area-level covariates. We further looked at this relationship in two sub-cohorts of enrollees who were always exposed to pollutant levels below the US EPA National Ambient Air Quality Standards [NAAQS] (annual PM_{2.5} ≤12 µg/m³, annual NO₂ ≤53 ppb, and warm-season ozone ≤50 ppb) and the WHO air quality guideline (annual PM_{2.5} ≤10 µg/m³, annual NO₂ ≤20 ppb, and warm-season ozone ≤40 ppb).

RESULTS: Increases of 10 µg/m³ in PM_{2.5}, 10 ppb in NO₂, and 10 ppb in ozone were associated with increased risk of first diagnosis with stroke, with HRs of 1.063 (95% CI, 1.048-1.077), 1.048 (1.043-1.052), and 1.031 (1.026-1.037), respectively. Among the below EPA low-exposure sub-cohort, the corresponding HRs were 1.041 (95% CI, 1.008-1.075), 1.067 (1.056-1.077), and 1.123 (1.108-1.138), respectively. When restricting analyses to levels below the WHO air quality guidelines, increasing pollution levels were consistently associated with a greater hazard estimate.

CONCLUSIONS: Long-term exposure to air pollution, even at concentrations below NAAQS or international standards, was significantly associated with increased stroke incidence among the US elderly population.

Keywords: Air pollution, Multi-pollutant, Stroke



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LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-012

Air pollution » General

Quantile regression to examine the association of air pollution with subclinical atherosclerosis in an adolescent population

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BACKGROUND AND AIM: Air pollution has been associated with early risk factors for later cardiovascular outcomes, including carotid intima-media thickness test (CIMT), a marker of subclinical atherosclerosis. To our knowledge, this is the first study to examine the association between air pollution exposure and CIMT in a younger adolescent population. We utilize quantile regression to examine the associations beyond mean regression analysis and examine if associations occur in the tails of the CIMT distribution.

METHODS: We measured CIMT at the age of 16 years in 418 adolescents participating in the Prevention and Incidence of Asthma and Mite Allergy (PIAMA) population-based birth cohort in the Netherlands. We fit separate quantile regressions to examine whether the associations of annual averages of air pollutants up to age 14 for nitrogen dioxide (NO₂), fine particulate matter (PM_{2.5}), PM_{2.5} absorbance (a marker for black carbon) and PM coarse assigned at the participants' residential addresses varied across deciles of CIMT. We report the quantile regression coefficients that corresponded to an average change in CIMT (μm) associated with an interquartile range increase in the air pollution concentrations. Models were adjusted for age, sex, body mass index (BMI), gestational age at birth and birthweight, parental education, parental smoking status and maternal BMI and breastfeeding status.

RESULTS: Interquartile range increases in NO₂, PM_{2.5} and PM_{2.5} absorbance during the first 2 years of life were associated with significantly higher CIMT in the lower tails of the distribution. NO₂ exposure at birth had the largest statistically significant association with a 7.22 μm (95% CI: 5.28, 10.42) increase per IQR increase in NO₂ for the 10th quantile of CIMT but was not significantly related to the 50th quantile (estimate: 1.64 μm, 95% CI: -1.49, 6.78).

CONCLUSIONS: Early childhood exposure to air pollution concentrations was associated with an increase at the lower tails of the CIMT distribution during adolescence.

Keywords: Quantile regression, Environmental Epidemiology, Air pollution, Cardiovascular, Atherosclerosis



ABSTRACT E-BOOK

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LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-013

Air pollution » Particulate matter

Associations between long-term fine particulate matter exposure and hospital procedures in heart failure patients

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BACKGROUND AND AIM: Airborne particulate matter smaller than 2.5 µm in diameter (PM2.5) contributes to global morbidity and mortality. Changes in observed hospital procedures may indicate worsening health and drive healthcare costs. However, there are few studies which quantify PM2.5 impacts on hospital procedures.

METHODS: We examined associations between annual average PM2.5 and hospital procedures observed among heart failure (HF) patients after HF diagnosis. Annual (365 day) average PM2.5 was estimated at 1x1 km resolution, and the 365 days leading up to the HF diagnosis were averaged to estimate annual average PM2.5 exposure. The final study cohort was composed of 15,979 HF patients seen at the University of North Carolina Healthcare System from 2004-2016 with an average follow-up time of 2.94 years. We used quasipoisson models to model the percent change in the number of observed procedures over the follow-up time while adjusting for age at HF diagnosis, race, sex, year of visit, short-term PM2.5 exposure, and socioeconomic status.

RESULTS: We examined 56 hospital procedures and observed significant ($P < 0.05/56$) associations between annual average PM2.5 exposure and 15 hospital procedures. We observed increases in procedures such as two view chest x-rays (6.99% change; 95% confidence interval = 5.47%, 8.54%) and echocardiograms (5.71% change; 95% confidence interval = 3.29%, 8.19%). Decreases were observed in stress test related procedures such as stress imaging tests involving regadenoson injections (-12.46% change; 95% confidence interval = -18.02%, -6.51%) and Technetium sestamibi radiological imaging which is used in conjunction with exercise stress tests (-13.47% change; 95% confidence interval = -18.90%, -7.68%).

CONCLUSIONS: PM2.5 exposure is associated with significant changes in hospital procedures in HF patients. Overall, these associations give a unique lens into patient morbidity and hospital system operations and healthcare costs linked to PM2.5 exposure. This abstract does not necessarily represent EPA policy.

Keywords: Air pollution, particulate matter, long-term exposure, cardiovascular diseases



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August 23, 2021 / 14:00 - 15:00 / Brooklyn Bridge Hall (Hall 2)

LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-015

Air pollution » Long-term exposure

The Effects of Short- and Long-term Exposures to Air Pollution on microRNA in Participants of the Normative Aging Study (NAS)

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BACKGROUND AND AIM: Previous research have suggested the link between air pollution and epigenetic changes such as microRNA expression. In this study, we examined whether short- and long-term exposures to PM_{2.5}, NO₂, and O₃ are associated with changes in the microRNA profile of patients in the Normative Aging Study (NAS).

METHODS: The study population consisted of persons enrolled in NAS which has followed male veterans every three to five years since 1963. Our study period of interest spanned from 1999 to 2015. Blood samples collected from participants were used to sequence microRNA found in extracellular vesicles. We included 712 samples from 657 participants which passed quality checks after processing. We used fine-scaled predictions derived from ensemble models to assign exposure values based on each subject's residential address. Mixed-effects quantile regression analyses were used to examine the exposure-outcome relationship with random intercepts for each person. We adjusted for covariates such as age, race, education level, smoking, drinking, BMI, diabetes, temperature and batch effects. We then linked microRNA which significantly changed in response to air pollution with their biological pathways. We further looked at the association between the detected microRNA sequences and cardiovascular health outcomes.



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RESULTS: Each 1- $\mu\text{g}/\text{m}^3$ increase in 12-week and 6-month moving averages of PM_{2.5} were associated with a decrease of 3.15 (95% CI: 5.93, 0.37) and 5.80 (95% CI: 9.57, 2.03) in the median number of unique microRNA reads in the patient population, respectively. In single-pollutant models, an increase in intermediate and long-term moving averages of PM_{2.5} were associated with significant changes in several microRNA species linked to pancreatic cancer and chronic myeloid leukemia (CML).

CONCLUSIONS: Air pollution exposures were associated with significant changes in several microRNA species.

Keywords: Air Pollution, Epigenomics, Cardiovascular Diseases, Environmental Epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 14:00 - 15:00 / Brooklyn Bridge Hall (Hall 2)

LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-016

Air pollution » Particulate matter

The Association Between PM_{2.5} and Blood Pressure in Indonesia

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BACKGROUND AND AIM: Indonesia faces significant air quality issues due to peatland fires associated with agricultural land management and rapid urbanization. Limited prior research has estimated the episodic shock of intense fires on morbidity and mortality in Indonesia but has largely ignored the impact of poor air quality on biomarkers of chronic disease risk. We conducted a cross-sectional study of the association between particulate matter less than 2.5 microns in diameter (PM_{2.5}) and blood pressure.

METHODS: Blood pressure was obtained from the fifth wave of the Indonesian Family Life Survey (IFLS5), fielded in late 2014 and early 2015. The IFLS is an ongoing population-based socioeconomic and health survey. We used a global chemical transport model, GEOS-Chem version 12.8.2, to simulate daily PM_{2.5} concentrations at 0.5° x 0.625° resolution across the IFLS domain. GEOS-Chem, a three-dimensional atmospheric composition model, was used to assign PM_{2.5} exposure based on each participant's kabupaten, or district, of residence. We assessed the association between PM_{2.5} and blood pressure, using mixed effects models with random intercepts for kabupaten and household and adjusted for age, sex, smoking status, BMI, hypertension medication, education, subjective socioeconomic status, and seasonality.

RESULTS: For each 10 µg/m³ increase in PM_{2.5} in the month before the clinical exam, we find a 0.14% (95% CI: -0.01, 0.28) increase in diastolic blood pressure in adults, with a greater association seen in participants age 65 and over (0.6%, 95% CI: 0.03, 1.17). For the same exposure metric, there was a 0.8% (95% CI: 0.18, 1.41) increase in systolic blood pressure in participants 65 and older.

CONCLUSIONS: To our knowledge, this is the first study to provide evidence for an association between PM_{2.5} and blood pressure in Indonesia. If this association is causal, the health burden of air quality within Indonesia may be severely underestimated.

Keywords: air pollution, particulate matter, wildfires, cardiovascular diseases



ABSTRACT E-BOOK

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LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-017

Air pollution » Particulate matter

Associations between Long-term UFP Exposure and Certain Inflammatory Biomarkers and Blood Lipid Indicators: An Analysis Featuring Peak Exposure Metrics

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BACKGROUND AND AIM: Recent studies suggested that certain inflammatory biomarkers and blood lipid indicators may be associated with annual average of ultrafine particle (UFP) exposure. However, associations with repeated peaks of UFP exposure are rarely studied. We previously proposed a novel metric for assigning UFP peak exposure. We hypothesize that, compared to annual average exposure, cumulative UFP peak exposure over a year may have stronger associations with the aforementioned biomarkers and indicators.

METHODS: Blood samples from 452 participants living in the Greater Boston Area were analyzed for three inflammatory biomarkers [high-sensitivity C-reactive protein, interleukin-6 and tumor necrosis factor receptor 2 (TNF-RII)] and four blood lipid indicators [total cholesterol, triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL)]. UFP exposure data was hourly averages of particle number concentration (PNC) estimated using a land use regression model based on mobile-monitored ambient UFP concentration, with time-activity adjustment applied. Both blood sample and UFP exposure data were previously reported in the literature. Multivariate regression models were used to analyze associations between our peak exposure metric and the outcome biomarkers and indicators.

RESULTS: An increase in cumulative UFP peak exposure was significantly associated with a decrease in blood total cholesterol and HDL level. It was also significantly associated with an increase in blood TNF-RII among Non-Hispanic Whites. The association with total cholesterol level was not found using annual average UFP exposure. The change of these three outcomes associated with one inter-quartile range's (IQR) increase in peak exposure was greater than the change associated with one IQR's increase in annual average exposure.

CONCLUSIONS: Associations between UFP exposure and inflammatory biomarkers and blood lipid indicators based on our peak exposure metric were generally similar to associations based on the annual average metric. However, for certain biomarkers and indicators, our peak exposure metric may show stronger associations than the annual average.

Keywords: Traffic-related, Particulate matter, Cardiovascular diseases, Exposure assessment, Modeling, Environmental epidemiology



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LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-018

Air pollution » Particulate matter

Associations between Air Pollution and County Level Cardiovascular Mortality in the United States by Ecoregions

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BACKGROUND AND AIM: Air pollution has been strongly associated with cardiovascular outcomes. However, it is unclear whether such associations vary with differences in biotic and abiotic surroundings. Therefore, we investigated whether the associations between air pollutants and mortality vary by ecosystems in the United States.

METHODS: County level age-adjusted mortality data were linked to average yearly pollutant levels (PM_{2.5}, PM₁₀, Ozone, NO₂, SO₂) for 2010 in the contiguous United States (n=3,071). Counties were classified into EPA level II ecoregions. Associations between IQR of pollutant levels and log-transformed mortality rates, clustered by ecoregion, were estimated using linear mixed models. All models were adjusted for population density, urbanicity, and percentage of the county residents who were: male, white, smokers, obese, high school educated, in poverty, and binge drinkers.

RESULTS: Cardiovascular mortality was strongly associated with PM_{2.5} (5.9% per 2.94 µg/m³; 95% CI: 5.1, 6.7), and to a lesser extent, PM₁₀, ozone, SO₂, and NO₂. In ecoregion specific analyses, we observed stronger associations between PM_{2.5} and cardiovascular mortality in the South Central Semi-Arid Prairies (9.4%; 95% CI: 7.8, 10.9), and Atlantic Highlands (8.4%; 95% CI: 6.2, 10.7). For PM₁₀ and ozone, the strongest associations with cardiovascular mortality were observed in the Southeastern USA Plains: 3.8% increase per 5.7 µg/m³ (95% CI: 2.8, 4.9), and 2.9% increase per 7.2 ppb (95% CI: 2.1, 3.7), respectively. We also observed stronger associations between NO₂ (4.2% per 2.1 ppb; 95% CI: 2.6, 6.0) and SO₂ (8.1% per 0.6 ppb; 95% CI: 5.7, 10.6) with cardiovascular mortality in the Mississippi Alluvial and Southeast USA Coastal Plains, an area with humid climate and wetlands.



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CONCLUSIONS: The county-level association between air pollution and cardiovascular mortality varies by ecoregion, suggesting that the type, quality, and quantity of the surrounding natural environment, or regional pollution composition, may modify the cardiovascular effects of air pollutants.

Keywords: air pollution, cardiovascular mortality, natural environment, ecosystem



ABSTRACT E-BOOK

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LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-019

Air pollution » General

Methylation markers associated with air pollution exposure and cardiometabolic health in the Framingham Offspring Study

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BACKGROUND AND AIM: We conducted a systematic literature review to identify methylation (CpG) sites associated with air pollution exposure. We assessed if these CpG sites were associated with air pollution and cardiometabolic health outcomes in the Framingham Offspring Study. We hypothesized that associated CpG sites could provide mechanistic insight into cardiometabolic health effects of air pollution.

METHODS: We used data from 480 Framingham Offspring Study participants with epigenome-wide methylation profiles (Illumina Infinium HumanMethylation450 BeadChip on blood-derived DNA) assessed at the eighth examination cycle (2005-2008; 70% men; mean age=71 years). We examined cross-sectional associations between 2358 CpG sites identified through our systematic literature review and (1) short-term air pollutant exposures (1- and 28-day average particle number concentration, nitrogen dioxide, black carbon (BC), and particulate matter (PM_{2.5}); linear regression); (2) annual average BC and PM_{2.5} exposure (from 2000; linear regression); and (3) cardiovascular disease or cardiometabolic multi-morbidity (CVD/CMD; logistic regression). We assessed longitudinal associations between methylation markers and cardiometabolic outcomes (CVD/CMD at the ninth examination cycle or CVD-related mortality; logistic regression). All models adjusted for age, sex, body mass index, and current smoking. We a priori chose $p < 0.001$ as the threshold for statistical significance (recognizing findings could still be due to chance).

RESULTS: We identified 16 CpGs associated with ≥ 1 air pollutant. One CpG corresponding to a gene encoding serine/threonine protein kinases was associated with both 28-day BC and PM_{2.5}. Thirteen CpGs associated cross-sectionally with CVD/CMD, and 42 CpGs associated longitudinally with CVD/CMD/CVD-related mortality (11 overlapping CpGs; 0 overlapping with air pollutant-associated CpGs). Four CpGs associated with air pollutants and seven CpGs associated cross-sectionally with CVD/CMD correspond to genes involving serine/threonine kinases. CpGs associated with air pollutants and health outcomes also corresponded to genes involved in inflammation/immunity (5 CpGs) and transcription (12 CpGs).

CONCLUSIONS: Serine/threonine protein kinases may affect biologic pathways relating air pollution exposure to cardiometabolic health.

Keywords: epigenomics, molecular epidemiology, long-term exposure, short-term exposure, cardiovascular diseases



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LIGHTNING TALKS 2

Air Pollution and Cardiovascular Outcomes

Chairs: Annette Peters, Germany & Leonard Stockfelt, Sweden

O-LT-020

Air pollution » Particulate matter

Critical windows of perinatal particulate matter (PM_{2.5}) exposure and preadolescent kidney function

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BACKGROUND AND AIM: Air pollution exposure, especially particulate matter $\leq 2.5 \mu\text{m}$ in diameter (PM_{2.5}), is associated with poorer kidney function in adults and children. Perinatal exposure may occur during susceptible periods of nephron development. We aimed to examine perinatal windows of susceptibility to PM_{2.5} exposure on preadolescent kidney function parameters and blood pressure (BP).

METHODS: We used distributed lag nonlinear models (DLNMs) to examine time-varying associations between early life daily PM_{2.5} exposure (periconceptional through 1 year of life) and kidney parameters as well as BP in preadolescent children aged 8 to 9 years. Participants included 427 mother-child dyads enrolled in the PROGRESS birth cohort study based in Mexico City. Daily PM_{2.5} exposure was estimated at each participant's residence using a validated satellite-based spatio-temporal model. Kidney function parameters included estimated glomerular filtration rate (eGFR), serum cystatin C, blood urea nitrogen (BUN), and BP. Models were adjusted for child's age, sex and body mass index (BMI) z-score, as well as maternal education, indoor smoking report, seasonality and average first year of life PM_{2.5} exposure.

RESULTS: Average perinatal PM_{2.5} was 22.7 $\mu\text{g}/\text{m}^3$ and ranged 16.4-29.3 $\mu\text{g}/\text{m}^3$. Early pregnancy PM_{2.5} exposures were associated with hyperfiltration in preadolescence. Specifically, we found that PM_{2.5} exposure between weeks 1 to 18 of gestation was associated with increased preadolescent eGFR. A constant 5 $\mu\text{g}/\text{m}^3$ increase in PM_{2.5} sustained throughout this window would predict a cumulative increase in eGFR of 4.44 mL/min (95%CI: 1.37, 7.52). Additionally, late pregnancy levels of



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PM2.5 were associated with elevated BUN. In a stratified analysis, an association between PM2.5 and higher systolic BP was evident among boys but not girls.

CONCLUSIONS: We identified perinatal windows of susceptibility to PM2.5 exposure with preadolescent kidney function parameters. Follow-up investigating PM2.5 exposure with peripubertal kidney function trajectories and risk of kidney disease in adulthood will be critical.

Keywords: particulate matter, kidney function, Cardiovascular diseases, Children's environmental health, environmental epidemiology,



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LIGHTNING TALKS 3

Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-021

Climate » Temperature

The association between postnatal exposure to ambient temperature and rapid infant weight gain

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BACKGROUND AND AIM: The global prevalence of childhood overweight and obesity has risen dramatically in recent years. Previous studies found associations between rapid infant weight gain and risk of obesity. We suggest exposure to high ambient temperatures may lead to infant weight gain, potentially through lower energy expenditure from reduced brown adipose tissue activation. We aimed to examine associations between exposure to ambient temperature and weight gain during infancy.

METHODS: This is a large population-based historical cohort study, using data from the Israeli national public network of maternal and child health clinics from 2008 to 2013. We assessed exposure to ambient temperature using a high-resolution hybrid spatio-temporal model and calculated the annual mean and minimum temperature for each infant based on daily mean and minimum temperatures at the child health clinic location. We fitted logistic regression and general additive models with thin plate regression splines to explore the association between ambient temperature and rapid infant weight gain, defined as a difference of >0.66 in adjusted weight z-scores between birth and one year of age.

RESULTS: The study population included 217,310 singleton-term infants. Logistic regression models demonstrated a J-shaped association between minimum ambient temperature exposure and rapid infant weight gain. When compared to infants exposed to the third quintile of minimum temperature, infants exposed to the fourth and fifth quintiles presented a higher adjusted risk of rapid infant weight gain, odds ratio = 1.06 (95% CI 1.03, 1.10) and odds ratio = 1.09 (95% CI 1.05, 1.13) respectively. These associations were similar but slightly weaker when examining mean ambient temperature.

CONCLUSIONS: Exposure to higher ambient temperatures in Israel is associated with an increased risk of rapid infant weight gain. Since this association has not been previously examined, it should be studied in other populations, and causality should be explored.

Keywords: Children's environmental health, Climate, Temperature



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LIGHTNING TALKS 3

Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-022

Climate » Temperature

Effect modification of omega-3 fatty acids on short-term associations between ambient air temperature and heart rate variability

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BACKGROUND AND AIM: Although the biological mechanisms remain uncertain, non-optimal air temperatures have been associated with cardiovascular mortality. Dietary intake of omega-3 fatty acids (n-3 FA) has been correlated with cardiovascular health. This panel study aimed to examine whether n-3 FA would modify associations between ambient air temperature and autonomic function measured by changes in heart rate variability (HRV).

METHODS: Six-two healthy adults (age: 25–55 years) residing in North Carolina, U.S. were recruited into low (n=28) and high (n=34) omega-3 groups based on dietary n-3 FA intake and blood levels of omega-3 index. Each participant underwent 3-5 examinations separated by at least one week between October 2016 and September 2019. HRV was measured using 5-minute resting electrocardiography recorded at each examination. Daily meteorological data were obtained from a central air monitoring station. We applied mixed-effects models with a distributed lag non-linear approach to assess associations between air temperature (lag 0-6 days) and HRV stratified by omega-3 levels.

RESULTS: We observed inverse U-shape relationships between HRV indices and temperature in the low omega-3 group, which were significant for high temperatures. No associations were observed in the high omega-3 group. An increase from 10 °C (approximate optimum temperature) to the 95th percentile (28 °C) of temperature was associated with decreases in standard deviation of NN intervals [SDNN, -40.6% (95% CI: -63.7, -2.7)], root mean square of successive RR interval differences [RMSSD, -63.9% (95% CI: -82.7, -24.8)], and high-frequency power [HF, -82.7% (95% CI: -97.2, 5.2)]. The between-group differences were significant for RMSSD and HF.

CONCLUSIONS: Non-optimal air temperatures, especially high temperatures were associated with decreased parasympathetic autonomic function that might explain the temperature effects on cardiovascular events. In addition, n-3 FA intake was associated with beneficial effects on autonomic function against non-optimal temperatures. This abstract does not necessarily reflect EPA policy.

Keywords: Cardiovascular diseases, Climate, Environmental epidemiology, Short-term exposure, Temperature



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Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-024

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

Environmental quality characterization of public schools transformed into climate shelters in Barcelona: A pilot innovative study

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BACKGROUND AND AIM: The Barcelona's Climate Shelters pilot project has converted eleven primary schools, considered vulnerable to heat and air pollution, into urban climate shelters by implementing a diverse package of blue (water), green (vegetation) and grey measures (shade and building ventilation). An evaluation strategy to assess the potential environmental benefits achieved on temperature, humidity and air quality has been implemented.

METHODS: Each of the eleven pilot schools was equipped with six low-cost Smart Citizen Kits and one multisensor AQMesh pod for climatological (temperature, relative humidity and atmospheric pressure), and air quality monitoring (PM_{2.5}, PM₁₀, NO₂, NO, O₃, CO and SO₂). According to the transformations applied, low-cost kits were deployed at outdoor and indoor locations in intervention and reference areas (control stations). Occasionally, intensive measurement campaigns using additional sensor kits and NO₂ passive diffusion tubes were also performed. Data collection began in August 2019 and will last until October 2021. We followed a pre (before school interventions) and post (after summer 2020) evaluation strategy to compare environmental measures trends over time.

RESULTS: To date, the pre-intervention results showed that on average schoolchildren were exposed 22% of the days to indoor temperatures higher than 26°C. Regarding PM_{2.5} and PM₁₀, outdoor daily mean limits of the World Health Organization (WHO) were exceeded up to 2.4% (> 25µg/m³) and 2.9% (> 50µg/m³) of the days, respectively. Finally, until early 2020 most of the schoolyards were exposed to NO₂ levels above the WHO annual mean limit of 40µg/m³. These levels significantly decreased due to the impact of the strict COVID-19 pandemic lockdown. The first post-intervention results will be available at the end of July 2021.

CONCLUSIONS: This innovative intervention schools project will help us to identify the most effective solutions, which could be reproduced and further scaled up in the future, both locally and across other cities.

Keywords: Air pollution, Climate, Children's environmental health, Methodological study design, Exposure Assessment.



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Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-025

Air pollution » Particulate matter

Local mortality impacts due to future air pollution under climate change scenarios in Mozambique, India, and Spain

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BACKGROUND AND AIM: The health impacts of global climate change mitigation will affect local populations differently. We aimed to quantify the local health impacts due to fine particles (PM_{2.5}) under the governance arrangements embedded in the Shared Socioeconomic Pathways (SSPs1-5) under two greenhouse gas concentration scenarios (Representative Concentration Pathways (RCPs) 2.6 and 8.5) in local populations of Mozambique, India, and Spain

METHODS: We simulated the SSP-RCP scenarios using the Global Change Analysis Model, which was linked to the TM5-FASST model to estimate PM_{2.5} levels. We used comparative risk assessment methods to estimate attributable premature deaths due to PM_{2.5} linking local population and mortality data with PM_{2.5}–mortality relationships from the literature. We incorporated population projections under the SSPs in sensitivity analysis.

RESULTS: PM_{2.5} attributable burdens in 2050 differed across SSP-RCP scenarios, and scenario-sensitivity varied across populations. Holding population change constant, variation in PM_{2.5} attributable deaths in 2050 across scenarios was small in Manhiça (min:103, max:116 deaths per 100,000) and Barcelona (min:73, max:115), compared to Vadu (min:154, max:264). Future attributable mortality burden of PM_{2.5} was highly sensitive to assumptions about how populations will change according to SSP. SSPs reflecting high challenges for adaptation (SSPs 3 and 4) consistently resulted in the highest PM_{2.5} attributable burdens mid-century

CONCLUSIONS: Our analysis of local PM_{2.5} attributable premature deaths under SSP-RCP scenarios in three local populations highlights the importance of both socioeconomic development and climate policy in reducing the health burden from air pollution. Sensitivity of future PM_{2.5} mortality burden to SSPs was particularly evident in low- and middle- income country settings due either to high air pollution levels or dynamic populations.

Keywords: climate change mitigation; shared socioeconomic pathways; air pollution; mortality, representative concentration pathways



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LIGHTNING TALKS 3

Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-026

Climate » Temperature extremes and variability

The missing exposure-outcome link: “equivalent” outdoor ambient temperatures for assigning heat-health effects to individual-level temperature exposures in three U.S. cities

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BACKGROUND AND AIM: Heat-health epidemiologic studies often lack information on key determinants of exposure, including occupation, housing, and air conditioning, at the individual or parcel (home) level. Therefore, effect estimates specific to people in subgroups defined by various combinations of these determinants are often not available. We derived subgroup estimates from modeled individually-experienced temperatures (IETs) during 10 days around a past city-specific extreme heat event for three U.S. cities of varying climates: Atlanta, Georgia (hot-humid), Detroit, Michigan (temperate), and Phoenix, Arizona (hot-dry).

METHODS: IETs were previously estimated for 2.5 million people in the three cities using modeled data: parcel-linked population microdata, housing-specific indoor temperatures, temporospatially-varying outdoor ambient temperatures, and time activity patterns. To each of the IETs we linked the daily outdoor ambient temperatures as measured at the regional airport—the temperature exposure often used in heat-health studies. We then fit a mixed-effects regression model to predict this often-used temperature exposure, ‘equivalent’ outdoor airport temperature, based on IET and housing type, demographics, air conditioning, and person-specific random effects. Using the equivalent temperatures, we assigned risk ratios (RRs, for increases in outdoor airport temperature) from existing literature on mortality, emergency department visits, and preterm births to each person-day and estimated attributable burdens (using age/race/sex) health event counts.

RESULTS: The equivalent temperatures, RRs, and attributable burdens, by design, differed between population subgroups due to variability in indoor and outdoor temperature exposure. For example, heat-associated deaths were 150% higher among Blacks vs. Whites in Atlanta and 40% higher in Detroit. Emergency department visits were 19%, 13%, and 25% higher in Atlanta, Detroit, and Phoenix, respectively, among those without vs. with air conditioning.

CONCLUSIONS: When IETs are known, these person-specific equivalent temperatures can be used to estimate subgroup and spatially-varying heat-health burdens for resource allocation for future heat waves and environmental and energy justice policies.

Keywords: climate change, indoor temperature exposure, urban heat island, climate vulnerability, extreme weather preparedness



ABSTRACT E-BOOK

August 23, 2021 / 14:00 - 15:00 / Empire State Building Hall (Hall 4)

LIGHTNING TALKS 3

Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-027

Climate » Temperature

Evaluation of heat mitigation and adaptation behaviors in NYC during COVID-19

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BACKGROUND AND AIM: Rising temperatures threaten the safety of at-risk populations in cities. The threat of COVID-19 introduced new risks.

METHODS: In May 2020, New York City (NYC) initiated the Get Cool NYC program, which addressed indoor heat exposure during the summer by distributing 74,000 air conditioners (ACs) to low-income seniors (60+) in private and public housing. In the fall, a survey to assess whether the ACs helped those who wished to stay home do so safely was distributed to: (1) program participants living in privately-owned housing (3,800) and (2) a group of non-eligible New Yorkers (12,029). The comparison group included section 8 tenants (55-59 years) living in private housing (NYC Department of Housing and Preservation and Development), NYC Department for the Aging clients and ineligible Get Cool applicants younger than 60. Difference in prevalence estimates across program participants and comparison respondents without AC, and within groups across years, were compared with Rao-Scott Chi-Square tests.

RESULTS: The American Association for Public Opinion Research response rate 2 among program participants and non-participants was 22.2% (845 complete) and 13.5% (1,126 complete), respectively. About 35% (395) of the non-participant group did not have an AC in 2020. While COVID-19 influenced both groups, within the participant group, respondents were more likely to stay home during summer 2020 than summer 2019 (90%, CI: 88, 92 vs. 71%, 95% CI: 67, 74). In contrast, we observed no difference in the non-participant group (67% in 2019 versus 68% in 2020). Both groups took similar advantage of other city-implemented mitigation strategies, such as green space and cooling centers.

CONCLUSIONS: Our findings demonstrate the need for heat intervention strategies to decrease barriers to thermal safety, providing people with a range of choices but focusing on the ability to stay home safely and in comfort for populations most impacted.

Keywords: Extreme Heat, Covid-19, Policy, mitigation, adaptation



ABSTRACT E-BOOK

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LIGHTNING TALKS 3

Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-028

Air pollution » Wildfires

Wildfire smoke as a driver of covid-19 fatality rates? A synthetic control analysis of San Francisco Bay Area Counties

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BACKGROUND AND AIM: The 2020 wildfire season broke records for the most active fire year on the West Coast, resulting in the worst air quality observed in decades. Concurrently, the public health threat of COVID-19 has caused approximately 3.6 million cases and 59,000 deaths in California to date. Due to the association between air pollution and respiratory disease outcomes, wildfire-specific particulate matter exposure is a hypothesized driver of COVID-19 severity. While several studies have considered this association, methodological challenges exist to study this question due to the ecological fallacy and threat of unmeasured confounders in this proposed etiological question. Additionally, no study has considered wildfire smoke as a natural experiment. This study proposes synthetic control methods (SCM) to study the impact of wildfire smoke on COVID-19 mortality rates, considering smoke exposure as a natural experiment. The San Francisco Bay Area (SFBA)—a densely populated region with record-high smoke exposure—is ideal to study this question.

METHODS: The CDC COVID data tracker was used to compute weekly case-fatality ratios for each county in the United States from May 11th to November 10th, 2020. The NOAA hazard mapping Smoke Product was used to identify county-level wildfire smoke exposure; counties with area covered by heavy smoke surpassing 70% on average in a given week were considered exposed. Unexposed counties were considered as potential controls. Counties were considered eligible if more than 100 COVID-19 deaths were reported during the study period.

RESULTS: Exposure to heavy smoke started between the weeks starting August 26th to September 7th in six eligible counties in which 1,307 COVID-19 deaths occurred within the study period. Results indicate some counties observed an increase in case fatality ratios, while other counties didn't exhibit change.

CONCLUSIONS: Results can be used to understand environmental drivers of COVID-19 mortality, and protect vulnerable populations from concurrent and potentially concomitant public health threats.

Keywords: Covid-19, wildfire smoke, synthetic control method



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Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-029

Climate » Natural disasters

Associations Between Drought and Childhood Diarrhea in Low- and Middle-Income Countries

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BACKGROUND AND AIM: Diarrheal diseases are the fifth leading cause of death among children under five. Climate change is projected to intensify hydrological variability and extreme weather events such as drought. However, current evidence on the association between drought and diarrhea is scarce. We aim to quantify this association in children under five in low- and middle-income countries (LMICs).

METHODS: Data on childhood diarrhea for 38 LMICs during 2010-2018 were obtained from the Demographic and Health Surveys program. The 24-month scale Standard Precipitation Evapotranspiration Index (SPEI) with a 0.5 degrees spatial resolution across the survey sites was retrieved from the Global SPEI database. Drought was defined as severe drought ($-1.6 < \text{SPEI} \leq -1.3$), extreme drought ($-2.0 < \text{SPEI} \leq -1.6$), or exceptional drought ($\text{SPEI} \leq -2.0$). Binomial generalized linear mixed models with random effects for survey cluster, and survey country and year, were constructed to examine the association of diarrhea with drought, adjusting for survey month and other sociodemographic and water, sanitation, and hygiene-related variables.

RESULTS: In total there were 294,453 childhood (<5 years) diarrhea occurrences recorded during the two weeks before the interview; the overall prevalence was 11.6%, with the highest prevalence among children aged 6-23 months. After controlling for inter-cluster heterogeneity and country-year variability, exposure to severe, extreme and exceptional drought events during the preceding two-year window was associated with an increased risk of diarrhea of 8% (95% confidence interval (CI) 2%-16%), 33% (95% CI 26%-42%), or 47% (95% CI 30%-67%), respectively, compared to non-exposure to drought.

CONCLUSIONS: Our study indicates all levels of drought are significantly associated with elevated risks of childhood diarrhea in LMICs, with a higher risk associated with more severe drought.

Keywords: Children's environmental health, infectious diseases, climate, natural disasters



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Climate-Related Exposures and Adverse Health Outcomes

Chairs: Tarik Benmarhnia, United States & Kate Burrows, United States

O-LT-030

Climate » General

Differential Susceptibility to Aridity for Mortality Outcomes in South Africa: Application of Mixed-Effect Regression Tree Analysis to a Case-Only Design

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BACKGROUND AND AIM: We investigated whether the relationship between recent aridity and mortality might be different according to demographic subgroups in South Africa over 1997-2013.

METHODS: DESIGN: This study drew on a case-only sample comprised of recorded deaths (n=8,509,130) in South Africa over 1997-2013, using data from the country's civil registration system. The dataset included race, sex, and age of the deceased, as well as the district municipality (52 clusters) of the deceased. We linked to each person the district-level 6-month Standardized Precipitation Index (6-month SPI) representing the relative aridity over the 6 months preceding their death. ANALYSIS: For this analysis we excluded participants with missing data (included n=6,139,287). We applied an algorithm for recursive partitioning based on linear mixed-effect models to distinguish demographic subgroups with high homogeneity in their 6-month SPI at time of death (conditional on partitioning variables), while accounting for the clustering of participants in districts. Our predictors were: recorded race (5 categories recorded in dataset: Black African, White, Indian or Asian, Coloured, or Other/Unknown/Unspecified), recorded sex (male or female), and age category (4 categories: 0-4 years, 5-14 years, 14-64 years, and 65+ years).

RESULTS: The recursive partitioning algorithm indicated six demographic subgroups that appeared to have potentially differential vulnerability to 6-month SPI for mortality outcomes: [1] "Coloured" males ages 14-64; [2] "Black African or White or Indian or Asian or Other" males ages 14-64; [3] females of any race ages 14-64; [4] "White or Indian or Asian or Coloured" of any sex ages 0-4; [5] "Black or Other/Unknown/Unspecified race" of any sex not ages 14-64; and [6] "White or Indian or Asian or Coloured" of any sex ages 5-14 or 65+.

CONCLUSIONS: This approach suggested several composite demographic groups that may be the focus of future research on aridity-demographic interactions for mortality rates, potentially simplifying from 40 strata to 6 priority groups.

Keywords: Climate, Methodological study design, Modeling, Environmental disparities, Environmental epidemiology, Socio-economic factors



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LIGHTNING TALKS 4

The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-031

Built environment » General

Associations of urban environment features with hypertension and blood pressure across 230 Latin American cities

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BACKGROUND AND AIM: Several urban risk factors may be linked to high blood pressure, a leading risk factor for global burden of disease. We examined associations of urban physical environment features with hypertension and blood pressure measures in adults across 230 Latin American cities.

METHODS: In this cross-sectional study we used data from the SALURBAL project. The individual-level outcomes were hypertension and levels of systolic and diastolic blood pressure. The exposures were city and sub-city built environment features, mass transit infrastructure, and green space. Odds ratios [OR] and mean differences and 95% confidence intervals (95% CI) were estimated using multilevel logistic and linear regression models, with single and multiple exposure models adjusted for individual-level age, sex, education, and sub-city educational attainment.

RESULTS: A total of 109,176 participants from 230 cities and 8 countries were included in the hypertension analyses and 50,228 participants from 194 cities and 7 countries were included in the blood pressure analyses. In multiple exposure models, higher city fragmentation was associated with higher odds of having hypertension [OR (95%CI): 1.11 (1.01, 1.21)]; presence of mass transit in the city was associated with higher odds of having hypertension [OR (95%CI): 1.30 (1.09, 1.54)]; higher sub-city population density was associated with lower odds of having hypertension [OR (95%CI): 0.90 (0.85, 0.94)]; and higher sub-city intersection density was associated with higher odds of having hypertension [OR (95%CI): 1.09 (1.04, 1.15)]. Higher fragmentation and the presence of mass transit in the city were also associated with higher diastolic blood pressure.

CONCLUSIONS: Our results suggest that urban fragmentation, mass transit, population density and intersection density may be related to hypertension levels in the cities of Latin American countries. Reducing chronic disease risks in the growing urban areas of Latin America may require attention to integrated management of urban design and transport planning.

Keywords: Built environment, Green space, Cardiovascular diseases



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LIGHTNING TALKS 4

The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-032

Built environment » General

Socioeconomic disadvantage is associated with increased risk of mortality from COVID-19

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BACKGROUND AND AIM: Living in a disadvantaged neighborhood has been linked to many adverse health outcomes. Chronic social and economic stressors associated with disadvantaged neighborhoods may also contribute to an increased risk of severe outcomes following infection with SARS-CoV-2, the causative agent of COVID-19. The aim of this study was to compare a standardized metric of neighborhood socioeconomic deprivation with COVID-19 mortality rates and case fatality rates.

METHODS: The area deprivation index (ADI) is a standardized measure of community deprivation based on 21 census-block level socioeconomic indicators (<https://www.neighborhoodatlas.medicine.wisc.edu/>). ADI is scaled from 1-100, with 1 indicating the least deprivation and 100 the most deprivation. For analysis, ADI was aggregated to county using the R-package “sociome” and categorized into quintiles and deciles. County level COVID-19 cases and mortality were obtained from the COVID-19 Data Repository maintained by Johns Hopkins University. Mortality and case-fatality rates were modeled as a function of ADI using a mixed effects negative binomial model, with a random intercept for state, controlling for percentage over age 65, percentage male, and percentage non-white.

RESULTS: Mortality rates ranged across quintiles of increasing ADI from 123, 163, 159, 176, to 233 deaths per 100,000 total population. Adjusted incidence rate ratios relative to the least deprivation were: 1.20 (95% CI: 1.15-1.27); 1.34 (95% CI 1.28-1.42); 1.54 (95% CI 1.46-1.63); 1.89 (95% CI 1.78-2.01) for the second through fifth quintiles of deprivation, respectively. Deciles of ADI showed a similar consistent trend ($p < 0.0001$) with increasing mortality. Counties in the upper 10th decile of deprivation experienced an excess of 124 deaths per 100,000 population due to COVID-19 compared to the least deprived (95% CI: 98.7-150.1). Case fatality rates also increased consistently with increasing ADI.

CONCLUSIONS: Socioeconomically disadvantaged counties experienced higher mortality and case fatality rates due to COVID-19.

Keywords: Socio-economic factors, Microbes, Environmental disparities, Respiratory outcomes



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The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-033

Built environment » Green space

Associations between minute-level smartphone GPS-derived exposure to greenness and consumer wearable-derived physical activity in the Nurses' Health Study 3

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BACKGROUND AND AIM: Increased exposure to greenness has been linked to increased physical activity and improved health outcomes, including better mental health and lower cardiovascular disease and mortality rates. However, most studies measure greenness exposure surrounding residential addresses, and do not account for each study participants' movements. We examine minute-level smartphone GPS-derived exposure to greenness and consumer wearable-derived physical activity.

METHODS: We assessed daily GPS-derived greenness exposure using wearable accelerometer data from participants in the US-based prospective Nurses' Health Study 3 cohort mHealth Substudy (2018-2020). The mHealth substudy consisted of 348 female participants (mean age 35.7) who undertook 7-day sampling periods, four times across a year, to capture seasonal variability in greenness and physical activity. Normalized Difference Vegetation Index data were derived from 30m resolution Landsat imagery, which was spatially joined to the GPS points that were recorded every 10 minutes during sampling periods. Fitbit proprietary algorithms provided physical activity summarized as mean number of steps per minute for each 10-minute period. Generalized linear and additive mixed models were utilized to examine near momentary associations between greenness and physical activity adjusting for socioeconomic status, season, age, and smoking.

RESULTS: Across study periods mean 10-minute step count ranged from 0-111.57 steps and 10-minute NDVI ranged from 0 to 0.71. Summer months had higher values and large ranges due to seasonal and individual-level mobility changes. Contrary to our hypotheses, higher non-linear greenness exposure was associated with lower mean steps per minute. Participants in the top greenness quintiles took 2.25



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(95% CI 2.42, 2.08) fewer steps per 10-minute average compared to those with the lowest greenness quintile, after adjusting for confounders.

CONCLUSIONS: We utilized objective data at fine temporal and spatial scales to present novel estimates on the real time association between greenness and physical activity. Increases in greenness were associated with small decreases in steps per minute.

Keywords: Activity Space, Green Space, Physical Activity, Mixed Models



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The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-034

Built environment » Green space

Impacts of green space on mental health during the COVID-19 pandemic in Denver

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BACKGROUND AND AIM: The COVID-19 pandemic is exerting both a mental health and a physical health toll. Spending time in nature or living in a place with greater exposure to vegetation has been shown to be beneficial for mental health. This study aimed to understand changes in stress and distress between pandemic time periods (referred to as “before covid”, “stay at home”, “reopening”, and “second wave”) and whether exposure to green space buffers against stress and distress during the COVID-19 pandemic.

METHODS: This study leverages a study on green space exposure and mental health among residents of Denver, CO that began in the winter of 2020 and continued throughout 2020, capturing measures of mental health across different time periods within the pandemic. We measured objective green space as the average NDVI from Landsat and NAIP imagery within 300m and 500m of the participant’s residence. Perceived greenspace was measured through likert scores on five questions about vegetation near the home. We used GLMs to assess whether each green space exposure was associated with stress and distress adjusted for important sociodemographic and COVID-19 impact variables.

RESULTS: We found significantly higher depression scores for all covid periods compared to the before period, and significantly higher anxiety scores during the second wave compared to both the stay at home period and the before covid periods. Adjusted for covariates, we found significant negative associations between perceived, but not objective, green space exposure and depression and anxiety scores. The strongest associations were for spending a lot of time in greenspace, having high quality green spaces near the home, and high levels of vegetation/greenery in the neighborhood. There were no significant associations for any green space metric and perceived stress.

CONCLUSIONS: This work adds to the evidence of the role of green space exposure on mental health, particularly during the COVID-19 pandemic.

Keywords: COVID-19, Green space, Mental health outcomes



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The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-035

Built environment » Green space

Time for 'Green' during COVID-19? A nationally-representative study of nature, connectedness and coping in Australia during the COVID-19 pandemic

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BACKGROUND AND AIM: We investigated to what extent visits to green and blue spaces may have enabled respite, connection and exercise during the COVID-19 pandemic, and whether such benefits might have been negatively impacted by restrictions in spatial mobility generated by 'lockdowns'.

METHODS: A nationally representative online and telephone survey conducted in 12–26 October on the Social Research Centre's Life in AustraliaTM panel (aged ≥ 18 y, 78.8% response, N = 3043) asked about access, visitation, and felt benefits (respite, connection, exercise) from visiting green and/or blue spaces. Participants in Melbourne, who were in lockdown during the study, were contrasted with counterparts in Sydney, who were not in lockdown.

RESULTS: Residents of Melbourne compared with Sydney reported consistently increased visitation of (OR = 1.66, 95% CI = 1.23, 2.19), discovery of (IRR = 1.16, 95% CI = 1.05, 1.29), and greater levels of various felt benefits derived from green and/or blue spaces, including more respite (OR = 1.65, 95% CI = 1.21, 2.19), connection (OR = 1.44, 95% CI = 1.05, 1.95), and exercise (OR = 2.11, 95% CI = 1.58, 2.79). The odds of visiting preferred green and/or blue space at least once a week for the past 4 weeks were also notably higher in Melbourne compared with Sydney (OR = 2.10, 95% CI = 1.56, 2.76). These results were robust to adjustment for a range of covariates including financial circumstances, working from home opportunities, and preferences for natural settings.

CONCLUSIONS: Contrary to expectation, people living through COVID-19 lockdown visited green and blue spaces more often, and appeared to benefit more from those visits, than counterparts who were not in lockdown. These results underline the importance of keeping green and blue spaces open, and highlights the value that previous investments in green and blue space have played in enabling coping during the COVID-19 pandemic.

Keywords: green space, environmental justice, mental health outcomes



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The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-036

Built environment » Green space

A systematic review of studies on the role of age and gender in associations between greenspace and mental health

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The University of Queensland

BACKGROUND AND AIM: Age and gender are two characteristics of individuals that play an important role in the prevalence of mental health. Globally, the burden of mental, neurological and substance use is higher in females compared with males. The burden of common mental disorders (depression and anxiety) increases gradually from adolescence to young age (10–29) and decreases gradually after mid-40s. **OBJECTIVE:** to systematically review observational epidemiological studies on greenspace metrics and mental health in adults, with a specific focus on identifying and critically appraising evidence on the effects of age and gender.

METHODS: The detailed review protocol was registered in PROSPERO in November 2018 and is available online (registration number: CRD42018115862). Four databases (PubMed, Scopus, Web of Science, and PsycINFO) were searched for observational epidemiological studies on different greenspace metrics and their associations with mental health outcomes in adults, with a focus on studies that assessed the effects of age and gender on those associations. Critical appraisal and risk of bias assessment were conducted to create grades of the studies.

RESULTS: We identified 36 studies, including 10 longitudinal studies and 26 cross-sectional studies. These comprised 21 analyses that considered age, and 32 that considered gender-specific differences, respectively. However, methodological heterogeneity restricted meta-analysis. The epidemiological evidence of the effect of age and gender on the association between mental health and greenspaces is limited. Our review found that older aged adults and women may have slightly greater benefits from residential greenspace for some outcomes.

CONCLUSIONS: Future studies are needed to further investigate the effects of age and gender in associations between residential greenspace and mental health outcomes.

Keywords: Greenspace, Mental Health, Age, Gender



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The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-037

Built environment » Walkability

Green walkability and physical activity in UK Biobank

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BACKGROUND AND AIM: Urban greenspace provides opportunities for outdoor exercise and may increase physical activity levels, with accompanying health benefits. Walkability – a measure of an area’s suitability for walking – is also associated with increased physical activity, though is inversely correlated with greenspace cover. We aimed to integrate greenspace exposure into a walkability index and explore associations with physical activity in an urban adult cohort, UK Biobank.

METHODS: We used cross-sectional data from UK Biobank cohort participants who resided in Greater London at baseline (2006-2010; N = 58,587). We assessed walkability within a 1000 m traversable network buffer surrounding each participant’s residential address to create a residence-based walkability index, which was scored on population density, street junction density, and business density in the network buffer. Additionally, we integrated vegetation cover (tree cover and low-lying vegetation cover) into this density-based walkability index to produce a *green walkability* index. We modelled associations of density-based walkability and *green walkability* with self-reported and accelerometer-measured physical activity, adjusted for individual and area-level confounders.

RESULTS: Higher *green walkability* surrounding UK Biobank residential addresses in Greater London was associated with favourable International Physical Activity Questionnaire (IPAQ) responses, achievement of weekly UK government physical activity guideline recommendations, and increased time spent on moderate-and-vigorous physical activity (MVPA). For example, participants living in the highest versus lowest quintile of *green walkability* participated in 2.41 (95% confidence intervals: 0.22, 4.60) additional accelerometer-measured minutes of MVPA per day. Notably, however, associations of *green walkability* and self-reported physical activity outcomes were weaker compared to associations with density-based walkability.

CONCLUSIONS: Our green walkability approach demonstrates the need to account for walkability and greenspace simultaneously to understand the role of the built environment on physical activity.

Keywords: Green space, Walkability, Built environment, Exposure assessment, Physical Activity, Accelerometer



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LIGHTNING TALKS 4

The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-038

Built environment » Green space

The impact of greenspace and air pollution exposure on incident dementia in the Ginkgo Evaluation of Memory Study

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BACKGROUND AND AIM: While long term exposure to fine particulate matter (PM_{2.5}) has been linked to all-cause dementia, less is known about potential modification of these effects by greenspace exposure.

METHODS: The Ginkgo Evaluation of Memory Study (GEMS) was a randomized trial in four US sites (Hagerstown MD, Pittsburgh PA, Sacramento CA, and Winston-Salem NC) from 2000-2008 with rigorous neuropsychological assessments for dementia every six months. Minimum age at enrollment was 75 years. Mean residence-specific PM_{2.5} concentrations were estimated using a novel spatiotemporal model and reconstructed from residential address histories for a 20-year period (1980-1999). Greenspace exposure was measured by averaging standardized 1) normalized difference vegetation index (NDVI), 2) reverse coded distance to nearest park, and 3) percentage of park overlap within a 10km buffer of residence. We evaluated modification by greenspace of the effects of PM_{2.5} on dementia risk by including an interaction term in Cox proportional hazards models adjusted for age, study site, year of randomization, gender, treatment assignment, neighborhood deprivation index, and education.

RESULTS: For 2,549 participants who were free of mild cognitive impairment (MCI) at enrollment, preliminary analyses indicate that an interquartile range (2 µg/m³) increase in 20-yr mean PM_{2.5} exposure was associated with a 19% (HR: 1.19; CI: 1.04, 1.37) greater risk of dementia. Relative to participants in the first tertile of greenspace, those in the second tertile had a 17% reduction (HR: 0.83; 95% CI: 0.63, 1.09) in dementia risk and those in the third tertile had a 25% reduction (HR: 0.75; 95% CI: 0.54, 1.03); however, these estimates included the null. Greenspace exposure did not modify the impact of PM_{2.5} on dementia risk (interaction term p-value=0.57).

CONCLUSIONS: Greenspace exposure may be a promising protective factor against dementia but does not appear to modify the impact of PM_{2.5} on dementia in this cohort of older adults.

Keywords: Greenspace, Air pollution, All-cause dementia, Fine particulate matter, Long-term exposure



ABSTRACT E-BOOK

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LIGHTNING TALKS 4

The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-039

Built environment » Light pollution

Outdoor artificial light at night, air pollution, and childhood acute lymphoblastic leukemia

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BACKGROUND AND AIM: Acute lymphoblastic leukemia (ALL) is the most common form of cancer in children. An environmental exposure that has been previously associated with childhood ALL is air pollution but less is known about the association with artificial light at night (ALAN), another pervasive pollutant, particularly in urban areas. ALAN is believed to disrupt circadian rhythm and potentially lead to detrimental health outcomes. We sought to evaluate the risk of ALAN and air pollution in a large population-based case-control study of childhood ALL in California.

METHODS: The California Linkage Study of Early-Onset Cancers is a large linkage study in the state of California. Childhood cancers identified in the California Cancer Registry are linked to birth records and 50 controls were randomly selected by year of birth. Between 2000-2015, a total of 2,782 cases and 139,100 controls were identified for this analysis. ALAN was assessed using the New World Atlas of Artificial Night Sky Brightness and PM_{2.5} with an ensemble-based air pollution model. Exposures were assigned to each participant's geocoded residential addresses at birth. The associations between ALAN, PM_{2.5} and childhood leukemia were assessed using logistic regression from which odds ratios (OR) and 95% confidence intervals (95% CI) were calculated.

RESULTS: After adjusting for known risk factors at birth (e.g. delivery by C-section), ALAN was associated with a 1.15 increased risk of childhood leukemia in Hispanic participants (95% CI 1.02-1.30) residing in the highest tertile of ALAN. There was an elevated risk of ALL among non-Hispanic White participants and PM_{2.5} (OR per 10 ug/m³ 1.23, 95% CI 0.98-1.55) but not in Hispanic participants (OR per 10 ug/m³ 1.04, 95% CI 0.90-1.21).

CONCLUSIONS: ALAN was associated with increased ALL risk among Hispanic children. Further work is needed to understand the difference in risk of ALL associated with ALAN and air pollution among Hispanic and non-Hispanic children.

Keywords: light pollution, air pollution, cancer and cancer precursors, children's environmental health, epidemiology



ABSTRACT E-BOOK

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LIGHTNING TALKS 4

The Role of Built Environment on Health

Chairs: Audrey de Nazelle, United Kingdom & Rena Jones, United States

O-LT-040

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

Social Determinants of Housing Quality for U.S. Immigrants: Intersections of Nativity, Race, and Socioeconomic Status

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BACKGROUND AND AIM: Indoor hazards can cause poor health with disproportionate burdens among racial/ethnic minorities and low socioeconomic status (SES) households. Little research has examined residential environmental exposures by nativity status, despite immigrants being a rapidly growing U.S. population. We investigated residential characteristics and housing quality by nativity and their intersections with race and SES in the national 2015 American Housing Survey (AHS).

METHODS: We generated risk scores for 11 poor-housing quality domains from 54 AHS variables: electricity, thermal discomfort, indoor and outdoor structures, lead-paint risk, bathroom and kitchen facilities, pests, mold, combustion sources, and crowding. We examined clustering of demographic and socio-contextual factors using polyserial correlations. We ran negative binomial regressions to evaluate risk scores by nativity, race, SES, and their interactions and adjusted for socio-contextual factors.

RESULTS: Socio-contextual factors correlated with poor-housing quality included being a single-parent, older building age, and poor neighborhood quality and were more prevalent among non-white and low SES households. Adjustment for these factors explained some but not all observed demographic disparities in poor-housing quality. Notably, immigrants had higher risks for crowding, combustion sources, pests, thermal discomfort, and mold than U.S.-natives ($\exp[\hat{\beta}]:1.08-3.15$). Black households had higher risks for the most poor-housing quality domains than other race groups (1.07-1.77). Households at 0-100% federal poverty-level had higher risks for almost all domains compared to higher-income households (1.06-4.08). At the intersections of race and nativity, Latinx and Asian immigrants had higher risks of lead-paint exposure and combustion sources, respectively, than their U.S.-native counterparts. In contrast, Black U.S.-natives fared worse for outdoor structure and combustion sources than Black immigrants.

CONCLUSIONS: In the U.S., we found significant disparities in housing quality, with non-white immigrant, Black U.S.-native, and low SES households experiencing worse housing conditions. Our



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findings underscore the importance of an intersectional framework to identify residential environmental exposure disparities and their socio-contextual drivers.

Keywords: Exposures, Environmental disparities, Socio-economic factors, Built environment, Housing quality



ABSTRACT E-BOOK

August 24, 2021 / 07:30 - 08:30 / Statue of Liberty Hall (Hall 1)

LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-041

Chemical exposures » Heavy metals

Cadmium exposure and coronary artery atherosclerosis

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BACKGROUND AND AIM: The general population is ubiquitously exposed to cadmium through the diet and smoking. Cadmium exposure is associated with increased morbidity and mortality in myocardial infarction. Our hypothesis was that this association is due to atherosclerosis, and our aim was to test this by examining associations between cadmium and coronary artery calcification, an established measure of atherosclerosis.

METHODS: We based our analysis on the population-based Swedish SCAPIS study, and included 5627 individuals (51% women), aged 50–64 years, enrolled from 2013 to 2018. The coronary artery calcium score (CACS) was obtained from computed tomography. Cadmium in blood (B-Cd) was analyzed by inductively coupled plasma mass spectrometry (ICP-MS). Associations between B-Cd and CACS (Agatston score) were evaluated using prevalence ratios (PRs) in models adjusted for sex, age, smoking, hypertension, diabetes, LDL/HDL ratio, and heredity.

RESULTS: The median B-Cd concentration was 0.24 µg/L. The prevalence of positive coronary artery calcification (CACS >0) was 41% and the prevalence of CACS ≥100 was 13%. The prevalence of CACS >0 was slightly increased (PR 1.1, 95% CI 1.0–1.3) in the highest quartile (Q4) of B-Cd (median 0.63 µg/L) with Q1 as reference. For CACS ≥100 the PR was 1.6 (95% CI 1.3–2.0). B-Cd was significantly associated with CACS ≥100 also in never-smokers (PR for Q4 vs. Q1 1.7, 95% CI 1.1 – 2.7), but based on few cases.



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CONCLUSIONS: Blood cadmium in the highest quartile was associated with CACS in this general population sample with low to moderate cadmium exposure, supporting the hypothesis that atherosclerosis is the main mechanism underlying the associations between cadmium and incident cardiovascular disease. Public health measures to reduce cadmium exposure are warranted.

Keywords: Cardiovascular diseases, Chemical exposures, Environmental epidemiology, Food/nutrition, Heavy metals,



ABSTRACT E-BOOK

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LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-042

Chemical exposures » Heavy metals

Association between cadmium and genotoxicity and oxidative stress risk biomarkers in a population of Northern Italy

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BACKGROUND AND AIM: Cadmium is a toxic heavy metal exerting several adverse effects in humans, especially for kidney, bone, liver, and cardiovascular system. In particular, genotoxic effects may occur through several epigenetic mechanisms, but a direct genotoxicity has been suggested. 8-oxo-7,8-dihydro-2'-deoxyguanosine (8-oxodG) is an oxidized derivative of deoxyguanosine, largely used as biomarker of oxidative stress in urine. In this study, we aimed to assess cadmium levels in a population in Northern Italy, in order to evaluate the correlation between cadmium exposure with different haematological and biochemical parameters, as well as the relationship with 8-oxodG levels.

METHODS: We recruited healthy and non-smoking subjects living in the Reggio Emilia province in the period 2017-2019 at the Transfusion Medicine Unit of Santa Maria Nuova Hospital, AUSL-IRCCS of Reggio Emilia, Northern Italy. Urinary cadmium and 8-oxodG, and fasting blood haematological and biochemical parameters were assessed.

RESULTS: We eventually recruited 140 participants (mean age 47.4 years). Mean urinary cadmium and 8-oxodG levels were 0.25 µg/L (range: 0.01–1.33 µg/L) and 3.68 µg/g creatinine respectively. All haematological and biochemical parameters were in the normal range. We found a positive association of cadmium concentrations with alanine aminotransferase, total cholesterol, triglyceride, and TSH levels, while a negative one was observed with glycaemia, HDL levels. In addition, we found a strong positive correlation between urinary cadmium and 8-oxodG.



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CONCLUSIONS: Our study suggests that cadmium exposure is associated with detrimental effects on some haematological and biochemical parameters even at very low levels, generally considered safe for the general population. The positive association between urinary cadmium levels and oxidative stress, as assessed through 8-oxodG levels, highlights the potential role of this heavy metal in causing direct genotoxic effects.

We acknowledge the collaboration of Transfusion Medicine Unit-Reggio Emilia Hospital personnel, AVIS-Section of Reggio Emilia staff and volunteers, and all blood donors who participated to this study.

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



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LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-043

Chemical exposures » Heavy metals

Arsenic Methylation and Body Composition among Pregnant Women in Rural Northern Bangladesh: The Pregnancy, Arsenic, and Immune Response (PAIR) Study

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BACKGROUND AND AIM: Arsenic methylation—the conversion of inorganic arsenic (iAs) to less toxic monomethyl (MMA) and dimethyl (DMA) species—could modify the developmental and reproductive toxicity of this metalloid. However, variability in arsenic methylation among pregnant women remains poorly understood. Arsenic methylation efficiency—the percentage of urinary arsenic methylated to DMA (DMA%)—is positively associated with body mass index (BMI) in pregnant women, but BMI is an ambiguous measure of body composition. We estimated arsenic methylation by body fat percentage as well as BMI in pregnant women in Bangladesh.

METHODS: We collected spot urine samples from pregnant women (n=784) in gestational weeks 11-17 and measured weight, height, and subscapular and triceps skinfolds. Urinary arsenic was speciated by HPLC-ICPMS. Arsenic metabolism was assessed by urinary iAs, MMA, and DMA, which were specific gravity-corrected, divided by their sum (Σ As), and multiplied by 100 (iAs%, MMA%, and DMA%). Body fat (%) was estimated using Siri's equation with body density estimated from skinfolds. We fit linear models of iAs%, MMA%, or DMA% by body fat or BMI (kg/m²), adjusting for ln Σ As (μ g/L), age (years), and gestational week.

RESULTS: In complete cases (n=771), median (IQR) iAs%, MMA%, DMA%, and Σ As were 12.1% (5.8%), 6.6% (3.0%), 81.0% (7.5%), and 33.3 μ g/L (37.2 μ g/L). Median (IQR) body fat and BMI were 28.4% (9.1%) and 21 kg/m² (4.4 kg/m²), and were highly correlated (Spearman's rho=0.83). Before adjustment, body fat was negatively associated with iAs% (beta per IQR-unit increase: -1.00, 95%CI: -1.50,-0.50) and MMA% (-0.65, 95%CI: -0.90,-0.39) and positively associated with DMA% (1.65, 95%CI: 1.00,2.30). BMI was negatively associated with iAs% (beta per IQR-unit increase: -0.85, 95%CI: -1.29,-



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0.41) and MMA% (-0.69, 95%CI: -0.91,-0.47) and positively associated with DMA% (1.54, 95%CI: 0.98,2.10). After adjustment, results were similar.

CONCLUSIONS: Arsenic methylation efficiency was positively associated with body fat and BMI among pregnant women in Bangladesh.

Keywords: Biomarkers of exposure, Chemical exposures, Female, Heavy metals, Obesity and metabolic disorders, Pregnancy outcomes



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LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-044

Chemical exposures » Heavy metals

**Association between heavy metal exposure and liver function markers among Korean adults:
Korean National Environmental Health Survey 2015 - 2017**

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BACKGROUND AND AIM: Heavy metals are widespread in nature and are reported to be associated with adverse health effects including decreased liver function. While, only a few studies have been conducted to examine the association between exposure to heavy metals and liver function in the general population. This study aimed to investigate the association between concentrations of heavy metals and decrease of liver function in the Korean adults.

METHODS: We included 3,699 participants who aged ≥ 19 years from the Cycle 3 of KoNEHS (Korean National Environmental Health Survey 2015 – 2017). Multiple linear regression was performed to assess the association between the levels of heavy metals [Blood lead level (BLL); Urinary Cadmium Level (UCL); Blood Mercury Level (BML); Urinary Mercury Level (UML)] and liver function markers [AST (Aspartate aminotransferase), ALT (Alanine aminotransferase), GGT (Gamma glutamyl transferase)] after adjusting for covariates.

RESULTS: For the BLL quartile, the participants in the highest quartile had 1.042 (95% CI 1.012-1.072) times higher AST and 1.098 (95% CI 1.032-1.169) times higher GGT compared to those in the lowest quartile, respectively. For the UCL quartile, the participants in the highest quartile had 1.093 (95% CI 1.034-1.157) times higher ALT and 1.074 (95% CI 1.007-1.145) times higher GGT compared to those in the lowest quartile, respectively. For the BML quartile, the participants in the highest quartile had 1.044 (95% CI 1.016-1.073) times higher AST and 1.119 (95% CI 1.074-1.165) times higher ALT and 1.184 (95% CI 1.112-1.260) times higher GGT compared to those in the lowest quartile, respectively. There was no significant difference in the UML.

CONCLUSIONS: This study investigated the association between exposure to lead, cadmium and mercury and liver function marker. Our results suggest that heavy metal exposures may affect liver function decrease. To elucidate the potential effect of heavy metal exposure, further studies should be performed.

Keywords: AST (Aspartate aminotransferase), ALT (Alanine aminotransferase), GGT (Gamma glutamyl transferase) Lead, Cadmium, Mercury



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Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-045

Outcomes » Microbiome

Association of childhood and perinatal blood metals with children gut microbiome in a Canadian gestation cohort

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BACKGROUND AND AIM: The gut microbiome is important in modulating health in childhood. Metal exposures affect multiple health outcomes, but their ability to modify bacterial communities in children is poorly understood. We assessed the associations of childhood and perinatal blood metals with childhood gut microbiome diversity, structure, species, and pathway alterations.

METHODS: We assessed the gut microbiome using 16S rRNA amplicon sequencing and shotgun metagenomic sequencing in 6-7 year-old children participating in the GESTation and Environment (GESTE) cohort study. We assessed blood metal concentrations (cadmium, manganese, mercury, lead, selenium) at two time points, i.e., perinatal exposures at delivery (N=70) and childhood exposures at the 6-7 year follow up (N=68). We used covariate-adjusted models to determine microbiome associations with continuous blood metal levels, including linear regression (Shannon and Pielou diversity indexes), permutational multivariate analysis of variance (adonis) (weighted UniFrac, Bray-Curtis, unweighted UniFrac, and Jaccard distance matrices), and multivariable association model (MaAsLin2) (phylum, family, species, and pathway).

RESULTS: Children's manganese and selenium exposure had significant associations with microbiome phylum (i.e., Verrucomicrobiota [coef=-0.305, q value =0.03]) and family (i.e., Eggerthellaceae [coef=-0.228, q value =0.05]) level differences. Individual species, including potential pathogens (i.e., *Bacteriodes vulgatus*, *Eubacterium rectale*) and beneficial species (i.e., *Bifidobacterium longum*, *Faecalibacterium prausnitzii*), had significantly higher relative abundance in relation to low level children or perinatal blood cadmium, mercury, and lead (q value < 0.1). We found significant negative associations between childhood blood lead and acetylene degradation pathway abundance (q value < 0.1). Finally, neither perinatal or childhood metal concentrations were associated with children's gut microbial inter- and intra-subject diversity.

CONCLUSIONS: Our findings suggest both long-term and short-term associations between metal exposure and the childhood gut microbiome, with stronger associations observed with more recent



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exposure. Future epidemiologic analyses may elucidate whether the observed changes in the microbiome relate to children's health.

Keywords: microbiome, heavy metals



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LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-046

Chemical exposures » PFAS

Poly- and perfluoroalkyl substances (PFASs) and lipidomics and inflammatory proteomics in the human EuroMix study

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BACKGROUND AND AIM: Exposure to PFASs has been associated with high cholesterol levels, lower vaccination response and higher childhood infections, in epidemiological studies. The mechanistic pathways involved are often unknown. Biomarkers of effect can provide insight in the biological implications of PFAS exposure. We explored the association between serum PFAS concentrations, lipoprotein particle subclasses and inflammatory biomarkers.

METHODS: In 127 adult participants of the EuroMix human biomonitoring study (mean age: 40 years, 70% women) we determined the concentrations and lipid content of the major lipoproteins in two plasma samples by nuclear magnetic resonance and the serum concentrations of five perfluoroalkyl sulfonates (PFASs) and six perfluoroalkyl carboxylates (PFCAs), and analysed their association by linear mixed-effect regression models. Further, we used an OLINK high-throughput proteomic assay to analyze plasma inflammatory proteins and explored the association with PFAS by linear regression analysis.

RESULTS: Most PFCAs, and PFOS were positively associated with HDL and LDL cholesterol concentrations and negatively associated with VLDL cholesterol and triglyceride concentrations in all lipoproteins. One interquartile range (IQR) increase in PFNA, PFDoDA and PFOS was associated with 11%-12% higher HDL cholesterol, independent of HDL particle size. One IQR increase in PFTrDA, PFHpS and PFOS was associated with 9%-14% higher cholesterol concentrations in the small-size LDL. Long-chain PFCAs were negatively associated with the cholesterol and triglyceride concentrations in the large- and mid-sized VLDL subfractions. We found mostly negative associations between PFAS and inflammatory biomarkers. One IQR increase in PFOS, PFNA, PFDA, PFUnDA and PFDoDA was associated with 2-3% lower anti-inflammatory factors, HGF and IL-10RB.

CONCLUSIONS: In this exploratory study, we aimed to identify serum lipoprotein and inflammatory biomarkers as markers of exposure to PFAS. We observed that PFAS exposure may influence the distribution and lipid composition of major lipoprotein subclasses, as well as modulation of inflammatory responses.

Keywords: Proteomics, PFAS, Cardiovascular diseases, Toxicology



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LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-047

Chemical exposures » PFAS

Physical activity modifies the association between prenatal perfluorooctanoic acid exposure and adolescent cardiometabolic risk

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BACKGROUND AND AIM: No studies have examined whether previously observed associations between higher gestational PFAS exposure and worse offspring cardiometabolic outcomes might be ameliorated through more physical activity and healthier diet in childhood.

METHODS: In 164 mother-child pairs from a prospective cohort in Cincinnati, OH (HOME Study), we measured concentrations of four PFAS in maternal serum collected at 16-weeks gestation. When children were age 12 years, we assessed visceral adiposity using dual x-ray absorptiometry, blood pressure, and fasting serum biomarkers. Using these variables, we calculated age/sex-standardized cardiometabolic risk z-scores. At this same visit, we assessed general physical activity levels and Healthy Eating Index (HEI) scores using the Physical Activity Questionnaire and three 24-hour diet recalls, respectively. We determined whether covariate-adjusted associations of PFAS with cardiometabolic risk z-scores and its components were modified by physical activity or HEI using multivariable linear regression.

RESULTS: Physical activity modified the association between perfluorooctanoic acid (PFOA) and cardiometabolic risk z-scores (interaction p-value<0.01). Each doubling of PFOA was associated with worse cardiometabolic risk z-scores among children with physical activity levels below the median (β :1.2; 95%CI:0.4, 2.0, n=80), but not among those with physical activity levels greater than the median (β :-0.3; 95%CI:-1.1, 0.6, n=84). Adverse associations among children with lower physical activity were most apparent for insulin resistance, adiponectin-leptin ratio, and visceral fat area (interaction p-values=0.01-0.06), but not triglyceride-high density lipoprotein ratio or systolic blood pressure (interaction p-values=0.41-0.65). The pattern of modification by physical activity was similar, but not



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statistically significant, for perfluorosulfonic acid and perfluorononanoic acid (interaction p-values=0.44 and 0.23). Diet quality (HEI scores < vs. >50) did not modify any associations (interaction p-values>0.28).

CONCLUSIONS: Childhood physical activity modified the association between gestational PFOA concentrations and cardiometabolic risk among adolescents in this cohort, suggesting that behavioral and lifestyle interventions may be an avenue to ameliorate the adverse effects of PFOA exposure.

Keywords: PFAS, Endocrine disrupting chemicals, Children's environmental health, Obesity and metabolic disorders



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LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-048

Chemical exposures » PFAS

COVID-19 and perfluoroalkyl substances (PFAS) from contaminated drinking water in the Veneto Region (Italy): a spatial ecological analysis

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BACKGROUND AND AIM: Given the evidence of immunosuppression by some perfluoroalkyl substances (PFAS), there is interest in assessing if PFAS may have an impact on the risk of Coronavirus infection or COVID-19 severity. The COVID-19 pandemic in Italy is an opportunity to test this hypothesis in a large area polluted with PFAS, and data on mortality from COVID-19 by municipality.

METHODS: For mortality from COVID-19 during the first wave of the pandemic (period 21 February - 15 April 2020), we fitted a Bayesian ecological regression model with spatially and not spatially structured random components on COVID-19 mortality at municipality level. We compared populations in the (red zone) of the Veneto Region, where residents were exposed for decades to drinking water contaminated by PFAS, with the rest of the Veneto. Serum PFOA in particular was raised in the Red Zone. Models included education score, background all-cause mortality (for the years 2015-2019), nursing homes provision in a sensitivity analysis, and an indicator for the Red Zone. The two random components are intended to adjust for potential hidden confounders spatially and not spatially structured.

RESULTS: During the first wave of the pandemic, the COVID-19 crude mortality rate ratio for the Red Zone compared to the rest of the Veneto, was 1.55 (90% Confidence Interval 1.25; 1.92). From the Bayesian ecological regression model adjusted for education level and baseline all-cause mortality, the rate ratio for the Red Zone was 1.60 (90% Credible Interval 0.94; 2.51).

CONCLUSIONS: We observed a higher mortality risk for COVID-19 in a population heavily exposed to PFAS, and plan to extend analyses to later periods of COVID mortality. If it is not simply a chance association, this may reflect a general immunosuppressive effect of PFAS, or bioaccumulation of PFAS in lung tissue, or PFAS-related pre-existing disease.

Keywords: PFAS, COVID-19, Spatial statistics, Hierarchical Bayesian models



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LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-049

Chemical exposures » PFAS

Maternal levels of perfluoroalkyl substances (PFAS) during early pregnancy in relation to preeclampsia subtypes

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BACKGROUND AND AIM: Prenatal exposure to perfluoroalkyl substances (PFAS) has been previously associated with preeclampsia, although findings are mixed. However, no studies have examined associations between PFAS and preeclampsia subtypes, which may have distinct etiologies. Thus, we examined associations between PFAS and individual preeclampsia subtypes (i.e. early- and late-onset) using both single- and multi-pollutant approaches.

METHODS: This case-control study (n = 75 cases, n = 75 controls) was sampled from the prospective LIFECODES birth cohort. Within the sample of preeclampsia cases, 21 were defined as early-onset (< 34 weeks gestation) and 54 were defined as late-onset (≥ 34 weeks). Nine legacy PFAS were quantified in maternal plasma from early pregnancy (median 10 weeks). As a single-pollutant approach, we used logistic regression to estimate the odds ratios (OR) and 95% confidence intervals (95% CI) of the association between an interquartile range (IQR)-increase in PFAS and preeclampsia subtypes. As a multi-pollutant approach, we used quantile g-computation to estimate the joint association of PFAS with preeclampsia subtypes.

RESULTS: After adjusting for potential confounders, both perfluorodecanoic acid (PFDA; OR: 1.76, 95% CI: 1.07, 2.91) and perfluorooctane sulfonic acid (PFOS; OR: 2.29, 95% CI: 1.21, 4.35) were associated with higher odds of late-onset preeclampsia. Using quantile g-computation, a simultaneous one-quartile increase in all PFAS was also associated with higher odds of late-onset preeclampsia (OR: 2.28, 95% CI: 1.12, 4.64). Individual and joint associations between PFAS and early-onset preeclampsia were null, as were associations with overall preeclampsia diagnosis.

CONCLUSIONS: Maternal PFAS concentrations were associated with odds of late-onset preeclampsia, though associations were null for early-onset preeclampsia. These findings suggest that PFAS exposure may be more closely associated with late-onset preeclampsia and warrant further study. In addition, heterogeneity of preeclampsia should be considered in future studies as populations may have different distributions of disease subtypes.

Keywords: PFAS, Pregnancy outcomes, Mixtures



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LIGHTNING TALKS 5

Epidemiology of PFAS or Heavy Metals

Chairs: Tony Fletcher, United Kingdom & Temitope Ayodeji Laniyan, Nigeria

O-LT-050

Chemical exposures » PFAS

Identifying periods of susceptibility to perfluoroalkyl substances and bone mineral density in early adolescence: the HOME Study

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BACKGROUND AND AIM: Perfluoroalkyl substance (PFAS) exposures may affect childhood bone mineral density (BMD), but no studies have assessed periods of heightened susceptibility. We estimated associations of individual PFAS and their mixture during gestation and three times during childhood with BMD in early adolescence.

METHODS: We examined 222 mother-child pairs enrolled in a prospective pregnancy and birth cohort in Cincinnati, OH from 2003-2006. We measured concentrations of perfluorooctanoic acid (PFOA), perfluorononanoic acid, perfluorohexanesulfonic acid, and perfluorooctanesulfonic acid in maternal serum collected at 16 weeks gestation and child serum collected at age 3, 8, and 12 years. At age 12 years, we measured areal BMD at six skeletal sites with dual x-ray absorptiometry and calculated height-, age-, sex-, and population ancestry-specific BMD Z-scores. Using linear regression, we estimated covariate-adjusted differences in BMD Z-scores per doubling of PFAS concentrations at each period. Using hierarchical Bayesian kernel machine regression (hBKMR), we estimated period-specific associations and posterior inclusion probabilities (PIPs) to determine periods of heightened susceptibility to PFAS mixtures.

RESULTS: Associations were strongest for PFOA and forearm (1/3 distal radius) BMD, with differing periods of susceptibility for males and females. Among males, forearm BMD Z-score differences (95% confidence interval) per doubling of PFOA were -0.26 (-0.50, -0.02), -0.33 (-0.68, 0.02), -0.24 (-0.61, 0.13), and -0.00 (-0.30, 0.29) for gestation and ages 3, 8, and 12, respectively. Among females, the corresponding estimates were -0.12 (-0.38, 0.15), -0.07 (-0.44, 0.30), -0.30 (-0.76, 0.17), and -0.44 (-0.81, -0.07). Patterns were generally similar but weaker for other PFAS and skeletal sites. Period-specific PIPs from hBKMR models were highest for the PFAS mixture at age 8 for males (0.76) and age 12 for females (0.62).



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CONCLUSIONS: PFOA and PFAS mixtures were associated with lower BMD in early adolescence. Susceptibility to PFAS may occur earlier in life for males compared with females.

Keywords: Chemical exposures, Children's environmental health, Mixtures analysis, PFAS, Endocrine disrupting chemicals, Environmental epidemiology



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LIGHTNING TALKS 6

Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-051

Air pollution » Particulate matter

Associations between Reduced PM_{2.5} and Improved Health during China's Clean Air Actions since 2013

Tao Xue

Peking University

BACKGROUND AND AIM: China has conducted the Clean Air Actions, which have reduced the PM_{2.5} concentrations rapidly. Here I present a series of studies, which examined whether the improved air quality was associated with improvements in multiple dimensions of public health.

METHODS: We applied quasi-experimental studies to examine how the health status changed before and after the conduction of the China's Clean Air Actions, since 2013, among the nation- or region-representative adult samples. We examined the associations between the reduced concentrations of PM_{2.5} and indicators of lung function, metabolic disorders, mental health, and medical expenditure.

RESULTS: We found the PM_{2.5} reductions were significantly associated to (1) an improved peak exhale flow, (2) a decreased level of blood pressure, (3) an improved lipid profiles, (4) a decreased score of depressive risk, and (5) a saved money in medical cost in China. Some of the relevant results have been published in PLoS Medicine, The Lancet Regional Health, Environment International and etc.. All the results are finalized.

CONCLUSIONS: China's clean air actions have protected the public health by reducing the levels of particulate pollution.

Keywords: Clean Air Actions, PM_{2.5}, Public Health, Medical expenditure, Lung function



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LIGHTNING TALKS 6

Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-052

Air pollution » Particle components

Long-term exposure to ambient particulate matter components and mortality: results from six European administrative cohorts within the ELAPSE project

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BACKGROUND AND AIM: Evidence of the association between long-term exposure to ambient particulate matter components and mortality is inconsistent. We evaluated this association in six large administrative cohorts in the Effects of Low-Level Air Pollution: A Study in Europe (ELAPSE) project.

METHODS: We analysed data from country-wide administrative cohorts in Norway, Denmark, the Netherlands, Belgium, Switzerland and in Rome (Italy). Annual 2010 mean concentrations of copper (Cu), iron (Fe), sulfur (S) and zinc (Zn) in PM_{2.5} were estimated using 100x100m Europe-wide land use regression models assigned to the participants' residential addresses. We applied cohort-specific Cox proportional hazard models controlling for area- and individual-level covariates to evaluate associations with natural, cardiovascular, non-malignant respiratory and lung cancer mortality. Two pollutant models adjusting for PM_{2.5} or NO₂ were also applied. We pooled cohort specific estimates using a random effects meta-analysis.

RESULTS: We included 27 million participants contributing more than 240 million person-years. Cu, Fe and S were associated with natural mortality [Hazard Ratios (HRs) (95% CI): 1.037 (1.014, 1.060) per 5 ng/m³ Cu; 1.069 (1.031, 1.108) per 100 ng/m³ Fe; 1.036 (1.016, 1.057) per 200 ng/m³ S] even after controlling for PM_{2.5} [e.g. 1.048 (1.022, 1.074) for Fe]. Adjustment for NO₂ decreased HRs to unity [e.g. 0.994 (0.954, 1.036) for Fe]. Associations with cardiovascular mortality were weaker and non-



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significant. We found positive significant associations of Cu, Fe and S with non-malignant respiratory [HRs: 1.047, 1.099 and 1.043, respectively] and lung cancer mortality [HRs: 1.091, 1.160 and 1.102, respectively] in single pollutant models, though only the effect of Fe persisted after control for PM_{2.5}.

CONCLUSIONS: Our results indicate associations of long-term exposure to PM_{2.5} components with natural and cause-specific mortality outcomes related to non-tailpipe emissions (Cu and Fe) and long-range transport (S). However, associations did not persist after NO₂ adjustment.

Keywords: Air pollution, Particle components, Long-term exposure, Environmental epidemiology, Survival, Mortality



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Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-053

Air pollution » Long-term exposure

Long-term air pollution exposure and incident dementia in American elderly population: a national cohort study

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BACKGROUND AND AIM: Evidence links air pollution to increased risk of dementia or Alzheimer's disease (AD). However, previous studies have focused on hospitalizations as the measure of morbidity, which is a poor measure of either incidence or prevalence for these conditions. In addition, neuropathologic changes are known to occur many years prior to the diagnosis, and the relevant time window in which air pollution might increase risk of dementia or AD remains unclear.

METHODS: We conducted a national, population-based, cohort study to investigate the impact of long-term exposure to PM_{2.5}, NO₂, and O₃ on dementia and AD incidence, using the nationwide Medicare population and high-resolution air pollution data. To better approximate dementia and AD incidence, we used a 5-year "clean" period and all Medicare claims nationwide (2000-2018), including Medicare inpatient and outpatient claims, carrier file (primarily doctor visits), skilled nursing facility, and home health-care claims. Cox proportional hazard models were fit to estimate hazard ratios (HRs) for dementia and AD incidence.

RESULTS: Using annual average pollutant level 5 years prior to diagnosis, per interquartile range (IQR) increase in annual PM_{2.5} (3.7 µg/m³), annual NO₂ (13.3 ppb), and warm-season O₃ (7.2 ppb), the HRs were 1.050 (95% CI: 1.045, 1.055), 1.017 (95% CI: 1.011, 1.023), and 0.994 (95% CI: 0.991, 0.998) for incident dementias, and 1.087 (95% CI: 1.078, 1.097), 1.045 (95% CI: 1.035, 1.056), and 0.972 (95% CI: 0.965, 0.978) for incident AD, respectively. For both outcomes there was strong evidence of linearity in concentration-response relationships for PM_{2.5} and NO₂, suggesting that no safe threshold exists for health-harmful pollution levels.

CONCLUSIONS: Using a large nationwide cohort, we provide strong evidence that exposure to PM_{2.5} and NO₂, but not O₃, were significantly associated with an increased incidence of dementia and AD. Improving air quality may yield substantial health benefits by reducing the burden of neurological disorders.

Keywords: Air pollution, Dementia, Alzheimer's disease, incidence



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Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-054

Outcomes » Childrens environmental health

Exposure to particulate matter air pollution and age of menarche in a nationwide cohort of US girls

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BACKGROUND AND AIM: In recent decades, age of menarche has decreased with some questioning whether environmental factors have played a role. We aimed to examine the association between exposure to particulate matter (PM) air pollution in various size fractions and time points throughout childhood and age at menarche.

METHODS: Study participants were 5203 US girls in the Growing Up Today Study born between 1989 and 1995. Girls self-reported their age of menarche in three follow-up surveys (2004-2008). We examined average exposure to PM_{2.5}, PM_{2.5-10}, and PM₁₀ during four windows: in utero (year prior to birth), 2 years prior to menarche, 1 year prior to menarche, and cumulative exposure from in utero to age at menarche. Air pollution measures were based on maternal address, which was updated every 2 years. Multivariable Cox proportional hazard models adjusted for race, birthweight, body size at age 5, and maternal age at menarche were used to estimate hazard ratios (HRs) and 95% CIs for the associations.

RESULTS: The mean age at menarche was 12.3 years (standard deviation: 1.2). For all PM exposures, as expected, the highest average exposures were observed in utero (PM_{2.5}: 16.1, PM_{2.5-10}: 11.6, and PM₁₀: 27.7 µg/m³) while the lowest were observed 1-year prior to menarche (PM_{2.5}: 12.2, PM_{2.5-10}: 7.2, and PM₁₀: 19.4 µg/m³). A 5 µg/m³ increase in PM_{2.5} exposure was associated with earlier age at menarche during all four exposure timepoints (in utero: 1.09, 1.04-1.15; 1-year prior: 1.21, 1.14-1.29; 2-years prior: 1.23, 1.16-1.31; cumulative: 1.13, 1.06-1.20). A 5 µg/m³ increase in PM₁₀ was associated with age at menarche during three timepoints (1-year prior: 1.05, 1.02-1.08; 2-years prior: 1.06, 1.03-1.09; cumulative: 1.03, 1.00-1.06). Exposure to PM_{2.5-10} was not associated with age at menarche.

CONCLUSIONS: Higher exposures to PM_{2.5} and PM₁₀ during childhood were associated with an earlier onset of menarche.

Keywords: Air pollution, Particulate matter, Reproductive outcomes



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Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-055

Air pollution » Particle components

Prenatal exposure to PM_{2.5} constituents and children's growth trajectory in the first two years: a birth cohort study

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BACKGROUND AND AIM: Limited studies on the associations of prenatal exposure to fine particulate matters (PM_{2.5}) with children's growth reported inconsistent results. No study evaluated the effects of specific constituents of PM_{2.5} on children's growth trajectory, which may contribute to discrepancies among PM_{2.5} studies. We aimed to examine the association of prenatal exposure to PM_{2.5} constituents and children's growth trajectory in the first two years.

METHODS: The study was based on a birth cohort (2014-2017) in China, involving 18,667 mothers with their children who were followed to two years old. We estimated prenatal PM_{2.5} constituents [organic carbon(OC), elemental carbon(EC), sulfate(SO₄²⁻), nitrate(NO₃⁻), and ammonium (NH₄⁺)] concentrations based on maternal home addresses. Height(or length) and weight of children were repeatedly measured at the age of 3,6,9,12,18,24 months. We calculated body mass index (BMI) Z-score based on the WHO Standards. Latent class growth modeling was used to identify children's BMI Z-score trajectory. Multinomial logistic regression was used to examine the association of prenatal exposure to PM_{2.5} constituents with children's growth trajectories.

RESULTS: Three BMI Z-score trajectories were identified: stable trajectory (n=15265,81.9%), decreased trajectory(n=2130,11.4%), and increased trajectory(n=1234,6.6%). Compared with stable trajectory, an interquartile range (IQR) increase in prenatal exposure to PM_{2.5}, NH₄⁺, and NO₃⁻ was associated with 0.847[95% confidence interval(95%CI):0.744,0.965], 0.806(95%CI:0.710,0.915), and 0.677(95%CI: 0.603,0.761) lower risk of increased trajectory, respectively. An IQR increase in prenatal exposure to OC and SO₄²⁻ was associated with 1.395(95%CI:1.236,1.575) and 1.562 (95%CI:1.324,1.842) higher



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risk of increased trajectory, respectively. The results were robust in two-pollutant models. We did not observe significant associations between prenatal exposure to PM_{2.5} constituents and risk of decreased trajectory.

CONCLUSIONS: The study suggested that prenatal exposure to PM_{2.5} and its constituents was associated with risk of children's increased growth trajectory in the first two years. Public health policy on regulation of harmful PM_{2.5} constituents should be developed to protect early-life health of children.

Keywords: particulate matters, constituents, body mass index, growth trajectory, children



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Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-056

Air pollution » Short-term exposure

Short-Term PM_{2.5} Exposure Impacts Cognitive Performance: A Longitudinal Repeated Measures Study of the Western US 2017-2018

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BACKGROUND AND AIM: There is increasing evidence that air pollution exposure adversely impacts cognitive health. While wildfire smoke is a pollutant of growing concern, there is little evidence to date if short-term exposure impacts cognitive function. Using repeated measures, we aimed to identify and quantify the relationship between daily and sub-daily PM_{2.5} and smoke exposure and changes in cognitive performance in adults.

METHODS: Cognitive performance data was obtained for 1,467 Lumosity users, age 18+, who completed 20 plays of a brain-training game targeted to improve cognitive flexibility in the western United States during 2017-2018. We considered two measures of daily and sub-daily air pollution exposure: (1) PM_{2.5} concentration estimates, obtained from a Bayesian Maximum Entropy data fusion of observations from FRM/FEM and PurpleAir monitors, and (2) smoke density, obtained from the NOAA Hazard Mapping System. We used a longitudinal repeated measures study design with an autoregressive linear mixed effects model to quantify the relationships between measures of short-term exposure and cognitive performance, overall and by age group.

RESULTS: A 10 µg/m³ increase in daily average PM_{2.5} in the week prior to play was associated with 46.9 (95% CI: -92.9, -0.9) point decrease in Lumosity game score. The highest impacts were observed in the youngest (18-29) and oldest (70+) age groups. The presence of medium smoke density on the day of game play was associated with a significant decrease in score. No other measures of smoke density in the 2 weeks prior to play were associated with Lumosity performance. No associations between measures of sub-daily PM_{2.5} exposure and performance were observed.

CONCLUSIONS: Results indicate that increases in daily average PM_{2.5} can adversely impact cognitive flexibility. Short-term smoke exposure may also be associated with cognitive performance, but more research is needed to investigate this relationship. This abstract does not reflect EPA policy.

Keywords: Particulate matter, Short-term exposure, Neurodevelopmental outcomes, Wildfires, Environmental epidemiology



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LIGHTNING TALKS 6

Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-057

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Prenatal Air Pollution, Maternal Immune Activation, and Autism Spectrum Disorders

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BACKGROUND AND AIM: Early-life causes of autism spectrum disorders (ASD) are multifactorial, including prenatal air pollution and gestational conditions with maternal immune activation (MIA) which may share common biological mechanisms. This study examined the potential synergistic effects of prenatal air pollution and MIA on ASD risk.

METHODS: This retrospective cohort study included 311,617 mother-child pairs with singleton deliveries in Kaiser Permanente Southern California (KPSC) hospitals in 2001-2014. Children were followed through electronic medical records (EMR) until ASD diagnosis, non-KPSC membership, death, or December 31, 2019, whichever came first. The presence of five broad categories of MIA during pregnancy (asthma, infections, any hypertension, allergies, and autoimmune diseases) were identified by International Classification of Diseases, Ninth Revision (ICD-9). Pregnancy average PM_{2.5}, NO₂, and O₃ exposures were estimated using high spatio-temporal resolution models based on maternal residential address history during pregnancy. Hazard ratios of ASD associated with air pollution and MIA were estimated using Cox regression models adjusted for birth year, KPSC medical center, child sex, and maternal sociodemographic characteristics. Multiplicative interactions were assessed in Cox models using interaction terms; additive interactions were assessed using relative excess risk due to interaction (RERI).

RESULTS: The prevalence of maternal asthma, infection, hypertension, allergy, and autoimmune diseases was 7.17%, 48.6%, 9.6%, 13.7%, and 11.2%, respectively. During follow-up 6,291 children were diagnosed with ASD. Higher levels of average pregnancy PM_{2.5}, and each of the five categories of MIA exposures was associated with ASD risk (p -value<0.05). However, no statistically significant interactions were found between the five categories of MIA and any of the three air pollutants on either multiplicative or the additive scales.

CONCLUSIONS: This study found little evidence that MIA and prenatal air pollution have synergistic effects on ASD. MIA and prenatal air pollution may contribute independently to ASD risk.

Keywords: Air pollution, Neurodevelopmental outcomes, Pregnancy outcomes



ABSTRACT E-BOOK

August 24, 2021 / 07:30 - 08:30 / Brooklyn Bridge Hall (Hall 2)

LIGHTNING TALKS 6

Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-058

Air pollution » Particulate matter

Long-term ambient PM_{2.5} and O₃ reduced cognitive function in young adults as measured through the Lumosity brain training platform

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BACKGROUND AND AIM: A growing body of evidence indicates that exposure to air pollution affects cognitive performance; however, few studies have assessed this in the context of repeated measures within a large group of individuals. To evaluate the association between long-term exposure to ambient air pollution and aspects of cognitive function we used cognitive performance data from the mobile Lumosity brain training platform.

METHODS: The study cohort included 29,091 Lumosity users in the contiguous US who completed 20 repetitions of the Lost in Migration game between 2017 and 2018. Game scores reflect focus and ability to filter information and avoid distracting information. Air pollution data included ambient PM_{2.5} and O₃ averaged for the 365-day period before each gameplay date. Air pollution data from Federal Reference Method monitors was aggregated to the ZIP code (three-digit) level to match the geography included in the game data set. Generalized linear models were used to examine the association between long-term ambient PM_{2.5} and O₃ and game score. Co-pollutant models were adjusted for meteorology, time trend, age, gender, device, education, local socioeconomic factors, and urbanicity.

RESULTS: A 5 µg/m³ increase in PM_{2.5} was associated with lower user focus scores (-0.50% 95% CI: -0.80, -0.15). No association was observed with O₃. Associations with scores were stronger among young adults (18-29 years old) for both PM_{2.5} (-1.25%; 95% CI: -2.25, -0.25) and O₃ (-2.93% per 0.01 ppm; 95% CI: -4.64, -1.20). In the oldest age group (60-90 years old), PM_{2.5} was associated with decreased scores (-0.33%; 95% CI: -0.75, 0.09) and O₃ associated with increased scores (1.22%; 95% CI: 0.54, 1.88).

CONCLUSIONS: We observed that elevated long-term PM_{2.5} and O₃ were associated with decreased focus score in young adults. This abstract does not reflect EPA policy.

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



ABSTRACT E-BOOK

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LIGHTNING TALKS 6

Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-059

Neurologic and Mental Health Outcomes » Mental health outcomes

Ambient air pollution and risk of daily hospital admission for anxiety in 56 Chinese cities

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BACKGROUND AND AIM: The potential impact of short-term exposure to ambient air pollution on risk of anxiety remains uncertain, and no study has investigated the association of major ambient air pollutants (including particulate matters and gaseous air pollutants) with risk of hospital admission for anxiety disorders at the same time.

METHODS: We performed a detailed evaluation on the association of interest based on data from national insurance databases in China. Daily hospital admissions for anxiety disorders were identified in 2013-2017 from the national insurance databases covering up to 261 million urban residents in 56 cities in China. A two-stage time-series study based on generalized additive models with quasi-Poisson regression and random-effect meta-analyses was conducted to evaluate the associations between short-term exposure to major ambient air pollutants, including fine particles (PM_{2.5}), inhalable particles (PM₁₀), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), ozone, and carbon monoxide, and risk of daily hospital admission for anxiety.

RESULTS: A total of 57,124 hospital admission cases were identified for anxiety in the included cities. Significant associations between short-term exposures to ambient NO₂ and SO₂ and risk of daily hospital admission for anxiety were found in the overall analysis. Per 10 µg/m³ increases in NO₂ at lag0 and SO₂ at lag6 were associated with significant increases of 1.30% (95% CI: 0.09, 2.53) and 1.53% (95% CI: 0.59, 2.48) in anxiety admission, respectively. A 10 µg/m³ increase in PM_{2.5} at lag5 was associated with a marginally significant increase of 0.45% (95% CI: -0.02, 0.92) in anxiety admission.

CONCLUSIONS: Short-term exposure to ambient air pollution is associated with increased risk of anxiety admission, which may provide new insights into the environmental risk factors of mental health and important implications for promotion of mental health in the public.

Keywords: air pollution; anxiety; hospital admission; nitrogen dioxide, sulfur dioxide



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LIGHTNING TALKS 6

Exposure to Fine Particles and Adverse Health Outcomes

Chairs: Haidong Kan, China & Sara Kress, Germany

O-LT-060

Air pollution » General

Association between air pollution exposure and handgrip strength as a marker of frailty: findings from the French CONSTANCES cohort

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BACKGROUND AND AIM: Air pollution exposure negatively affects human health and might also be linked to frailty. We aimed to evaluate whether exposure to air pollution is associated with poorer handgrip strength, a marker of frailty.

METHODS: Data from the enrollment phase of the French CONSTANCES cohort participants aged 45-years and more were analyzed cross-sectionally. Modeled concentrations of PM_{2.5}, black carbon, and NO₂ from the ELAPSE land-use regression model were assigned to the residential address of each participant. Sex-specific maximum handgrip strength (HGS_{max}) was used as an outcome in multilevel linear regression models adjusted for a set of confounders (reported as β and 95% confidence interval (CI)), using the center of recruitment as a clustering factor. Subgroup analyses were performed across different levels of urbanicity and different personal variables including clinical risk factors.

RESULTS: Of the 53,379 participants (mean age 57.4 \pm 7.2 years), 50.3% were women. The median concentration of PM_{2.5}, black carbon, and NO₂ was 16.1 (IQR=3.8) $\mu\text{g}/\text{m}^3$, 1.6 (IQR=0.7) 10⁻⁵/m, and 22.5 (IQR=13.7) $\mu\text{g}/\text{m}^3$, respectively. HGS_{max} in men was significantly higher than in women (42.1 vs. 25.6 kg). Exposure to all the three pollutants was associated with lower HGS_{max} in both sexes (e.g. β = -0.08; 95% CI: -0.11: -0.04 in men, and β = -0.08; 95% CI: -0.12: -0.04 in women per 3.8 $\mu\text{g}/\text{m}^3$ exposure to PM_{2.5} in the adjusted model). Significantly stronger associations were found for all three pollutants (in single pollutant models) in men aged 65 years and older compared to younger men. Men with diabetes, depression, and cardiovascular disease tended to have poorer HGS_{max} associated with exposure to all of the pollutants. Stratified results for women were less conclusive.

CONCLUSIONS: In this large general population study, air pollution was associated with poorer HGS, especially in men. It is of importance because HGS is a marker of general well-being and frailty.

Keywords: Frailty, Handgrip strength, Black carbon, Particulate matters, Nitrogen dioxide, CONSTANCES Cohort



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August 24, 2021 / 14:00 - 15:00 / Statue of Liberty Hall (Hall 1)

LIGHTNING TALKS 7

Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-061

Exposures » Environmental disparities

Environmental Racism: The Relationship Between Historical Residential Redlining and Current Environmental Hazards

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BACKGROUND AND AIM: Communities of color in the United States (U.S.) are disproportionately exposed to environmental hazards. However, few studies have examined the relationship between historical discriminatory practices and current environmental hazard exposure, across a range of locations and hazards. In the 1930s, the Home Owners' Loan Corporation (HOLC) created community maps to indicate the level of security for real-estate investments, using grades A (good) to D (poor), a practice known as redlining. We conducted an ecological study to assess the association between historical redlining and present-day environmental hazards in 196 U.S. communities.

METHODS: HOLC security maps were obtained from the University of Richmond's Mapping Inequality Project. We used a spatial weighting method to assign a redlining score to each census tract, where at least 20% of its area was previously graded, so that higher scores represented tracts with more "D" rated neighborhoods. Data on air quality and proximity to hazardous waste and Superfund sites were obtained from the U.S. Environmental Protection Agency's EJSCREEN. We used linear mixed effects regression models, with a random intercept for community, to assess the relationship between redlining score and current environmental hazards. Models were adjusted for percent minority population and poverty.

RESULTS: Census tracts in the fourth quartile of redlining score had higher concentrations of fine particulate matter (PM_{2.5}) [$\beta=0.05$, 95% CI: 0.04, 0.06] and diesel particulate matter [$\beta=0.12$, 95% CI: 0.10, 0.14] than census tracts in the first quartile. Census tracts in the fourth quartile were also significantly closer to hazardous waste and Superfund sites than census tracts in the first quartile. We also demonstrate a publicly-available tool to visualize this data.

CONCLUSIONS: We found evidence for an association between historical government-sponsored discriminatory practices and disproportionate environmental burden in communities today. These results add to the growing literature pointing to the role of systemic racism in environmental injustice.

Keywords: environmental justice, environmental disparities, policy research, particulate matter, exposures



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LIGHTNING TALKS 7

Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-062

Exposures » Occupational exposures

The “cost” of noise at work: an occupational injustice among low wage workers and communities

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BACKGROUND AND AIM: Noise exposure is ubiquitous in the US and has been associated with various health outcomes. Chronic occupational noise exposure of an 8-hour time weighted average (TWA) ≥ 85 A-weighted decibels (dBA) leads to permanent noise-induced hearing loss, which has major social impacts and may cost $> \$100$ billion annually in lost wages alone. It is estimated that tens of millions of workers are exposed to hazardous levels of occupational noise. Understanding potential occupational and environmental injustices in the distribution of occupational noise across communities and worker income groups is important to examine whether those exposed to hazardous levels of occupational noise are also disproportionately burdened populations.

METHODS: Publicly available noise measurements from the US noise job exposure matrix (JEM) and wage estimates from the Bureau of Labor Statistics (BLS) Occupational Employment Statistics (OES) were utilized in mixed-effects logistic regression to analyze (1) national-level job-title noise exposure and the odds of earning $< \$39,810$ (median national salary), and (2) metropolitan/nonmetropolitan (M/NM) level population-weighted occupational noise estimates and the odds of a M/NM area earning $< \$36,020$ (median M/NM-level salary).

RESULTS: A one-dBA increase in the average noise exposure experienced at work is significantly associated with 1.19 (95% CI: 1.03, 1.38) times higher odds of earning $< \$39,810$, and 1.21 (95% CI: 1.03, 1.42) higher odds when controlling for total employment count. A one-dBA increase in a M/NM area's population-weighted occupational noise estimate is significantly associated with 2.46 (95% CI: 1.50, 4.03) higher odds of a M/NM area earning $< \$36,020$, and 1.75 (95% CI: 1.06, 2.89) times higher odds when controlling for rural/urban area.

CONCLUSIONS: Higher occupational noise exposure is unequally distributed among lower wage-earning jobs and communities.

Keywords: Noise, occupational exposures, socio-economic factors, environmental disparities



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Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-063

Air pollution » Traffic-related

Asthma and Environmental Justice at Ezra Prentice Homes: The South End Community Health Survey

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BACKGROUND AND AIM: Ezra Prentice Homes (EP) is a public housing complex located in the industrial, southernmost tip of Albany, NY, dissected by a busy state highway and adjacent to the Port of Albany. Residents, community leaders, and environmental activists drew attention to residents' environmental health concerns and residents requested a community-based health survey. In response to this attention, the New York State Department of Environmental Conservation launched the Albany South End Community Air Quality Study, observing traffic related air pollutants (TRAPS) at 'considerably higher' levels in the EP community compared to the rest of the neighborhood (Report October 2019).

AIM: Measure the impact of living at Ezra Prentice homes on asthma prevalence.

METHODS: The South End Community Health Survey of EP households, in partnership with local community-based organizations, began in 2016. A Resident Outreach Worker (ROWs) model was developed. ROWs connected with neighbors, introduced the survey, and created appointments for graduate students to administer an in-depth health survey. In 2018, it expanded to Creighton Storey Homes (CS), a public housing complex in a residential section of the South End that is surrounded by green space, to capture data from a demographically similar group.

RESULTS: 119 households (301 individuals) from EP (66%) and 66 households (164 individuals) from CS (52%) participated. When tested by z-score for 2 population proportions, the number of children under 18 with active asthma was significantly higher at EP (34%) than CS (18%) ($p=.02$). A similar pattern was observed for all ages combined: 34% and 21%, $p=.0002$, respectively.

CONCLUSIONS: Initial analysis of the South End Community Health Study data observed significantly higher rates of asthma at a public housing complex where elevated TRAPS have been documented. Analyses adjusted for race and smoking status will be explored. Results will be shared with the community to inform future policy.

Keywords: Environmental justice, asthma, traffic-related air pollutants (TRAPS), public housing



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Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-064

Air pollution » Particulate matter

COVID-19 Highlights an Environmental Injustice: Influence of Energy Insecurity on Urban Outdoor Air Pollution during Community Lockdown in South-Central Chile

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BACKGROUND AND AIM: In south-central Chile, outdoor air pollution primarily originates as household air pollution from wood burning for heating. The effect of COVID-19 lockdowns on ambient air pollution levels in urban south-central Chile, may therefore be different from trends observed in cities where transportation/industrial emission sources dominate. This study investigates the impact of COVID-19 lockdown on outdoor fine (PM_{2.5}) and coarse (PM₁₀) particulate matter concentrations in Temuco, Chile.

METHODS: Hourly PM_{2.5} and PM₁₀ measurements from six air monitoring stations (three reference-grade beta attenuation monitors and three low-cost sensors) in commercial and low- and middle-income residential areas of Temuco were compared during winter months (March-September) in 2019 and 2020 (spanning COVID-19 lockdown).

RESULTS: Average monthly PM_{2.5} concentrations in low-income residential areas of Temuco during winter 2019 ranged from (36-53 µg/m³), approximately twice as high as concentrations in commercial areas (12-29 µg/m³). During COVID-19 lockdown, average monthly ambient PM_{2.5} concentrations in a commercial and middle-income residential area of Temuco were up to 50% higher (12 µg/m³ to 18 µg/m³) and 59% higher (22 µg/m³ to 35 µg/m³) than 2019 levels, respectively. Conversely, PM_{2.5} levels decreased by up to 52% (43 µg/m³ to 21 µg/m³) in three low-income neighborhoods. The night-time mass percent of PM₁₀ that was PM_{2.5} in April 2020 increased by 48% above April 2017-2019 proportions (50% to 74%) in a commercial area.

CONCLUSIONS: Wood burning was responsible for a significantly higher proportion of ambient PM_{2.5} pollution in commercial areas and a middle-income neighborhood of Temuco during COVID-19 lockdown, compared to winter months in 2019. Energy insecure households likely refrained from wood heating during lockdown, leading to PM_{2.5} concentration declines in low-income neighborhoods. To reduce ambient air pollution and energy insecurity resulting from reliance on wood for heating in south-central Chile, affordability of clean heating fuels (e.g. electricity, liquefied petroleum gas) should be a policy priority.

Keywords: COVID-19, residential heating, household air pollution, particulate matter, energy insecurity, PM_{2.5}



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Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-065

Chemical exposures » PFAS

Exposure to per and polyfluoroalkyl acids (PFAAs) from diet and lifestyle factors among Inuit adults of Nunavik, Canada

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BACKGROUND AND AIM: Perfluoroalkyl acids (PFAAs) are water/stain resistant compounds resistant to metabolic degradation, making them environmentally stable, mobile and bioaccumulative. This leads to high concentrations in wildlife species essential to the cultural identity and subsistence of Arctic populations, including the Inuit. Our objective was to characterize the distribution and exposure determinants of PFAAs among the Inuit adults of Nunavik.

METHODS: The study included 443 randomly selected Nunavik residents (Nunavimmiut) aged 16-82 years who participated in the Qanuilirpitaa? 2017 Nunavik Inuit Health Survey. Associations between plasma concentrations of nine PFAAs and country food consumption, drinking water source, and traditional activity participation were examined using multiple linear regression models.

RESULTS: PFAAs concentrations among Nunavimmiut were up to seven times higher than those in the general adult Canadian population. After adjustment, above-median consumption of marine mammal, fish, and game bird were associated with increased concentrations of perfluorooctanoic-acid (PFOA), perfluorononanoic-acid (PFNA), perfluorodecanoic-acid (PFDA), perfluoroundecanoic-acid (PFUndA), perfluorohexanesulfonic-acid (PFHxS), and perfluorooctanesulfonic-acid (PFOS). Of note, marine mammal consumption ≥ 1 /week was associated with a 43.2-53.5% increase in PFNA, PFDA, PFUndA,



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PFHxS, and PFOS (p -values ≤ 0.008). In addition, the omega-3 to omega-6 polyunsaturated fatty acids ratio in red blood cell membranes, indicative of marine mammal and fish consumption, was linearly associated with higher long-chain PFAAs (PFNA, PFDA, PFUdA), including a 97.3% (95% CI: 81.9-115.7%) increase in PFNA, and a 146.2% (95% CI: 118.1-181.1%) increase in PFDA, when contrasting the fourth versus the first quartile of the omega-3/omega-6 ratio. There were no associations between PFAAs and drinking water sources or traditional activities.

CONCLUSIONS: The results speak to the importance of characterizing PFAAs exposure in Arctic communities for improved public health messaging on country foods and to provide evidence for actions aimed at reducing PFAAs exposure in the Arctic to protect the exceptional quality of country foods in Nunavik.

Keywords: pfas, Community-engaged research, Environmental disparities, Exposure assessment, Long-term exposure, Environmental epidemiology



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Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-066

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

Is the installation of stormwater control measures (i.e., green infrastructure) associated with racial and ethnic minority displacement?

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BACKGROUND AND AIM: Stormwater Control Measures (SCMs) (i.e., green infrastructure) are becoming common approaches to tackle urban stormwater. The efficient use of space and health/ecological benefits make SCMs an attractive alternative or addition to traditional stormwater management. However, studies suggest that the installation of greening methods, such as parks, may lead to gentrification or displacement of racial/ethnic minorities due to factors such as increased housing costs and property values. We studied whether the installation of SCMs is associated with displacement of racial/ethnic minorities and how this association varies by SCM type, pre-installation income, and SCM size. Washington DC, our study site, installed a higher density of SCMs in areas with a higher percentage of racial/ethnic minorities, adding to the importance of studying how these installations may impact minority groups.

METHODS: We compared the change in percentage of racial/ethnic groups at the Census block group level between the 5-year periods before and after SCM installation (2011-2014) among four levels of SCM Installation Exposure Density. We stratified our findings by SCM type, pre-installation median household income, and SCM size.

RESULTS: Preliminary results reveal that SCM installation is associated with racial and ethnic minority displacement (i.e., a decrease in the percentage of racial/ethnic minority residents). Census block groups with a higher density of surrounding SCM installations have more racial/ethnic minority displacement. This association was observed for most types of SCMs and pre-installation median household incomes. Preliminary results also revealed that the installation of multiple small green roofs, a common type of SCM, is associated with less racial minority displacement than fewer medium and large sized green roofs.

CONCLUSIONS: In conclusion, careful attention is needed to address racial/ethnic minority displacement in relation to SCM installation and strive to ensure that SCMs can benefit all the surrounding residents.

Keywords: Environmental Justice, Minority Displacement, Stormwater Control Measures, Green Infrastructure, Racial/Ethnic Minorities, Built Environment



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Environmental Racism and Inequities

Chairs: Ami Zota, United States & Yanelli Nunez, United States

O-LT-067

Air pollution » Particulate matter

Exploring the connection between air pollution and COVID-19 in Louisiana

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BACKGROUND AND AIM: Minority communities, especially African Americans are disproportionately impacted by COVID-19 in the United States (US). In Louisiana, African Americans account 32.2% (1.5 million) of the population with higher rates of social disparities and chronic health conditions such as heart disease, diabetes, obesity, asthma, and hypertension. These health conditions are often linked to long-term exposure to air pollutions and are known to compromise the immune system and increase vulnerability to COVID-19 infection and death. The aim of this study is to determine the associations between air pollution PM_{2.5} and COVID-19 mortality and infection rates.

METHODS: Spatial analysis of COVID-19 was conducted using Getis-Ord (GI*) statistics. Pearson correlation coefficient and negative binomial regression were used to quantify associations between PM_{2.5} concentration with COVID-19 mortality and incidence rates.

RESULTS: We found that Louisiana average long-term PM_{2.5} (9.1 µg/m³) is higher than the U.S. (8.4 µg/m³). A 1 µg/m³ increase in PM_{2.5} is associated with a 2%-3% increase in the COVID-19 death and case in both count and rate (p<0.03), adjusting for health conditions and social factors. In high PM_{2.5} areas, African Americans who were exposed to long-term PM_{2.5}, mortality rate was 2.4% higher than other races (p<0.0001) and 13% higher risk to COVID-19 death if infected (p<0.05).

CONCLUSIONS: The outcomes of the study highlight the importance of continuing to control air pollution and help to plan effective responses to prevent and mitigate the risks of COVID-19 infection, and future respiratory diseases on local and state levels.

Keywords: COVID-19, Air Pollution, Particulate Matter, Long-term exposure



ABSTRACT E-BOOK

August 24, 2021 / 14:00 - 15:00 / Statue of Liberty Hall (Hall 1)

LIGHTNING TALKS 7

Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-068

Exposures » Occupational exposures

Experiences of female agricultural workers in Michigan: Perspectives from the Michigan Farmworker Project

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BACKGROUND AND AIM: Agricultural work is recognized as one of the most physically demanding and hazardous occupations worldwide and farmworkers face a myriad of complex social vulnerabilities that create greater health risks from these occupational exposures. Although demographically the United States farming industry mainly employs male workers, about 33% are female, and they face unique working conditions that are relatively understudied. In the present study, we examine the unique social and occupational hazards female farmworkers face, utilizing data from the Michigan Farmworker Project, a community-engaged project that seeks to understand the working and living conditions of farmworkers in Michigan.

METHODS: We conducted in-depth interviews with farmworkers (n=34) and health, legal, and social service providers (n=21) in four Michigan counties with higher concentration of farmworkers. Interviews were recorded, transcribed, and analyzed thematically using NVivo 12. The present analysis primarily draws on interviews with female farmworkers.

RESULTS: Female farmworkers in our study (n=19; average age=40) reported hazardous and exploitative working conditions such as lack of ventilation, chemical exposures, harmful weather conditions, and problems with proper hygiene and sanitation especially during menstruation, including lack of bathroom access and problems leading to urinary tract infections. Participants discussed pregnancy-specific concerns (i.e., chemical exposures, lack of disclosure of pregnancy to supervisors due to fear, lack of access to prenatal and postnatal care, inability to breastfeed due to work schedule) and concerns regarding children (i.e., lack of childcare, inappropriate living conditions for children). Other themes included sexual harassment and assault, disproportionately excluded from employment consideration due to gender, and social isolation.

CONCLUSIONS: Our findings suggest that female farmworkers are disproportionately burdened with occupational hazards and lack social and labor protections to ensure their health and well-being and that of their families. Study results can inform policies and interventions to improve working and living conditions for female workers.

Keywords: Female, Occupational epidemiology, Occupational exposures, Environmental justice, Environmental disparities, Pregnancy outcomes



ABSTRACT E-BOOK

August 24, 2021 / 14:00 - 15:00 / Statue of Liberty Hall (Hall 1)

LIGHTNING TALKS 7

Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-069

Air pollution » General

Women's empowerment as a pathway to sustainable and modern energy for all: evidence from the Demographic and Health Surveys

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BACKGROUND AND AIM: Household air pollution (HAP) is a leading cause of environmental pollution and health burden. Many countries in Africa cook with polluting fuels (main cause of HAP). Women's empowerment (WE) is known to improve healthcare service use, child nutrition and agricultural productivity. In Africa, however, little is known about the relationship between WE and household fuel use. We aimed to examine if WE is associated with cooking fuel use in Africa, and whether it varies between countries.

METHODS: We used the Demographic and Health Surveys conducted between 2003 and 2018 (n= 264 269 [women-household pairs]). We used a novel, Africa-specific index (Survey-based Women's emPOWERment index), including three dimensions of empowerment: attitude to violence, social independence and decision-making. We used hierarchical logistic regression models to assess the relationship between WE dimensions and the type of fuel used in the household ('clean': electricity, liquefied petroleum gas, biogas or natural gas; 'polluting': solid fuels or kerosene). Results from binomial and multinomial regressions were expressed as odds ratios (OR). The country-specific estimates were combined using meta-analysis.

RESULTS: Only 43 778 (14.5%) households used clean fuels. Overall, 12/31, 22/31 and 13/31 country-level estimates showed a significant association between a one standard deviation increase in attitude to violence, social independence and decision-making (higher scores indicate greater empowerment) dimensions, respectively, and higher odds of using clean fuel as primary energy source for cooking. The estimates from random-effect meta-analyses showed that increased empowerment was associated with higher odds of using clean fuel for attitude to violence (OR = 1.22; 95% CI: 1.12–1.33), social independence (OR = 1.34; 95% CI: 1.28–1.42), and decision-making (OR = 1.10; 95% CI: 1.05–1.15).

CONCLUSIONS: These results suggest that empowering women in these dimensions has potential to mitigate global climate, and accelerate transitions to clean fuel in Africa. An integrated multi-sector effort could be crucial.

Keywords: Air pollution, Climate, Environmental disparities, Exposure, Female, Policy



ABSTRACT E-BOOK

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LIGHTNING TALKS 7

Environmental Racism and Inequities

Chairs: Ami Zota, Unites States & Yanelli Nunez, United States

O-LT-070

Air pollution » General

Ambient air pollution and socioeconomic status in China

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BACKGROUND AND AIM: Air pollution disparities by socioeconomic status (SES) are well documented for the US, with most literature indicating an inverse relationship (i.e., higher concentrations for lower-SES populations). Limited knowledge exists for China, a country accounting for 26% of global premature deaths from ambient air pollution. We propose and test the opposite relationship as in the US: in China, air pollution exposures are higher for high-SES than for the low-SES populations. Underlying this framework is that in China's current industrialization and urbanization stage, economic development is correlated with both SES and air pollution.

METHODS: We test our air pollution inequality theory by combining estimated 2015 annual-average ambient concentrations for nitrogen dioxide (NO₂) and fine particulate matter (PM_{2.5}), derived from a national empirical model for China with 1 km spatial resolution, with demographic information derived from national gridded GDP per capita at 1 km resolution and (separately) a national representative sample of 21,095 individuals from the China Health and Retirement Longitudinal Study (CHARLS) 2015 cohort. We quantify the air pollution disparities among individual's rural-to-urban migration status and SES factors (education, occupation, and income). We compare results using three approaches to SES measurement (individual SES score; community-averaged SES score; gridded GDP per capita).

RESULTS: Consistent with our theory, ambient NO₂ and PM_{2.5} concentrations are higher for higher-SES populations than for lower-SES population, and higher for long-standing urban residents than for rural-to-urban migrant populations. For example, for the three SES measurements, a 1-IQR increase in SES corresponds to concentration (units: µg/m³) increases of 5.6 - 9.4 NO₂ and 3.5 - 6.0 PM_{2.5}. This pattern holds in rural and urban locations, across geographic regions, across levels of spatial resolution, and for modeled versus measured pollution concentrations.

CONCLUSIONS: Multiple analyses reveal that in China, ambient NO₂ and PM_{2.5} air pollution levels are higher for high-SES than for low-SES individuals.

Keywords: Ambient air pollution, Socioeconomic status, NO₂, PM_{2.5}



ABSTRACT E-BOOK

August 24, 2021 / 14:00 - 15:00 / Grand Central Hall (Hall 5)

LIGHTNING TALKS 8

Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-071

Air pollution » Long-term exposure

Long-Term Air Pollution Exposures and Major Depression in Older U.S. Adults: The Health and Retirement Study

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BACKGROUND AND AIM: Major depression is a leading cause of morbidity worldwide, especially during later life. Since heritability is modest (40-50%), there is interest in understanding risk from environmental factors like air pollution. However, research examining this issue is scarce, and often does not use clinical diagnostic criteria. Here, we aimed to quantify associations of air pollution with prevalent major depression in a cohort that deploys diagnostic assessments.

METHODS: We conducted a repeated measure analysis of 2008-2016 interviews from the Health and Retirement Study, a nationally representative cohort of older adults in the United States. Major depression status was determined biennially using the Composite International Diagnostic Interview Short Form, with a cutoff of 5. We estimated 1-year average PM_{2.5}, PM_{10-2.5}, NO₂, and O₃ concentrations at participant residences using fine-scale spatiotemporal models. To estimate prevalence ratios, we fit generalized linear models that accounted for sample weights and clustering by participant. All models included demographic characteristics, individual and neighborhood socioeconomic status, calendar time, and geographic area.

RESULTS: Among 25,305 participants with complete data, there was a mean age of 63 years, 53% were female, and most were Non-Hispanic White (73%), with some Black (11%) and Hispanic participants. Eight percent reported major depression. In fully adjusted models, we observed that higher PM_{2.5} and NO₂ concentrations were associated with a greater prevalence of major depression (PR: 1.13 per 3 µg/m³ PM_{2.5}, 95% CI: 1.03, 1.23; PR: 1.23 per 5 ppb NO₂, 95% CI: 1.06, 1.20). Only the association with NO₂ was robust to adjustment for other pollutants, however, and no associations were observed with PM_{10-2.5} or O₃.

CONCLUSIONS: Overall, we observed a robust association of major depression prevalence with long-term exposure to NO₂ but not with other air pollutants. This suggests that traffic may be a modifiable risk factor that could be targeted to reduce socioeconomic disparities in mental health.

Keywords: Traffic-Related Air Pollution, Major Depression, Psychiatric Epidemiology, Health Disparities



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LIGHTNING TALKS 8

Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-072

Neurologic and Mental Health Outcomes » Mental health outcomes

Early life air pollution exposure elevates general psychopathology risk at the transition to adulthood

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BACKGROUND AND AIM: Air pollution exposure has been shown to damage the brain but its associations with the development of psychopathology are not fully characterized. This study tested whether early life air pollution exposure is associated with greater psychopathology at the transition to adulthood.

METHODS: Air pollution exposure and young adult psychopathology were investigated in the Environmental-Risk (E-Risk) Longitudinal Twin Study, a population-representative UK-based cohort of 2,232 children born in 1994-1995 and followed to age 18 years. High-resolution annualized estimates of outdoor nitrogen oxides (NO_x) and fine particulate matter (PM_{2.5}) linked to age-10 and age-18 home addresses were combined with data on mental-health disorder symptoms assessed through structured interview at age 18. Symptom counts were transformed through confirmatory factor analysis into continuous measures of General Psychopathology and Internalizing, Externalizing, and Thought Disorder symptoms, all standardized to mean(SD)=100(15). Adjustments were made for high-resolution measures of disadvantageous neighborhood characteristics, including socioeconomic deprivation, physical dilapidation, social disconnection, and dangerousness.

RESULTS: After adjustment for family and individual factors, each interquartile range increment increase in NO_x exposure was associated with a 1.40-point increase (95%CI=0.41-2.38, P=.005) in General Psychopathology. Associations between continuously measured PM_{2.5} and General Psychopathology were non-significant; however, those in the highest quartile of PM_{2.5} exposure scored 2.04-points higher (95%CI=0.36-3.72, P=.017) than those in the bottom three quartiles. Co-pollutant models including both NO_x and PM_{2.5} implicated NO_x as the significant factor. NO_x exposure was associated with all secondary outcomes, although associations were weakest for Internalizing, medium for Externalizing, and strongest for Thought Disorder symptoms. Despite NO_x concentrations being highest in neighborhoods with worse physical, social, and economic conditions, adjusting estimates for neighborhood characteristics did not change the results.



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CONCLUSIONS: Youths exposed to higher levels of NO_x outdoor-air pollution experienced greater psychopathology at the transition to adulthood. Air pollution may be a non-specific risk factor for the development of mental illness.

Keywords: Air pollution, Oxides of nitrogen, Mental health outcomes, Children's environmental health



ABSTRACT E-BOOK

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LIGHTNING TALKS 8

Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-073

Neurologic and Mental Health Outcomes » Mental health outcomes

Associations of Short-term Exposure to Air Pollution and Ambient Temperature Increase with Psychiatric Admissions in Elderly Adults

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BACKGROUND AND AIM: Little is known about the associations between ambient environmental exposures and risk of acute episodes of psychiatric disorders. We aim to estimate the risk of acute psychiatric hospital admission associated with short-term exposure to ambient air pollutants and temperature increase in the US elderly population.

METHODS: Daily ambient levels of air pollutants (PM_{2.5}, O₃, and NO₂) and daily ambient surface temperature were assigned to participants by zip code. A time-stratified case-crossover study design was applied to estimate the relative risk increases (RRI) and annual absolute risk differences (ARD) in targeted psychiatric admission rate per 5 units increase in ambient exposures ($\mu\text{g}/\text{m}^3$ for PM_{2.5}, ppb for ozone and NO₂, °C for temperature). We included all emergency and urgent admissions with primary diagnosis of depression (n=458,492), schizophrenia (n=165,572) and bipolar disorder (n=166,833) from 2000 to 2016 in the entire US Medicare population.

RESULTS: Each 5 $\mu\text{g}/\text{m}^3$ increase in short-term exposure to PM_{2.5} was associated with an RRI of 0.62% (95% CI: 0.23%, 1.02%) for depression, an RRI of 0.77% (95% CI: 0.11%, 1.44%) for schizophrenia, and an RRI of 1.19% (95% CI: 0.49%, 1.90%) for bipolar disorder. Each 5 ppb increase in short-term exposure to NO₂ was linked with an RRI of 0.35% (95% CI: 0.03%, 0.66%) for depression, as well as an RRI of 0.64% (95% CI: 0.20%, 1.08%) for schizophrenia. For each 5 °C increase in short-term exposure to cold season temperature, relative risk increased by 3.66% (95% CI: 3.06%, 4.26%), 3.03% (95% CI: 2.04%, 4.02%) and 3.52% (95% CI: 2.38%, 4.68%) for depression, schizophrenia and bipolar disorder, respectively. No associations were found with ozone and warm season temperature.

CONCLUSIONS: In the US nationwide Medicare elderly population, short-term exposure to elevated levels of PM_{2.5}, NO₂ and cold season ambient temperature was significantly associated with increased risk of acute psychiatric admissions.

Keywords: Air pollution, Temperature, Mental health outcomes, Short-term exposure, Multi-pollutant



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Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-074

Neurologic and Mental Health Outcomes » Mental health outcomes

Early pregnancy exposure to metals and maternal depressive symptom trajectories in Project Viva

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BACKGROUND AND AIM: Exposure to neurotoxicant metals, hypothesized to alter dopaminergic function, have not been sufficiently explored as a risk factor for maternal depression. We evaluated the extent to which early pregnancy blood levels of essential and non-essential metals were prospectively associated with depressive symptom trajectories from mid-pregnancy to 7-years postpartum.

METHODS: Participants were 872 women in Project Viva, a longitudinal Boston-area cohort recruited during pregnancy (1999-2002). We measured levels of 11 metal(loid)s (arsenic, barium, cadmium, cesium, copper, mercury, magnesium, manganese, lead, selenium, zinc) in maternal first trimester erythrocytes. We assessed depressive symptoms via the Edinburgh Postnatal Depression Scale at mid-pregnancy and four postpartum timepoints (6 months, 1, 3, 7 years). Utilizing latent class mixed modeling, we identified three depressive symptom trajectories: stable low (86%); elevated perinatal symptoms, then decreasing (9%); and moderate perinatal symptoms, then increasing (5%), among women with ≥ 3 repeat measures. Adjusting for maternal sociodemographics and dietary intake, we used multinomial logistic regression to test associations of individual metal levels with odds of having an increasing or decreasing trajectory.

RESULTS: In our cohort of moderately high socioeconomic status participants (e.g., 75% college graduate), correlations between metal levels were mostly positive (Spearman: 0.01-0.60), except for negative correlations between barium and all other elements. Compared to having a stable low trajectory, a doubling of blood arsenic was associated with 1.27 (95% confidence interval: 1.01, 1.59) odds of an increasing depressive trajectory. Greater prenatal mercury blood level was associated with



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lower odds of having a decreasing trajectory [0.88 (95% confidence interval: 0.77, 1.00)]. All other first trimester metal levels were not associated with depressive symptom trajectory.

CONCLUSIONS: In our study investigating associations of several early pregnancy metals with maternal depressive symptom trajectories, we did not observe strong evidence of associations. Residual confounding or multiple testing may explain observed associations with arsenic and mercury.

Keywords: Mental health outcomes, heavy metals, chemical exposures, female



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Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-075

Neurologic and Mental Health Outcomes » Mental health outcomes

The association between fine particulate matter exposure and anxiety in US-based cohort Nurses' Health Study II

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BACKGROUND AND AIM: A growing body of evidence has connected air pollution exposure to anxiety outcomes, but existing studies have only been cross-sectional. Previous studies have found associations of varying magnitude between both short- and long-term fine particulate matter (PM_{2.5}) exposure and anxiety outcomes. Here, we focus on short-term exposure. We examined the association between one-month average PM_{2.5} exposure and high anxiety symptoms in a prospective nationwide US-based cohort study.

METHODS: We included 58,615 participants of the Nurses' Health Study II (NHSII) who had complete outcome and covariate data in the analysis. Anxiety symptoms (Crown Crisp Index (CCI) phobic anxiety subscale) were measured via questionnaires administered in 1993 and 2005. CCI score was dichotomized at a clinically relevant cutoff (CCI ≥ 6). We used spatiotemporal prediction models to estimate monthly levels of PM_{2.5} exposure at each participant's residential address at the time of each questionnaire. We used generalized estimating equation (GEE) regression models to estimate multivariable-adjusted odds ratios (OR) and corresponding 95% confidence intervals (CIs).

RESULTS: A total of 6610 participants met the clinical cutoff for anxiety in 1993, and 6727 in 2005. The average one-month PM_{2.5} exposure level in 1993 was 15.8 µg/m³ and in 2005 was 14.3 µg/m³. After adjusting for individual and neighborhood-level sociodemographic factors, the odds ratio for clinically relevant anxiety symptoms associated with each 10 µg/m³ increase in PM_{2.5} exposure was 1.07 (1.02, 1.07).

CONCLUSIONS: In this prospective cohort of US women, we observed increased odds of phobic anxiety in association with an increase in PM_{2.5} exposure. Our results support the findings from cross-sectional studies indicating that air pollution exposure may be related to adverse mental health outcomes.

Keywords: air pollution, short-term exposure, particulate matter, mental health outcomes



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LIGHTNING TALKS 8

Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-076

Chemical exposures » PFAS

Prenatal Exposure to Perfluoroalkyl Substances and Mental Health in Childhood

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BACKGROUND AND AIM: Epidemiological studies have evaluated the effect of prenatal exposure to perfluoroalkyl substances (PFAS) on neurobehavioral and cognitive endpoints in childhood, but a research focus on mental health is lacking. We evaluated the associations between prenatal PFAS exposure and mental health including depressive symptoms, physical or emotional stress, and psychosis-like experience in children at age 11.

METHODS: Using pooled samples in the Danish National Birth Cohort established between 1996 and 2002 (N=2,250), we estimated the associations between concentrations of six types of PFAS in maternal plasma (median, 8 gestational weeks) and child self-report mental health outcomes using validated questionnaires. Binary classifications (with or without moderate/severe symptoms) for each of the outcomes and continuous outcome variables were analyzed. We used unconditional logistic regressions to estimate the adjusted odds ratio (OR) and 95% confidence interval (CI) for the binary outcomes according to log₂-transformed PFAS concentrations and PFAS tertiles. PFAS mixture by using the weighted-quantile-sum index was conducted. Analyses were repeated using negative binomial regressions for continuous count outcome variables. Sex-specific analyses were conducted.

RESULTS: The highest exposure tertile for perfluorooctanoic acid (OR=1.34, 95% CI: 1.06, 1.71), perfluorohexane sulfonate (OR=1.43, 95% CI: 1.06, 1.92) and perfluoroheptane sulfonate (OR=1.37, 95% CI: 1.02, 1.84) were associated with elevated physical or emotional stress in childhood. The WQS index for PFAS mixture was also positively associated with stress in childhood (OR=1.21, 95% CI: 1.05, 1.40). There were no consistent associations found for these PFAS compounds and depressive symptoms or psychosis-like experience. Findings from negative binomial regressions were similar. There were also no apparent differences in analyses stratified by sex.

CONCLUSIONS: Higher prenatal levels of three PFAS compounds and PFAS mixtures might influence physical and emotional stress in childhood. More research of fetal exposures to environmental pollutants and mental health risk in the offspring would be needed.

Keywords: PFAS, Mental health outcomes, Children's environmental health, Environmental epidemiology



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LIGHTNING TALKS 8

Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-077

Air pollution » General

Air pollution exposure and different dimensions of depression: findings from the French CONSTANCES cohort

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BACKGROUND AND AIM: The evidence for the association between air pollution exposure and depression is growing. We aim to explore this association across different dimensions of depressive symptoms.

METHODS: Data from the enrollment phase of the French CONSTANCES cohort were analyzed cross-sectionally. Annual concentrations of PM_{2.5}, black carbon (BC), and Nitrogen dioxide (NO₂) from the ELAPSE land-use regression models were assigned at the residential addresses of participants. The z-score of depressive symptoms measured by the Centre of Epidemiologic Studies Depression (CES-D) questionnaire, and its four dimensions (depressive affect, interpersonal relations, low positive affect, somatic complaints) were used as outcomes in multiple linear regression models (reported as β and 95% confidence interval (CI) for an interquartile range (IQR) increase in exposure), for each pollutant separately. Stratified analyses were performed by sex, income, family status, education and community-level deprivation index.

RESULTS: Of the 116,170 included participants (mean age: 46.4±13.6 years), 53.2% were women. The median exposure to PM_{2.5}, BC and NO₂ was 14.4 $\mu\text{g}/\text{m}^3$ (IQR=4.4), 1.4 10⁻⁵/m (IQR=0.8), and 19.8 $\mu\text{g}/\text{m}^3$ (IQR=15.3), respectively. The prevalence of depressive symptoms in women was higher than in men (27.7% vs. 17.0%). Exposure to BC and NO₂ were significantly associated with higher total CES-D and all dimensions scores. PM_{2.5} was associated with depressive affect only ($\beta= 0.03$; 95% CI=0.01: 0.04). For all models and pollutants, the largest estimate was observed for the depressive affect. We found stronger associations for men, lower-income participants, low education groups, and those living alone.

CONCLUSIONS: Air pollution exposure was associated with all dimensions of depressive symptoms and not only somatic complaints. Considering the burden related to depression, its prevalence, and the increasing trend of urbanization which is associated with higher exposure to pollutants, our findings are of utmost importance.



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ABSTRACT E-BOOK

Keywords: Depressive symptoms, Particulate matters, Black carbon, Nitrogen dioxide, CONSTANCES Cohort



ABSTRACT E-BOOK

August 24, 2021 / 14:00 - 15:00 / Grand Central Hall (Hall 5)

LIGHTNING TALKS 8

Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-078

Climate » Temperature

Ambient Heat and Risk of Emergency Department Visits for Mental Health among Adults in the United States

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BACKGROUND AND AIM: Ambient temperature has long been thought to play a role in the exacerbation of symptoms for many mental and behavioral disorders. However, the impacts of elevated temperature on specific mental health outcomes remain poorly documented. Accordingly, we sought to quantify the association between heat and mental health-related emergency department (ED) visits in the conterminous US among adults aged 18 years and older with commercial health insurance.

METHODS: We analyzed de-identified data from ~3.5 million ED visits involving a psychiatric diagnosis during the warm seasons from 2010 and 2019 among adults aged 18 years and older with commercial health insurance living in 2,987 US counties using the OptumLabs® Data Warehouse. We estimated daily population-weighted county average maximum ambient temperature (May to September), and evaluated the association between warm-season ambient temperature and specific mental health diagnoses, as well as any diagnosis among those examined, using a case-crossover study design with a distributed lag nonlinear model.

RESULTS: We found monotonic increases in the odds ratio (OR) of ED visits associated with any mental health diagnosis. A 10°C increase in temperature was associated with an OR for any mental health ED visits of 1.042 (95% confidence interval [CI]: 1.036, 1.047). Associations with a 10°C increase in temperature were also pronounced for ED visits due to specific illness, including anxiety and stress disorders (OR: 1.039; 95% CI: 1.030, 1.049), mood disorders (OR: 1.033; 95% CI: 1.024, 1.042), substance abuse disorders (OR: 1.049; 95% CI: 1.041, 1.058), and schizophrenia (OR: 1.049; 95% CI: 1.025, 1.074).

CONCLUSIONS: We found that in this large population of insured adults in the US, elevated temperature exposures are associated with increased mental health-related emergency department (ED) visits. Future work should aim to further characterize the relationship between sustained periods of extreme temperature (i.e., heat waves) and mental health.

Keywords: Temperature, Climate, Epidemiology, Mental Health



ABSTRACT E-BOOK

August 24, 2021 / 14:00 - 15:00 / Grand Central Hall (Hall 5)

LIGHTNING TALKS 8

Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-079

Neurologic and Mental Health Outcomes » Other (to be specified with keywords in the keywords section)

Association of neighborhood greenness with depressive symptoms in elderly women

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BACKGROUND AND AIM: Epidemiological evidence of the beneficial association between greenness and depression in the elderly is still limited and results of studies are inconsistent. In this study, we aimed to investigate the association between neighbourhood greenness and depression in elderly women.

METHODS: We enrolled 821 women (aged 66-80) from the German SALIA cohort for the 2007-2010 follow-up examination. Greenness was assessed for each participant using the Normalized Difference Vegetation Index (NDVI) (year 2009) for different circular buffers (100-m, 300-m, 500-m and 1000-m) around the residential address. We used two depression outcomes: self-reported doctor diagnosis of ever depression and the frequency of depressive symptoms by using the 20-items Center for Epidemiological Studies Depression Scale (CESD-R). Cross-sectional associations were assessed using adjusted logistic and linear regression models.

RESULTS: In the adjusted models, a 0.1-point increase in NDVI within 300-m was associated with a decreased odds of prior diagnosis of depression (odds ratios (OR): 0.691, 95% confidence intervals (CI): 0.495, 0.965). Similarly, a 0.1-point increase in NDVI within 1000-m was associated with decreased depressive symptoms assessed with the CESD-R score (-12.5% difference in the mean; 95% CI: -21.2%, -3.7%). The results were not consistent across different buffers even though they were in the same direction.

CONCLUSIONS: Urban greening might potentially decrease depression rates in elderly population.

Keywords: depression, depressive symptoms, elderly, greenspace, NDVI



ABSTRACT E-BOOK

August 24, 2021 / 14:00 - 15:00 / Grand Central Hall (Hall 5)

LIGHTNING TALKS 8

Environmental Exposures and Mental Health

Chairs: Rupa Basu, United States & Cole Brokamp, United States

O-LT-080

Climate » Natural disasters

The association between drought conditions and occupational psychosocial stress among Midwestern U.S. farmers: an occupational cohort study

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BACKGROUND AND AIM: Drought represents a globally relevant natural disaster linked to adverse health. Evidence has shown agricultural communities to be particularly susceptible to drought conditions, but there is a limited understanding of how drought may impact occupational psychosocial stress in farmers.

METHODS: We used repeated measures data collected in the Musculoskeletal Symptoms among Agricultural Workers Cohort study, including 498 Midwestern U.S. farmers surveyed with a Job Content Questionnaire (JCQ) at six-month intervals in 312 counties (2012-2015). A longitudinal mixed effects model was used to estimate the change in job strain ratio, a metric of occupational psychosocial stress, during drought conditions measured with a 12-month standardized precipitation index. We further evaluated associations between drought and psychological job demand and job decision latitude, the job strain components, and applied a stratified analysis to evaluate differences by participant sex, age, and geography.

RESULTS: During the growing season, the job strain ratio increased by 0.031 (95% CI: 0.012, 0.05) during drought conditions, an amount equivalent to a one-half standard deviation change, compared to non-drought conditions. The association between drought and the job strain ratio was driven mostly by increases in the psychological job demand (2.09; 95% CI: 0.94, 3.24). No risk differences were observed by sex, age group, or geographic region.

CONCLUSIONS: Our results suggest a previously unidentified association between drought and increased occupational psychosocial stress among farmers. With North American climate anticipated to become hotter and drier, these findings could provide important health effects data for federal drought early warning systems and mitigation plans.

Keywords: natural disasters, mental health outcomes, occupational epidemiology, climate



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

LIGHTNING TALKS 9

Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-081

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Early-life exposure to lead and antisocial behaviors during childhood and adolescence

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BACKGROUND AND AIM: An association between lead (Pb) exposure and antisocial behaviors has been documented over the last decades, but the findings have been inconsistent. We aimed to estimate the association between prenatal, early-childhood, and preadolescent/adolescent (periadolescent) Pb exposure, and aggression and conduct problems in periadolescents of Mexico City.

METHODS: We studied participants from the Early Life Exposures in Mexico to Environmental Toxicants (ELEMENT) cohorts. We used 1) maternal patella Pb at puerperium as a proxy for prenatal Pb exposure, 2) cumulative blood lead index (a summary of repeated blood Pb (BPb) measurements) between birth and 60 months of age as a measure of early-childhood Pb exposure, and 3) a single BPb measurement concurrent with behavioral evaluation as a measure of periadolescent Pb exposure. The parent-reported scales of aggression and conduct problems of the Behavioral Assessment System for Children-2nd version (BASC-2) were evaluated during periadolescence (at a mean age of 10.38 years). We estimated the association between Pb exposure at each stage and having obtained an elevated T-score (≥ 60) in each scale, while adjusting for household socioeconomic status, maternal education and age at delivery, child sex, and Pb exposure at previous stages.

RESULTS: 743, 704, and 595 participants were included in the models for prenatal, early-childhood, and periadolescent Pb exposure, respectively. On average, mothers had 10.6 years of education, and were 26.3 years old at delivery. 49% of children were female. A one-unit increase in Pb exposure during the prenatal period ($1 \mu\text{g/g}$ of maternal patella Pb), but not during childhood or periadolescence, was associated with increased odds of aggression (Odds Ratio (OR)=1.021; 95% Confidence Interval (CI): 1, 1.041) and conduct problems (OR=1.019; 95% CI: 1.002, 1.037)

CONCLUSIONS: Exposure to Pb during the prenatal stage, but not during childhood or adolescence, was associated with aggression and conduct problems during periadolescence in this longitudinal cohort study.

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



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

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Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-082

Chemical exposures » Fluoride

Fluoride exposure and internalizing symptoms in adolescents in a United States cohort

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BACKGROUND AND AIM: Studies have shown a relationship between early chronic, low-level fluoride exposure and attention-deficit hyperactivity disorder and learning abilities in children. Animal studies suggest a link between fluoride exposure and internalizing behaviors. No human studies have examined the impact of fluoride on internalizing behaviors during adolescence.

METHODS: Participants enrolled in the Cincinnati Childhood Allergy and Air Pollution Study (CCAAPS) provided non-fasting spot urine samples at age 12 (n=286). Urine samples were analyzed using a microdiffusion method to determine childhood urinary fluoride (CUF) concentrations. Caregivers of CCAAPS participants completed the Behavior Assessment System for Children-2 at the age 12 study visit to assess symptoms of anxiety, depression, and somatization in their children. Race, age of the child, household income, maternal age at birth, caregiver depression, caregiver-child relationships, and age 12-year serum cotinine levels were considered covariates in linear regression models. Sex-specific effects of fluoride exposures were investigated through the inclusion of interaction terms.

RESULTS: We observed a positive, significant association between CUF concentrations and increased somatization ($\beta = 3.64$, 95% CI 0.49, 6.81) and a positive, but not statistically significant, association with the internalizing composite scale ($\beta = 2.64$, 95% CI -0.15, 5.44). Significant sex differences were also observed; compared to females, males with higher CUF levels exhibited a greater degree of internalizing (pinteraction=0.04) and somatization behaviors (pinteraction=0.02). No associations between urinary fluoride levels and depressive symptoms were found.

CONCLUSIONS: This is the first study to examine fluoride concentrations in urine collected during adolescence and internalizing symptoms, specifically somatization, with males being more at risk. Somatization straddles the interface between physical and psychological health and is often comorbid with anxiety and depression. This was a cross-sectional study; therefore, continued follow-up will help shed light on the impact of fluoride exposure on mental health in children.

Keywords: children's environmental health, fluoride, mental health outcomes



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Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-083

Built environment » Green space

Residential greenspace and internalizing behaviors in early childhood

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BACKGROUND AND AIM: Prior studies suggest that greenspace promotes better mental health among adolescents and adults. We investigated associations between greenspace and internalizing behaviors in earlier childhood.

METHODS: This study included children in the Conditions Affecting Neurocognitive Development and Learning in Early Childhood (CANDLE) pregnancy cohort in Memphis, TN, within the ECHO-Pathways Consortium. Child behaviors were parent-reported using the Child Behavior Checklist. We examined the internalizing behavior broadband score and six related subscales. Greenspace was characterized at participant residences as the Normalized Difference Vegetation Index (NDVI) within 300m, percent tree canopy coverage of the census block group, and distance to the nearest park. Poisson regression models of raw scores were adjusted for a suite of child, maternal and neighborhood factors.

RESULTS: In this sample (n=955), 65% of mothers identified as Black/African-American, 29% as White; 53% had at least a college/technical school degree. Children were on average 4.3 (SD 0.4) years old. Mean NDVI weighted across the year prior to outcome ascertainment was 0.59 (SD 0.08). The mean internalizing raw score was 6.2 (SD 2.1); 5.2% of the sample scored above the clinical threshold (>63 t-score). A 0.1 unit higher NDVI was associated with a 9.4% lower internalizing score (95%CI: -17.5, -0.5), a 10.3% lower anxious/depressed score (95%CI: -19.3, -0.2), an 11.3% lower somatic complaints score (95%CI: -21.1, -0.3), and a 12.7% lower anxiety problems score (95%CI: -20.8, -3.8). Tree canopy was associated with the anxious/depressed and anxiety scores (-5.7% [95%CI: -11.0, -0.2] and -7.7% [95%CI: -12.5, -2.6], respectively, per 10% higher tree canopy coverage), but for the internalizing score confidence intervals included the null (-4.9% [95%CI: -9.7, 0.2]). No associations were observed with park proximity.

CONCLUSIONS: More residential greenness and tree canopy were associated with fewer internalizing problems, suggesting that nature-based interventions may be relevant even early in childhood.

Keywords: Green space, Neurodevelopmental outcomes, Children's environmental health



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August 24, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

LIGHTNING TALKS 9

Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-084

Exposures » Environmental disparities

Does Early Life Phthalate Exposure Mediate Racial Disparities in Children's Cognitive Abilities?

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BACKGROUND AND AIM: Early life exposure to phthalates is associated with diminished childhood cognitive abilities. However, it is unclear if disproportionate exposure to some phthalates among non-Hispanic Black individuals contributes to racial disparities in children's intellectual abilities (e.g., IQ). Here, we assess the extent that phthalates mediate racial disparities in child IQ.

METHODS: We used data from 253 mother-child pairs in Cincinnati, OH (HOME Study). We quantified urinary concentrations of eleven phthalate metabolites twice during pregnancy and up to six times in childhood (ages 1,2,3,4,5 and 8 years). We evaluated children's cognitive abilities using the Wechsler Preschool and Primary Scale of Intelligence and Wechsler Intelligence Scale for Children at ages 5 and 8 years, respectively. Using causal mediation models, we quantified covariate-adjusted direct and indirect effects of race/ethnicity on child IQ through individual measurement-error corrected phthalate metabolite concentrations during gestation and childhood.

RESULTS: Average IQ scores among non-Hispanic Black children (n=90) were 7.0-points lower (95% CI: -12.1, -1.8) than non-Hispanic White children (n=145) after adjustment for socioeconomic factors. Urinary monobenzyl phthalate (MBzP) and monoethyl phthalate (MEP) concentrations during childhood were 33-100% higher in non-Hispanic Black children than non-Hispanic White children. We found evidence that childhood MEP concentrations mediated the race-IQ association. For instance, the disparities in IQ scores between non-Hispanic Black and non-Hispanic White children would have been reduced by 1.9 points (95% CI: -4.7, 0.7), in the absence of childhood diethyl phthalate exposure, the parent metabolite of MEP, at age 2. Other phthalate metabolite concentrations during pregnancy or childhood did not mediate the race-IQ association.

CONCLUSIONS: Children's urinary concentrations of MEP partly mediated racial disparities in IQ scores among these children. While phthalate exposures do not fully explain racial disparities in IQ, reducing exposure to some phthalates might reduce IQ differences among non-Hispanic Black and non-Hispanic White children.

Keywords: Phthalates, children's environmental health, Neurodevelopmental outcomes



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Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-085

Outcomes » Childrens environmental health

Evidence for Transgenerational Effects on Autism Spectrum Disorder Using Multigenerational Space-time Cluster Detection

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BACKGROUND AND AIM: Space-time cluster analyses are commonly used in spatial epidemiology. There is evidence of transgenerational factors associated with ASD. Space-time clusters of parents and grandparents of ASD cases may provide evidence of transgenerational effects and generate hypotheses regarding ancestral conditions associated with ASD. The Aim of this study is to identify and describe space-time clusters of ancestors of individuals with a clinical diagnosis of ASD.

METHODS: Parents and grandparents of diagnosed ASD individuals were identified using the Utah Registry of Autism Developmental Disabilities (URADD) linked to their pedigrees in the Utah Population Database (UPDB). Inclusion criteria for ASD case ancestors included (1) three generations of continuous Utah residency, and (2) first reported case of ASD in the family. Ancestors of individuals without ASD were selected based on a 2:1 random sample matched by age, time-period, and sex to the ASD cases. Residential addresses of the ancestors for their perinatal, childhood and adolescent time periods were compiled from administrative databases linked to the UPDB and geocoded. Bernoulli space-time scan statistic was used to identify clusters for each type of ancestor and developmental window.

RESULTS: The study included 7,914 parents and 15,828 grandparents generated from 3,957 ASD cases. Over 90% of the addresses were geocoded to street address. Twenty statistically significant space-time clusters (p -value < 0.05) were identified (13 increased relative risk (RR) and 7 with $RR < 1$). The four strongest clusters ($RR = 2.74 - 2.96$) were from paternal grandparents at the perinatal time-period spanning 1 to 10 years and covering 8 to 132 km² in predominantly urban residential areas. Of the 13 clusters with $RR > 1$ (range=1.27 - 2.96) 11 began between 1946 and 1960, nine were grandparents.

CONCLUSIONS: Multiple very high relative risk space-time clusters of ASD ancestors during early life provide evidence of potential transgenerational effects on ASD in grandchildren.

Keywords: Space-time clustering, Multigenerational, Autism Spectrum Disorder, Transgenerational Effects



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Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-086

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Critical windows of metal mixture exposure on functional connectivity in adolescents

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BACKGROUND AND AIM: Exposure to neurotoxic metals occurs as a mixture, yet most studies consider single exposures, potentially missing the combined effects of environmental metals. Further, health impacts of mixtures may be missed if studied at a single developmental timepoint. In this study, we investigated associations between early life exposure to a mixture of neurotoxic metals and developmental trajectories of brain networks associated with executive functions (EF) among young adults. We hypothesize that associations between early-life metal mixture exposure and developmental trajectories depend upon the timing of exposure and the developmental stage of the outcome.

METHODS: In preliminary analysis of 32 subjects enrolled in the Public Health Impact of Metals Exposure (PHIME) study, we generated prenatal (2nd week of gestation to birth), early postnatal (birth to one year) and childhood (1-6 years of age) concentrations of 5 toxic and nutritive metals including manganese, lead, zinc, copper and chromium in naturally shed deciduous teeth using laser ablation-inductively coupled plasma-mass spectrometry. We acquired resting state functional magnetic resonance imaging scans at ages 16-22 years. We used generalized weighted quantile sum (gWQS)



ABSTRACT E-BOOK

regression to examine associations between metal mixtures at each developmental timepoint and functional connectivity in resting state networks.

RESULTS: We observed a significant inverse association between the postnatal metal mixture and connectivity in the attention network, i.e., higher metals associated with reduced connectivity ($\beta = -0.029$ [95% CI - 0.046, -0.012]). Mn (29%) and Cu (42%) contributed most to the mixture association, suggesting both that these metals were key components and that Mn does not act alone on the brain but is a key part of a larger mixture.

CONCLUSIONS: Our preliminary results suggest that postnatal Mn disrupts the trajectory of development in the neural circuitry supporting EF and that the association may be specific to the timing of exposure.

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



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Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-087

Air pollution » Oxides of nitrogen

Effects of prenatal exposure to air pollution on toddler neurodevelopment and effect modification by ambient temperature

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BACKGROUND AND AIM: To evaluate the impacts of prenatal exposure to ambient SO₂ and NO₂ on toddler neurodevelopment and the effect modification by ambient temperature.

METHODS: A prospective birth-cohort study was conducted from 2010 to 2012 in Shanghai and 223 mother-child pairs were followed-up until 24-36 months postpartum. Daily concentrations of SO₂ and NO₂ and daily average temperature were obtained for each woman based on the district where she lived during pregnancy and toddler neurodevelopment was assessed at 24-36 months old. Distributed-lag-nonlinear-models (DLNMs) were used to assess the effects of weekly air pollution exposure and the interactions between prenatal air pollution and temperature on toddler neurodevelopment.

RESULTS: Each 10 µg/m³ increase in SO₂ had negative associations with gross motor during gestational weeks 1 to 16 with developmental quotients (DQs) changing from -0.26% to -0.14%, with fine motor from week 25 to 34 with DQs changing from -0.23% to -0.13%, and with adaptive behavior from week 7 to 27 with DQs changing from -0.14% to -0.09%. Each 10 µg/m³ increase in NO₂ had negative associations with gross motor from week 28 to 36 with DQs changing from -0.38% to -0.14%, and with fine motor from week 25 to 36 with DQs changing from -0.54% to -0.13%. The cumulative effects for a 10 µg/m³ increase in SO₂ induced changes of -4.7% (95% CI: -8.4 to -0.9%) for gross motor and -3.7% (95% CI: -6.6% to -0.7%) for adaptive behavior. We found interactions between low SO₂ and high temperature on gross motor (-11.3%, 95%CI:-21.3 to -0.04%) and adaptive behavior DQs (-12.5%, 95%CI:-18.9 to -5.7%), and interactions between low NO₂ and high temperature on gross motor (-23.2%, 95%CI: -39.9 to -1.7%).

CONCLUSIONS: Prenatal exposure to ambient SO₂ and NO₂ in specific time windows could impair toddler neurodevelopment and high temperature may aggravate the neurotoxicity induced at low pollution levels.

Keywords: Air pollution, Temperature, Neurodevelopmental outcomes



ABSTRACT E-BOOK

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LIGHTNING TALKS 9

Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-088

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Prenatal PM2.5 and subcortical volumes in children with neurodevelopmental disorders

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BACKGROUND AND AIM: With the growing climate crisis, particulate matter (PM) air pollution is expected to increasingly impact human health with effects magnified in vulnerable populations including pregnant women and young children. Air pollution (particulate matter < 2.5 μm ; PM2.5) exposure increases risk for autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD), yet the neural mechanisms underlying these associations are largely unknown. To understand links between prenatal PM2.5 exposure and structural brain changes, we pilot a mixtures approach in cohort enriched with ASD and ADHD subjects. We aim to examine the impact of prenatal exposure to ambient PM2.5, on sub-cortical brain volumes linked to ASD and ADHD.

METHODS: We used Freesurfer to quantify 14 subcortical volumes from high-resolution structural T1-weighted images acquired from 238 children (5-15 years; 88 females; 4% ASD; 49% ADHD; 11% comorbid ASD/ADHD; 24% other diagnosis, 12% no diagnosis) enrolled in the Healthy Brain Network (HBN); a well-established behavioral and magnetic resonance imaging (MRI) phenotyping biobank. We estimated average prenatal PM2.5 levels using a satellite-based gradient boosting hybrid model at a 1x1 km spatial resolution. We used weighted quantile sum (WQS) regression to generate a subcortical volume index (representing 14 subcortical brain regions volumes) and investigated associations between the subcortical index and PM2.5. Models were adjusted for age and sex.

RESULTS: PM2.5 was positively associated with the subcortical index ($\beta = 0.19$ [95% CI 0.18, 0.20]), indicating higher prenatal exposure to PM2.5 is associated with increased subcortical volumes. This association is driven mainly by volumetric changes in the thalamus and pallidum, regions that play key roles in ASD and ADHD.

CONCLUSIONS: Prenatal exposure to PM2.5 is associated with changes in subcortical volumes in a pediatric population enriched with ASD and/or ADHD; these results may inform prevention and intervention efforts for reducing PM2.5 exposures.

Keywords: Air pollution, Particulate matter, Mental health outcomes, Children's environmental health, Neurodevelopmental outcomes,



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O-LT-089

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Fine particulate matter relates to white matter microstructure alterations in U.S. children

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BACKGROUND AND AIM: Recent epidemiological findings have increased concern that exposure to fine particulate matter air pollution (aerodynamic diameter $\leq 2.5 \mu\text{m}$; PM_{2.5}) may be neurotoxic, even at low levels. Earlier human MRI and animal studies suggest that PM_{2.5} may impact white matter, yet questions remain about potential localized effects on microstructure. The goal of the current cross-sectional study was to examine how PM_{2.5} exposure relates to white matter microstructure in a large, diverse sample of children.

METHODS: We examined the associations between annual average outdoor PM_{2.5} exposure and white matter microstructure in 7,602 9-10 year-old children from the landmark Adolescent Brain Cognitive Development study. Diffusion Tensor Imaging was used to characterize white matter microstructure using fractional anisotropy (FA). Annual average PM_{2.5} concentrations were assigned to the primary residential address at the baseline visit in 2016-2018 using an ensemble-based model approach.

RESULTS: After correcting for multiple comparisons and adjusting for study site (n=21), socio-demographics, and MRI-related covariates, residential PM_{2.5} exposure (mean 7.65; range 1.72–15.90 ug/m³) was found to have significant non-linear associations with FA in multiple tracts. Increasing exposure to PM_{2.5} was associated with bilateral increases in FA in the uncinate fasciculus, superior longitudinal fasciculus, and inferior longitudinal fasciculus and bilateral decreases in the cingulate cingulum. PM_{2.5} exposure from 1.72 to 7.5 ug/m³ was also positively associated with increases in the left hemisphere fornix and right hemisphere anterior thalamic radiation.

CONCLUSIONS: White matter microstructure in today's developing youth may be affected by ambient fine particulate matter. Different patterns were observed in the left and right hemispheres and along specific white matter tracts. Our findings suggest that annual average PM_{2.5} exposure may relate to



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greater restricted diffusion as indexed by FA in tracts important for motor, emotion, and attention, which may reflect a combination of alterations in myelination, microarchitecture, and/or packing density.

Keywords: Air pollution, Particulate matter, Neurodevelopmental outcomes, Children's environmental health



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Environmental Exposures and Child Neurodevelopment

Chairs: Marc Weisskopf, United States & Hannah Laue, United States

O-LT-090

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Portable HEPA Filter Air Cleaner Use During Pregnancy and Children's Behavior Problem Scores: The UGAAR Randomized Controlled Trial

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BACKGROUND AND AIM: Developmental exposure to fine particulate matter (PM_{2.5}) may impair children's behaviors; the timing of exposure may also play an important role.

METHODS: In this single-blind parallel-group randomized controlled trial, we randomly allocated 540 non-smoking pregnant women in Ulaanbaatar, Mongolia to receive 1-2 portable HEPA filter air cleaners from enrollment until the end of pregnancy or no air cleaners. We administered the Behavior Assessment System for Children, 3rd Edition (BASC-3) to caregivers when children were a mean age of 23 months, and again at 48 months. The primary outcomes were the four BASC-3 composite scales. We imputed missing outcome data using multiple imputation with chained equations and our primary analysis was by intention to treat (ITT). In a secondary analysis, we evaluated associations between BASC-3 composite indices and trimester-specific indoor PM_{2.5} concentrations.

RESULTS: We enrolled participants at a median of 11-weeks gestation. After excluding pregnancy losses and neonatal deaths, analysis included 478 children (233 control and 245 intervention). No differences in mean BASC-3 scores were found between groups. In a secondary analysis, indoor PM_{2.5} during first trimester of pregnancy was associated with worse behavior scores at age 4. An interquartile range (20.1 µg/m³) increase in PM_{2.5} was associated with higher behavioral problem scores for externalizing (2.4, 95% CI: 0.7, 4.1), internalizing (2.4, 95% CI: 0.7, 4.0), and behavioral symptoms index (2.3, 95% CI: 0.7, 3.9). No significant associations for PM_{2.5} concentrations observed during the second trimester or any of the BASC indices at age 2.

CONCLUSIONS: We found no benefit of reducing indoor air pollutants during early brain development on children's behaviors. Childhood behavior may be sensitive to indoor PM_{2.5} concentrations during first trimester and interventions in early pregnancy may be necessary to protect children. However, these exploratory findings should be interpreted cautiously and require replication.

Keywords: Particulate matter, Neurodevelopmental outcome, Children's environmental health



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LIGHTNING TALKS 10

Biomarkers in Human Studies

Chairs: Allison Kupscio, United States & Anne Bozack, United States

O-LT-091

Chemical exposures » Heavy metals

Prenatal metal exposure, cord blood DNA methylation and persistence in childhood: epigenome-wide association study of twelve metals

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BACKGROUND AND AIM: Associations between prenatal metal exposure and birth and child health outcomes, including fetal growth and neurodevelopment, may be mediated by changes in DNA methylation (DNAm). We analyzed associations between maternal blood metal(loid)s (As, Ba, Cd, Cr, Cs, Cu, Hg, Mg, Mn, Pb, Se and Zn) and differential methylated positions (DMPs) at individual CpGs and differentially methylated regions (DMRs) in cord blood, and tested if associations persisted in blood cells collected in middle childhood.

METHODS: In the Project Viva cohort, metal(loid) concentrations were measured in first-trimester maternal erythrocytes. DNAm was measured in cord (N=361) and mid-childhood blood cells (N=333, range 6-10 years) using the Illumina HumanMethylation450 BeadChip. DMPs and DMRs were identified using limma and combp, respectively, adjusting for sex, race, gestational age, parity, maternal age, BMI, education, smoking, income, and estimated cell types. Multiple comparisons were adjusted for using a false discovery rate (FDR) correction for DMPs and the Sidak method for DMRs. Sex-stratified analyses were also conducted.

RESULTS: Mn was associated with differential methylation of cg02042823 (A2BP1) in cord blood (FDR=9.27x10⁻⁶). This association was nominally significant in middle childhood (p=0.009). Mn was associated with 2 and 9 DMPs in male and female infants, respectively (FDR<0.05). No other metal(loid)s were associated with cord blood DMPs. All metal(loid)s except Ba and Pb were associated with ≥1 DMR among all infants (Sidak p<0.05). Among males, all exposures except Cr, and among females, all exposures except Hg and Pb were associated with ≥1 DMR. DMRs annotated to genes in the chr6 human leukocyte antigen (HLA) region were identified for Cr, Cs, Hg, Mg, and Mn.



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CONCLUSIONS: Prenatal metal(loid) exposure is associated with DNAm, including DMRs in the HLA region. Future research is needed to assess whether epigenetic associations partially explain the relation of prenatal metal exposures to health outcomes.

Keywords: children's environmental health, heavy metals, environmental epidemiology, epigenomics



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Biomarkers in Human Studies

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O-LT-092

Omics Technologies » Epigenomics

Epigenome-wide DNA Methylation in Leukocyte and Toenail Metals: the Normative Aging Study

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BACKGROUND AND AIM: Environmental metal exposures have been associated with deleterious health endpoints. DNA methylation (DNAm) may provide insight into mechanisms underlying these associations. We aimed to examine variation in leukocyte DNAm and its relationship to toenail arsenic (As), cadmium (Cd), lead (Pb), manganese (Mn), and mercury (Hg) among elderly men in the Normative Aging Study.

METHODS: We repeatedly collected blood samples and toenails clippings and measured DNAm with the Illumina HumanMethylation450K BeadChip. We performed median regression with subject-specific intercepts for each of the five toenail metals and DNAm at individual cytosine-phosphate-guanine (CpG) site adjusting for covariates. We adjusted for multiple comparison using two thresholds: 1) Bonferroni correction based on effective degrees of freedom using the number of principal components explaining >95% variation of the total CpGs (i.e., PC-based); and 2) false discovery rate at the level of 0.05. We further conducted regional analyses using *comb-p* and pathway analyses using *Metacore*.

RESULTS: We included 549 men with 758 visits (1999-2013). The numbers of significantly differentially methylated CpGs using PC-based Bonferroni correction or false discovery rate (in parenthesis) were 51 (38) for As, 55 (52) for Mn, 11 (5) for Cd, 1 (0) for Hg, and 2 (0) for Pb, respectively. The annotated genes by As, Mn, and Cd were associated with cardiovascular disease, psychiatric disorders, diabetes and cancer. For example, the identified gene *HDAC4* by As is associated with myocardial infarction. We observed 14 significant regions for As and Mn, 4 for Cd, 2 for Hg, and 0 for Pb. We also found 3



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significant pathways, which have been related to Alzheimer's disease (As), heart diseases (Cd), and psychiatric disorders (Cd).

CONCLUSIONS: This study provides preliminary data on epigenetic mechanisms that may underlie environmental metals and adverse health endpoints. Further work is needed to assess interactions among metals and among health outcomes associated with exposure.

Keywords: Heavy metals, Epigenomics, Male



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O-LT-093

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

Effect of metal co-exposures on DNA methylation age in Bangladeshi children

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BACKGROUND AND AIM: The ubiquitous presence of toxic metal exposures in the environment is a global public health concern. Lead, chromium, arsenic, cadmium, and mercury are commonly occurring toxic environmental metal exposures in the general population. These metal exposures appear among the top 20 of the Agency for Toxic Substances and Disease Registry Substance Priority List, prioritizing substances based on a combination of their frequency, toxicity, and potential for human exposure. Observations from population studies support associations between select metal exposures and cardiovascular diseases in adulthood. Research on the childhood origins of cardiovascular diseases shows that early life factors influence cardiovascular risk over the life course. Furthermore, emerging evidence of environmental factors eliciting biological aging, such as alterations to DNA methylation, supports this as a potential mechanism for how early life metal exposures can affect cardiometabolic health later in life. This study evaluates the associations between metal exposures and DNA methylation age among 500 Bangladeshi children aged 5-7 years enrolled in the Bangladesh Environmental Research in Children's Health (BiRCH) cohort.

METHODS: We investigated the associations between five metals, measured in toenails, and DNA methylation age based on Horvath estimation using linear regression models (single-metal model and mutually-adjusted model). Additionally, principal component analysis (PCA), weighted quantile sum (WQS) regression, and Bayesian kernel machine regression (BKMR) were conducted as secondary analyses to test the robustness of findings and potential exposure patterns.

RESULTS: Arsenic and chromium were positively associated with DNA methylation age. Secondary analyses examining metal mixtures yielded similar results.

CONCLUSIONS: Findings from linear regression modeling and secondary analyses using PCA, WQS, and BKMR, suggest biological aging may serve as an important mechanism for arsenic and chromium toxicity. Future research is needed to evaluate the inter-related roles of metal exposures, biological aging, and cardiometabolic health across the life course.

Keywords: metals, epigenetic aging, DNA methylation, children's health



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Biomarkers in Human Studies

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O-LT-094

Air pollution » Short-term exposure

Short-term Exposure to PM2.5 and Epigenetic Aging: A Quasi-Experimental Study

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BACKGROUND AND AIM: Fine particulate matter <2.5µm in aerodynamic diameter (PM2.5), has been considered a global threat to accelerated biological aging. DNA methylation age (DNAMAge) is one of the most studied forms of biological age, its discrepancy with chronological age (i.e. age acceleration, AA) was associated with multiple aging-related health outcomes and had positive associations with long-term PM2.5 exposure. However, the associations of the AAs with short-term PM2.5 exposure are still partly understood. In order to elucidate the causal associations between short-term PM2.5 and DNAMAge, we performed a quasi-experiment with a social experiment design in 26 healthy adults. We aimed to understand whether short-term PM2.5 exposure via PM2.5 pollution waves (PPWs, ambient PM2.5 concentration >75 µg/m³ for 2 or more days) could accelerate the AAs.

METHODS: We conducted three visits of the participants: pre-PPW (baseline), during-PPW (1st follow-up), and post-PPW (2nd follow-up). DNA isolated from collected peripheral CD4+ T-helper cells was used to detect DNA methylation levels. Seven forms of AAs including Horvath's, Hannums', PhenoAge, GrimAge, DunedinPoAm, mortality risk score, and epiTOC were estimated.

RESULTS: Comparing to the baseline, we first observed that all AAs increased during the PPWs and considerably declined after the PPWs, albeit not statistically significant. We further tested the associations of the change in AAs between the two follow-ups with the average personal PM2.5 exposure 0-24h and 24-48h prior to the blood collection. We found that the z-scored AAs of GrimAge and DunedinPoAm were significantly elevated by 0.097 and 0.081-unit with a 5 µg/m³ increase in 0-24h personal PM2.5 exposure. Such acute effects were mediated by several oxidative and inflammation biomarkers with up to 18% mediated proportions.

CONCLUSIONS: This quasi-experiment exhibited that short-term exposures to high levels of PM2.5 could moderately accelerate biological aging, which could be captured by the GrimAge and DunedinPoAm, and mediated by the inflammation responses and oxidative stress.

Keywords: Air pollution, PM2.5, DNA methylation age, biological aging



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O-LT-095

Air pollution » General

Exposure to Air Pollutants, Circulating miRNAs, and Cardiometabolic Health among Young Adults

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BACKGROUND AND AIM: Prior work has linked exposure to ambient air pollutants (AAP) with cardiometabolic risk factors in young adults. This association may be mediated by changes to microRNAs (miRNAs), which regulate gene expression. This study aimed to examine relationships between circulating miRNAs with AAP exposure and cardiometabolic risk factors in young adults.

METHODS: Residential exposure to AAP (particulate matter <2.5 and 10 microns in aerodynamic diameter [PM_{2.5}, PM₁₀]; nitrogen dioxide [NO₂]; 24-hour ozone [O₃]) was modeled for 113 participants from the Metabolic and Asthma Incidence Research (Meta-AIR) Study, a cohort of young adults (17-22 years) from Southern California. NanoString technology was used to measure circulating miRNAs in serum. Multivariate linear regression was performed to examine the relationships between pre-selected circulating miRNAs (miR-146a-5p, miR-148a-3p, miR-126-3p, miR-122-5p), short-term (prior 1-month) and long-term (prior 1-year) AAP exposure, and cardiometabolic risk factors (e.g., fasting glucose, fasting insulin, lipids). Models adjusted for age, sex, and body mass index. Sex interactions were tested, and effects are reported for each standard deviation increase in exposure.

RESULTS: Short-term O₃ exposure was associated with greater expression of miR-148a-3p and miR-122-5p ($\beta=12.7$, $p=0.01$ and $\beta=0.56$, $p=0.04$, respectively). MiR-148a-3p (pinteractions=0.001) was also associated with triglycerides and VLDL among males ($\beta=21.8$, $p=0.003$ and $\beta=4.4$, $p=0.003$, respectively), but not females ($\beta=0.7$, $p=0.90$ and $\beta=0.1$, $p=0.90$, respectively). Long-term O₃ exposure was positively associated with miR-146a-5p ($\beta=19.6$, $p=0.04$) and miR-146a-5p was inversely associated with fasting glucose levels ($\beta=-2.0$, $p=0.03$). Short-term PM_{2.5} was inversely associated with miR-126-3p ($\beta=-195.4$, $p=0.04$) and miR-126-3p was also modestly inversely associated with fasting glucose levels ($\beta=-1.7$, $p=0.06$).

CONCLUSIONS: Circulating miRNAs with putative gene targets involved in hepatic lipid metabolism (miR-122-5p, miR-148a-3p), NF κ B signaling (miR-146a), and insulin signaling (miR-126-3p) were associated with residential AAP exposure among young adults. Results suggest that miRNA expression may be a mechanistic link between AAP and cardiometabolic disease risk.

Keywords: Air pollution, Particulate matter, Obesity and metabolic disorders, Environmental epidemiology, Molecular epidemiology



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Biomarkers in Human Studies

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O-LT-096

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

An environment wide association study on body mass index in adolescents using 2003-2004 and 2013-2014 NHANES data

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BACKGROUND AND AIM: Excess weight is a global public health challenge affecting millions of people, including younger age groups. The human exposome concept presents a novel opportunity to comprehensively characterize all non-genetic disease determinants at particularly susceptible time windows. Our study aimed to describe the association between multiple lifestyle and nutritional exposures and body mass index (BMI) in adolescents using the exposome framework

METHODS: We conducted an environment-wide association study using the U.S. National Health and Nutrition Examination Survey (NHANES) survey of 2003-2004 for discovery of associations between the study population characteristics and BMI and the 2013-2014 survey to replicate the analysis. We included non-diabetic and non-pregnant adolescents aged 12-18 years-old. We analyzed variables available in both survey rounds, with <20% of missing values in relation to BMI z-scores. We performed univariable and multivariable linear regression analysis adjusted for age, sex, race-ethnicity, education, smoking, and income to poverty ratio.

RESULTS: A total of 1899 (18.4% overweight and 18.1% obese) and 1224 (18.5% overweight and 20.6% obese) participants were identified in the target study population of the discovery and replication dataset, respectively. Retained exposure factors included 63 dietary and 50 clinical variables. After correction of false-discovery rate (FDR), univariable regression identified 10 and 13 clinical variables in the discovery and replication dataset, respectively. Multivariable regression identified 4 clinical variables in discovery dataset (uric acid; alanine aminotransferase; gamma glutamyl transferase and triglycerides) of which only uric acid remained significant in the replication dataset after FDR correction.

CONCLUSIONS: Associations between BMI and different nutritional and clinical factors were explored and identified in adolescents. Future studies are warranted to investigate the possible role of uric acid as an early-stage biomarker of increased BMI and associated pathologies among adolescents and to replicate these findings to other populations.

Keywords: exposome, environment-wide association study, biomarker



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Biomarkers in Human Studies

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O-LT-097

Omics Technologies » Epigenomics

Arsenic concentrations in the placenta are associated with dysregulation of placental microRNA expression

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BACKGROUND AND AIM: Normal placental function is essential for successful pregnancy outcomes and programming lifelong health. MicroRNAs (miRNAs) are epigenetic post-transcriptional regulators of gene expression that participate in critical processes during early development, including embryogenesis, implantation and placentation. Placental function and placental miRNA expression are both susceptible to environmentally-induced dysregulation. Gestational exposure to arsenic is associated with adverse birth weight outcomes in newborns, as well as increased risk of chronic disease in the long-term. We hypothesize that prenatal exposure to arsenic can alter the expression of placental miRNAs which may in turn impact newborn health.

METHODS: This study used data from 272 mother-infant pairs from the New Hampshire Birth Cohort Study (NHBCS) and 149 from the Rhode Island Child Health Study (RICHHS). Placental arsenic concentrations were determined by ICP-MS, and small RNA sequencing determined the abundance of all miRNAs expressed in the placenta. We used negative binomial generalized linear models, fit separately to each cohort, to identify miRNAs that are associated with placental arsenic concentrations. We then aggregated cohort-level results using an inverse variance weighted fixed-effects meta-analysis approach.

RESULTS: We identified that a doubling of placental arsenic concentration was associated with a 0.19-fold-increase in the expression of miRNAs 509-3p and 514a-5p (FDR <0.1). Using bioinformatic miRNA target prediction, followed by pathway analysis, we found that mRNAs targeted by these two miRNAs participate in various biochemical pathways critical for cell-to-cell adhesion, systemic blood pressure maintenance and various nervous system processes (q<0.1).



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CONCLUSIONS: Arsenic may disrupt miRNA expression in the placenta, leading to dysregulation of the placenta's transcriptional landscape, which in turn could contribute to the developmental programming of chronic disease risk. Future work aims to identify associations between early life health outcomes and differential expression of arsenic-sensitive placental miRNAs.

Keywords: Arsenic, microRNA, Epigenetics, Placenta, Sequencing



ABSTRACT E-BOOK

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LIGHTNING TALKS 10

Biomarkers in Human Studies

Chairs: Allison Kupscio, United States & Anne Bozack, United States

O-LT-098

Air pollution » Particle components

The Oxidative Potential of Fine Particulate Matter and Metabolic Perturbations in Plasma and Saliva

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BACKGROUND AND AIM: Exposure assessment and health impact evaluation of particulate matter (PM) mixtures remain very challenging. Fine particle oxidative potential (FPMOP) has been considered as a key health-relevant particulate parameter. We measured FPMOP exposures in a recent panel study and corresponding metabolic perturbations to evaluate its potential epidemiologic value and examine molecular mechanisms underlying PM-related health impacts.

METHODS: We recruited 54 participants from two dormitories in Atlanta, GA near and far from a congested highway. Indoor or outdoor FPMOP levels at the dormitories were measured using dithiothreitol (DTT) assay. Plasma and saliva samples were collected from participants at four time points during 12 weeks. Liquid chromatography coupled with high-resolution mass spectrometry was used to profile the participants' metabolome. We used mixed effect models to examine associations between metabolic features and FPMOP, controlling for potential confounders including age, gender, race, and body mass index. Significant metabolic features meeting false positive discovery rate at 20% were used for pathway enrichment analysis and metabolite annotation.

RESULTS: The 96h-mean water soluble FPMOP levels at the near and far dormitories prior to biosample collection were 26.3 and 22.9 nmol/min/ μ g, respectively. In total, we extracted 20,766 metabolic features from plasma samples and 29,013 from saliva samples. Purine metabolism, N-glycan biosynthesis, and beta-alanine metabolism were most strongly associated with 5 or more FPMOP-related measurements in plasma, while vitamin E metabolism, leukotriene metabolism, and glycosphingolipid metabolism were found associated with FPMOP in saliva. We confirmed 6 metabolites directly associated with FPMOP measurements including hypoxanthine, histidine, pyruvate, (s)-lactate/glyceraldehyde, azelaic acid, and petroselinic acid/elaidic acid/oleate, which were implications of perturbations in amino acid, carbohydrate, nucleotide and lipid metabolism.

CONCLUSIONS: We identified metabolites and pathways perturbations in plasma and saliva following by higher FPMOP exposure in panel-based setting. Perturbations in amino acid, carbohydrate, nucleotide and lipid metabolism may elicit PM-related health impacts.

Keywords: Fine Particle Oxidative Potential, Metabolomics, Air Pollution, Dithiothreitol Assay



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O-LT-099

Exposures » Microplastics

Effects of prenatal exposure to phthalates and Hexamoll® DINCH derived from urinary untargeted metabolomics analysis

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BACKGROUND AND AIM: Phthalates and their substitute Hexamoll® DINCH® are a group of plasticisers with a production volume of millions of tons per year found in daily use products. There is a societal concern due to their endocrine-disrupting properties. Previous studies suggest that prenatal exposure to phthalates, ubiquitous, may adversely affect early childhood development. We aimed to investigate associations of prenatal plasticisers exposure with neurodevelopment and metabolic dysfunction in early childhood in the European Exposure and Health Examination Survey (EXHES) study (n=80 pairs of mother-neonate).

METHODS: The links between in utero exposure to plasticisers, metabolic pathway dysregulation, and clinically observed phenotypes were drawn through a urinary untargeted metabolomics analysis using UPLCQ-TOF/MS, followed by integrative bioinformatics 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 pathway analysis was performed using the MetaboAnalyst R package, which mapped significant biomarkers to known biochemical pathways based on the information in public databases (MetaCyc, Wikipathways, and KEGG). Also, we have developed, optimised and validated a new analytical method for the quantification of 14 phthalates metabolites (MEP, MBzP, MiBP, MnBP, MCHP, MnPeP, MEHP, 5OH-MEHP, 5oxo-MEHP, 5cx-MEHP, MnOP, OH-MiNP, cx-MiNP, and OH-MiDP) and 2 Hexamoll® DINCH® metabolites (OH-MINCH and cx-MINCH). Separation of the isomers was achieved following the developed online SPE LC-MS/MS method. The method mentioned above was applied in 80 pairs of mother-neonate.

RESULTS: Most perturbed metabolic pathways were related to oxidative stress and stress-activated signalling pathways, including the tricarboxylic acid cycle (TCA cycle), the metabolism of amino acids, and phosphatidylcholines.

CONCLUSIONS: This study is the first to measured 16 metabolites of plasticisers to assess prenatal exposure with children's neurodevelopment and metabolic dysfunction. These findings will provide information towards AOPs development relevant to neurotoxicity and metabolic abnormalities.

Keywords: microplastics, plasticisers, exposure



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Biomarkers in Human Studies

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O-LT-100

Chemical exposures » PFAS

Metabolic signatures of youth exposure to per- and polyfluoroalkyl substances

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BACKGROUND AND AIM: Human exposure to per- and polyfluoroalkyl substances (PFAS), including perfluorooctane sulfonate (PFOS), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA) is ubiquitous and has been associated with increased risk of metabolic disorders. Exposure during periods of development, including childhood, may exacerbate these effects. The purpose of this study was to identify metabolic pathways associated with youth exposure to PFAS and to test the generalizability of these associations in an independent cohort of young adults.

METHODS: 310 overweight/obese adolescents from the Study of Latino Adolescents at Risk of Type 2 Diabetes (SOLAR) and 135 young adults from the Southern California Children's Health Study (CHS) were included in analysis. Fasting blood plasma samples were used to determine concentrations of PFAS and to measure the plasma metabolome using liquid-chromatography/high resolution mass spectrometry (LC-HRMS). Individual and joint effects of PFAS were analyzed using a metabolome wide association study (MWAS) coupled with functional pathway analysis using Mummichog. Analyses were performed for each PFAS individually and for all PFAS in a single model using multivariate linear regression, and models were adjusted for important covariates.

RESULTS: In both cohorts, PFAS concentrations were comparable to NHANES. In SOLAR and CHS, respectively, 13,706 and 19,110 features met quality control standards and were included in the analysis. For SOLAR participants, exposure to PFAS was associated with altered amino acid and lipid metabolism, and similar effects were observed in young adults from the CHS. For example, exposure to PFAS was associated with altered tryptophan metabolism (SOLAR: $p=0.008$; CHS: $p=0.009$), arginine and proline metabolism (SOLAR: $p=0.02$; CHS: $p=0.09$), and the carnitine shuttle (SOLAR: $p=0.007$; CHS: $p=0.006$).



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CONCLUSIONS: Exposure to PFAS in youth is associated with alterations in important amino acid and lipid metabolism pathways in two independent cohorts. These associations may help explain the adverse metabolic effects of PFAS exposure.

Keywords: Perfluoroalkyl substances, Metabolomics, Metabolism Disrupting Chemicals, Metabolic disorders, children



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Exposure Assessment for Environmental Epidemiology

Chairs: Jesse Berman, United States & Apolline Saucy, Spain

O-LT-101

Exposure Assessment Methods » Exposure assessment-air pollution

Uncertainty Characterization in PM_{2.5} Estimates Across the Contiguous US

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BACKGROUND AND AIM: Accurate PM_{2.5} exposure assessment, often performed using statistical prediction models, is a critical component of health studies and regulatory action. Ensemble modeling is becoming increasingly popular as it improves accuracy by combining the unique strengths of different models. Identifying where prediction uncertainty is greatest can inform monitor deployment and model development. We fit an ensemble model integrating multiple existing PM_{2.5} prediction models, estimated location-specific uncertainty in predictions, and then identified factors contributing to uncertainty.

METHODS: We predicted 2015 annual PM_{2.5} concentrations at 0.01°×0.01° resolution across the contiguous US by combining three well-validated prediction models with the Bayesian Non-parametric Ensemble (BNE). Training data came from the US Environmental Protection Agency's Air Quality System database. We estimated model uncertainty, which captures disagreement between models, uncertainty of weights, and random error, as the standard deviations of predictions' location-specific posterior predictive distribution. We analyzed how predicted PM_{2.5}, AQS monitor count within a 50-km radius, summer- and winter-mean temperature, and population density vary with uncertainty via



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a generalized additive mixed model, with penalized splines and a random intercept for state.

RESULTS: Mean (standard deviation; SD) predicted PM_{2.5} was 6.37 $\mu\text{g}/\text{m}^3$ (1.78), with a spatial RMSE of 0.71 $\mu\text{g}/\text{m}^3$, and mean (SD) uncertainty was 0.47 (0.20) $\mu\text{g}/\text{m}^3$. We observed greater uncertainty in the Midwest and Great Lakes areas. Predicted concentration had a complex relationship with uncertainty, with a generally positive association above $\sim 8 \mu\text{g}/\text{m}^3$. Monitor density had a negative association. Winter temperature below 0°C was positively associated with uncertainty, and summer temperature was positively associated below 19°C and negatively above 19°C. Very high population density was associated with lower uncertainty.

CONCLUSIONS: PM_{2.5} prediction uncertainty varied across space; uncertainty was greater in areas with more pollution, fewer monitors, colder winters, more moderate summers, and lower population density. Subsequent monitoring and prediction model development should consider prioritizing these areas.

Keywords: Exposure assessment, particulate matter, spatial statistics



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Exposure Assessment for Environmental Epidemiology

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O-LT-102

Exposure Assessment Methods » Exposure assessment-air pollution

Using a mobile monitoring campaign to characterize average exposures to ultrafine particulate matter and black carbon for a Seattle-based cohort

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BACKGROUND AND AIM: A growing body of evidence has begun linking traffic-related air pollution (TRAP) to brain health, including dementia. Ultrafine particles (UFP, <100 nm diameter) and black carbon (BC) are important components of traffic pollution, both of which may play an important role in the adverse health effects associated with particulate matter. Still, epidemiologic investigations of UFP and BC are limited in part by the absence of relevant long-term exposure models.

METHODS: We leveraged an innovative mobile monitoring campaign specifically designed to assess, at high spatial precision, long-term UFP and BC exposure for the Adult Changes in Thought (ACT) study, a Seattle-based, prospective cohort study of aging and the brain. We systematically collected repeated short-term monitoring samples (~275 drive days) and used these to build annual-average UFP and BC universal kriging models with partial least squares regression summarizing hundreds of geographic covariate predictors.

RESULTS: The external validation results indicated low model bias and high precision (RMSE: 930 UFP particles/cm³, 58 BC ng/m³; R²: 0.87 for UFP, 0.85 for BC). Predicted annual-average UFP and BC exposure for the ACT cohort had a median (IQR) of 6,800 (6,000-7,800) pt/cm³ and 530 (460-590) ng/m³, respectively; those values are generally lower than levels reported in other cities around the world. Similar to past studies, predicted concentrations were highest near the airport, downtown and industrial areas as well as along major highways. Furthermore, airport locations had much higher UFP levels relative to BC.

CONCLUSIONS: We successfully predicted annual-average concentrations of UFP and BC throughout a large metropolitan area using a novel and extensive mobile monitoring campaign. This use of mobile monitoring data as inputs to prediction models creates opportunities for epidemiologic investigations of traffic-related air pollution exposures, including UFP and BC.

Keywords: mobile monitoring, ultrafine particulate matter (UFP), exposure assessment, study design



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Exposure Assessment for Environmental Epidemiology

Chairs: Jesse Berman, United States & Apolline Saucy, Spain

O-LT-103

Exposure Assessment Methods » Exposure assessment-air pollution

Design and evaluation of mobile monitoring campaigns for exposure assessment in epidemiologic cohorts

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BACKGROUND AND AIM: Mobile monitoring has recently made it possible to measure the long-term trends of less commonly measured pollutants. While many different monitoring approaches have been taken, few studies have looked at the importance of study design when the goal is application to epidemiologic cohort studies. We carried out a simulation study to better understand the role of short-term mobile monitoring design on the prediction of long-term air pollution exposure surfaces. Since air pollution concentrations include random and systematic variability, we hypothesized that mobile campaigns will benefit from balanced designs that randomly sample from all seasons of the year, days of the week and hours of the day.

METHODS: We simulated various short-term sampling designs using oxides of nitrogen (NO_x) monitoring data from California air quality system (AQS) sites. Designs studied included a year-around, Balanced Design and two more common designs from the literature: a Rush Hours and a Business Hours Design. We evaluated the resulting annual average exposure predictions against the observations from each design and against the measured true concentrations.

RESULTS: We found that the Balanced Design consistently produced accurate annual averages, while the Rush Hours and Business Hours Designs generally resulted in more biased estimates and model predictions. The superior performance of the Balanced Design was evident when predictions were evaluated against true concentrations; importantly, this superior performance was less detectable when predictions were evaluated against the measurements from the same sampling campaign since these measurements were themselves biased.

CONCLUSIONS: Balanced design campaigns are expected to produce generally unbiased, long-term averages. Differential exposure misclassification could result from unbalanced designs, which may result in misleading health effect estimates in epidemiologic investigations. Appropriate study design



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is crucial for mobile monitoring campaigns aiming to assess accurate long-term exposure in epidemiologic cohorts.

Keywords: air pollution, study design, exposure assessment, oxides of nitrogen, environmental epidemiology, long-term exposure



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Exposure Assessment for Environmental Epidemiology

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O-LT-104

Air pollution » General

Real-time characterization of personalized air pollution exposure in pregnant women participating in a birth cohort study

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BACKGROUND AND AIM: Air pollution is a health risk in pregnant women and young children. Despite the importance of refined exposure assessments particularly at low exposure levels, characterization of personalized air pollution exposure remains a challenge in pediatric and perinatal epidemiology. Our objective was to use small and portable personal monitors to characterize exposure to indoor and outdoor air pollutants in pregnant women.

METHODS: We recruited 291 pregnant women from the New York University Children's Health Study (November 2019–February 2021). We provided women with a monitor, Flow by Plume Labs, which measures concentrations of particulate matter (PM), nitrogen dioxide (NO₂), and volatile organic compounds (VOC) in the personalized air inhaled by individuals. For 184 women (63%), real-time air pollution data were stored in the secure database via HTTPS synchronization with a smart phone application.

RESULTS: Compared to women with no pollution data (n=107), women with effective use of monitors were more likely to be Non-Hispanic White (48% vs 21%) and married/partnered (94% vs 85%) and had Associate degree or higher (76% vs 36%). Participants were more likely to effectively use the device, if given in-person than by mail. The median for duration of air monitor use was 7 days [interquartile range (IQR): 10]. The median of daily average exposure was 1.42 µg/m³ for PM_{≤1µm} (IQR=2.22), 3.25 µg/m³ for PM_{≤2.5µm} (IQR=4.03), 12.48 µg/m³ for PM_{≤10µm} (IQR=14.94), 12.35 ppm for NO₂ (IQR=12.48), and 167.72 ppb for VOC (IQR=40.93). Average hourly levels during night and day were similar. Using functional principal component analysis, we identified three patterns of diurnal exposure, which explained 85% of variation in data. The most dominant pattern showed relatively stable exposure with a drop in exposure levels around late morning.

CONCLUSIONS: Small wearable devices represent a promising method for assessment of short- and long-term exposure to air pollution in epidemiological settings.

Keywords: Exposure assessment-air pollution, pregnancy outcomes



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Exposure Assessment for Environmental Epidemiology

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O-LT-105

Exposure Assessment Methods » Exposure assessment-air pollution

Integrating monitor wearing to estimate household air pollution exposure parameters in the Ghana Randomized Air Pollution and Health Study (GRAPHS)

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BACKGROUND AND AIM: Personal monitoring can enhance exposure-response studies. Prior studies employ a wearing compliance minimum threshold to reduce exposure misclassification. Leveraging the full range of device wearing data illuminates important exposure outcomes in the context of a large household air pollution cookstove intervention study with three arms (control, liquified petroleum gas (LPG), and improved biomass).

METHODS: Evaluating the association between accelerometer-derived device wearing and mean 48-hr personal exposures in generalized estimating equations yields three parameters: (1) the y-intercept (0% device wearing) estimates community air pollution per study arm; (2) the difference between estimated concentrations per study arm at maximum device wearing is the effect of the cooking interventions on overall personal exposure; (3) estimated concentrations at maximum device wearing minus the y-intercept concentration estimates the average direct contribution of cooking events to personal exposure.

RESULTS: Median device wearing during waking hours was 7- 8 hrs/day across study arms (range 0 - 15.9 hrs). Estimated community-level PM_{2.5} concentrations were similar across study arms (37-48 µg/m³). On average, the overall exposure was estimated at 108 ± 14 µg/m³ for the control arm and 53 ± 23 µg/m³ for LPG, suggesting a 50% reduction from this intervention. We estimate the direct contribution of individual cooking activities to exposure to be 60 ± 14 µg/m³ in the control arm and 6.2 ± 22.6 µg/m³ in the LPG arm (90% less). The improved biomass stove had negligible impact on reducing personal air pollution exposure. Using only data from cooking hours provided relatively similar % reductions for the LPG intervention (45% for overall; 85% for direct cooking impact).

CONCLUSIONS: The association between device wearing and personal exposure allows quantification of important household air pollution exposure assessment outcomes, two of which previously could not be obtained without additional monitoring.

Keywords: Air pollution, Particulate matter, Modeling, Exposures



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Exposure Assessment for Environmental Epidemiology

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O-LT-106

Exposure Assessment Methods » Exposure assessment-air pollution

50 chemical exposures of concern discovered using wearable passive samplers and gas chromatography high-resolution mass spectrometry in South African children

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BACKGROUND AND AIM: Children and other vulnerable populations in the developing world are increasingly prone to experience adverse health issues from environmental exposures.

Comprehensive identification of chemical exposures in children is needed to determine which exposures are of most concern from a public health standpoint.

METHODS: We deployed personal exposure monitors in Limpopo South Africa, as part of the Venda Health Examination of Mothers, Babies, and their Environment (VHEMBE) study. These exposure monitors consist of a polydimethylsiloxane (PDMS) as passive samplers, contained in a polytetrafluoroethylene capsule connected to a wristband. Passive samplers were worn by 147 children ages 5-6.5 years for about 2 days. Samplers were then analyzed by direct thermal desorption gas-chromatography high-resolution mass spectrometry. Spectra were screened across nearly 1 million chemicals using compound discover and in-house software, and exposure hazard information was obtained using the US-EPA CompTox Chemicals Dashboard and prototype Hazard Comparison.

RESULTS: Personal exposure profiles consisted of 637 exposures with retention index, EI, molecular ion, and exact mass matches. Exposures included biocides, plasticizers, organophosphates, dyes, combustion products, and perfumes. Over 50 of these chemicals had predicted or experimental inhalation toxicity, oral toxicity, dermal toxicity, carcinogenicity, or were on priority lists. Exposure profiles changed across season, with chemicals used for malaria control or mosquito repellent (DDT, propoxur, and DEET) higher in the wet season, and many remaining chemicals reduced in the wet season likely due to heavy rainfalls scrubbing the air of contaminants.

CONCLUSIONS: This study shows a diverse array of over 50 chemicals of health concern in South African children and is the first study to characterize exposure profiles of children in rural South Africa. Further work is needed to measure these prioritized chemicals in children's blood and urine, determine acceptable cutoffs, and design interventions to reduce any chemicals that are shown to have direct health implications.



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



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Exposure Assessment for Environmental Epidemiology

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O-LT-107

Exposure Assessment Methods » Exposure assessment-general

Contributions of nearby agricultural insecticide applications to indoor residential exposures

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BACKGROUND AND AIM: Pesticide exposure has been associated with adverse health effects; individuals may be exposed to pesticide drift from nearby agricultural fields. We evaluated relationships between agricultural insecticide applications and insecticide levels in carpet dust.

METHODS: We measured concentrations (ng/g) of allethrin, azinphos-methyl, carbaryl, chlorpyrifos, cyfluthrin, cypermethrin, deltamethrin, diazinon, malathion, permethrin, phosmet, propoxur, tetramethrin in carpet-dust samples collected from 558 California homes. After using the California Pesticide Use Reporting database (reporting unit: ~2.59km²) to estimate agricultural insecticide use within buffers with radii of 0.5-, 1-, 2-, 3-, and 4km around each home, we calculated the density of use (kg/km²) during 30-, 60-, 180-, and 365-day periods prior to dust collection and evaluated relationships between insecticide density and concentrations in dust. We modeled natural-log transformed dust concentrations using Tobit regression for insecticides with >40% detection. For insecticides detected ≤40%, odds of detection were modeled with logistic regression. Models were adjusted for season, year, occupation, and home/garden uses.

RESULTS: Detection frequencies ranged from <10% for allethrin, azinphos-methyl, and malathion to >80% for diazinon, chlorpyrifos, and permethrin. Chlorpyrifos applications within 1-4km of the residence during all time periods were associated with higher dust concentrations compared to homes without nearby applications. Carbaryl applications within 2-4km of homes 30- and 60-days prior to dust collection were associated with higher concentrations (30-days/2km, β any applications vs. none=8.2, 95%CI 1.8-37.6; 60-days/4km, β >median density vs. none=4.2, 95%CI 1.1-15.7). Cyfluthrin and phosmet applications 180- and 365-days prior to dust collection were associated with higher odds of detection (365-days/4km, highest density vs. none: OR=2.2, 95%CI 1.2-4.0 and 6.2, 95%CI 3.3-12.0, respectively) compared to homes with no nearby use.



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CONCLUSIONS: Agricultural insecticide use within 4km of a home could be an important determinant of indoor contamination. Our findings provide valuable information for the development of exposure metrics for epidemiologic health studies.

Keywords: Pesticides, Exposures, Exposure assessment, Environmental epidemiology, Children's environmental health



ABSTRACT E-BOOK

August 26, 2021 / 14:00 - 15:00 / Times Square Hall (Hall 3)

LIGHTNING TALKS 11

Exposure Assessment for Environmental Epidemiology

Chairs: Jesse Berman, United States & Apolline Saucy, Spain

O-LT-108

Exposure Assessment Methods » Exposure assessment-air pollution

Exposure to Unconventional Oil and Gas Development and All-cause Mortality in Medicare Beneficiaries

Longxiang Li¹, Francesca Dominici², Annelise J. Blomberg¹, Joel D. Schwartz¹, Brent A. Coull², John D. Spengler¹, Yaguang Wei¹, Joy Lawrence¹, Petros Koutrakis¹

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BACKGROUND AND AIM: Wide-scale adoption of Unconventional Oil and Gas Development (UOGD) has changed the domestic and global energy landscape. However, little is known about whether and how UOGD impact all-cause mortality.

METHODS: We used an open cohort design and Cox Proportional Hazard model to estimate the relative risk of mortality associated with living proximity and downwind to UOGD. The study region of this population-based research includes all counties within major UOGD production areas in the conterminous United States. We studied 15,198,496 Medicare beneficiaries (N=136,215,059 person-years) in the study region from 2001 to 2015. We obtained records for more than 2.5 million oil and gas wells from Enverus™. For each person-year, we calculated proximity-based exposure (PE) to UOGD and categorized PE into four levels from high to low. To isolate the impact contributed by UOGD-related air pollutants, we calculated the proportion of PE contributed by upwind wells, defined as downwind exposure (DE) to UOGD. Each PE level was dichotomized into downwind and upwind sub-levels (DE+ and DE-) accordingly. Due to the independence of wind direction on potential confounders, the estimated associations are less vulnerable to unobserved confounding bias.

RESULTS: High PE level was associated with a statistically significant increase in mortality risk compared to the unexposed group (hazard ratio [HR], 1.025; 95% confidence interval [CI], 1.021 to 1.029). Within high PE, the HR associated with DE+ is 1.031 (95% CI 1.025 to 1.037), significantly higher than that associated with DE- (HR 1.022, 95% CI, 1.016 to 1.027), when both are compared to the same unexposed group.

CONCLUSIONS: Exposure to UOGD, characterized by PE and DE, is statistically significantly associated with an increased mortality risk in Medicare beneficiaries. The wind-dependent difference in the health effects indicates that air pollution sourced from UOGD is one of the exposure pathways.

Keywords: Long-term exposure, Mixtures, Multi-pollutant/Multi-media, Mortality.



ABSTRACT E-BOOK

August 26, 2021 / 14:00 - 15:00 / Times Square Hall (Hall 3)

LIGHTNING TALKS 11

Exposure Assessment for Environmental Epidemiology

Chairs: Jesse Berman, United States & Apolline Saucy, Spain

O-LT-110

Air pollution » Particulate matter

Openly accessible low-cost measurements in PM_{2.5} exposure modeling: guidance for monitor deployment

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BACKGROUND AND AIM: High-resolution, high-quality exposure modeling is critical for assessing the health effects of PM_{2.5} in epidemiological cohorts. Sparse ground-level PM_{2.5} measurements, as key model input, may result in two critical issues in high-resolution exposure prediction: (1) they may affect the models' accuracy in predicting the spatial distribution of PM_{2.5}; (2) internal evaluation based on these measurements may not reliably reflect the model performance at the locations of interest (e.g., cohort residential locations). This study aimed to take advantage of PM_{2.5} measurements from an openly accessible low-cost PM_{2.5} network, PurpleAir, with an external validation dataset at residential locations of an epidemiological cohort to improve the accuracy of exposure prediction at the cohort locations, and propose metrics assessing the similarity between the monitor and cohort locations to guide future monitor deployment.

METHODS: We utilized a spatiotemporal modeling framework to incorporate PM_{2.5} measurements from 51 agency/non-agency stations and 58 PurpleAir monitors in the Puget Sound region of Washington into high-resolution exposure assessment. A similarity metric based on principal component analysis (PCA) was developed to assess the PurpleAir monitors' representativeness of the cohort locations.

RESULTS: After including calibrated PurpleAir measurements as part of the dependent variable, the spatiotemporal validation (at the two-week level) R² (root-mean-square error, RMSE) improved from 0.84 (2.22 µg/m³) to 0.92 (1.63 µg/m³). The spatial validation (in the longer term) R² (RMSE) improved from 0.72 (1.01 µg/m³) to 0.79 (0.88 µg/m³). The exposure predictions showed a more realistic spatial pattern as well. We found that the PurpleAir monitors with shorter PCA distances could improve the model's prediction accuracy more substantially than monitors with longer PCA distances.

CONCLUSIONS: To our knowledge, this was the first attempt to evaluate the benefits of low-cost PM_{2.5} measurements for long- and short-term exposure prediction at cohort residential locations and to provide practical guidance for future monitor deployment with similarity metrics.

Keywords: PurpleAir, High-resolution, Exposure assessment, Fine particulate matter, Long-term, Short-term



ABSTRACT E-BOOK

August 23, 2021 / 07:30 - 09:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 1

Health Effects of Traffic-Related Air Pollution: Assessing the Evidence in an Evolving and Complex World

Chairs: Barbara Hoffmann, Germany & Fred Lurmann, United States

O-SY-001

Air pollution » Traffic-related

Traffic-Related Air Pollution: A Moving Target

Jeffrey R Brook

Dalla Lana School of Public Health and Department of Chemical Engineering and Applied Chemistry,
University of Toronto, Toronto, Canada

BACKGROUND AND AIM: Traffic-related air pollution (TRAP) is variable on multiple and spatial and temporal scales. Its chemical and physical characteristics represent additional, highly variable dimensions and thus TRAP is described as a complex mixture. This presentation will explore this complexity, highlighting implications for exposure and epidemiological research for informing, understanding and reducing its health effects.

METHODS: Real-world measurements of TRAP, focusing on near-road and mobile platforms, were analyzed and interpreted. Examples of changing mixture characteristics and changing patterns in inter-pollutant correlations were identified and compared. Changes having implications for precise exposure assessment and subsequent epidemiological analyses as well as interpretation of heterogeneity among studies were of particular interest.

RESULTS: Nitrogen dioxide (NO₂) has been a common indicator of TRAP and black carbon (EC or BC) has been of interest as a TRAP-related sub-component of fine particles (PM_{2.5}). Ultrafine particles (UFP) represent another dimension of TRAP and of PM_{2.5}, which is less-specific to TRAP, due to less urban-scale variability. Measurements from the tailpipe to the urban background show that while each of these are linked to TRAP their interrelations are inconsistent and also highlight the complexity of the mixture in terms infrequently measured components (e.g., metals, VOCs, toxics). Secondary products of traffic emissions contributing to urban exposures are potentially underappreciated given the challenge of characterizing their behavior independent of the urban background.

CONCLUSIONS: Characterizing TRAP exposure for epidemiological research uncovering the level of risk attributed to motor vehicle contributions to air pollution has been reasonably-well served through the use of certain indicators. However, the common indicators (e.g., NO₂) are less able to advance understanding into ongoing critical questions such as what components in the mixture, including secondary products, should be prioritized for control or whether current and/or future decreasing trends in NO₂ translate into the benefits past epidemiological studies suggest.

Keywords: Air Pollution, Exposures, Traffic-Related



ABSTRACT E-BOOK

August 23, 2021 / 07:30 - 09:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 1

Health Effects of Traffic-Related Air Pollution: Assessing the Evidence in an Evolving and Complex World

Chairs: Barbara Hoffmann, Germany & Fred Lurmann, United States

O-SY-002

Air pollution » Traffic-related

Systematic Methods to Select and Review Epidemiological Literature on the Health Effects of Long-term Exposure to TRAP

Allison P Patton¹, Hanna Boogaard¹, Dan Crouse¹, Eleanne van Vliet¹, Annemoon van Erp¹, Meltem Kutlar Joss², HEI Panel on the Health Effects of Long-Term Exposure to Traffic Related Air Pollution¹

¹Health Effects Institute, Boston, MA, USA

²Swiss TPH, Basel, Switzerland; University of Basel, Basel, Switzerland

BACKGROUND AND AIM: The health effects of traffic-related air pollution (TRAP) continue to be of important public health interest. Following its well-cited 2010 critical review, HEI appointed a new expert Panel to review the literature on the health effects of long-term exposure to TRAP.

METHODS: The Panel followed a systematic protocol they published in Prospero to search the literature, assess study quality, summarize results, and reach conclusions about the body of evidence. An extensive search was conducted of literature published between January 1980 and July 2019 on selected health outcomes (all-cause and cause-specific mortality, respiratory effects, cardiometabolic effects, and adverse birth outcomes). The Panel considered studies both within and outside the near-road environment because traffic contributes to ambient air pollution at neighborhood and urban scales. They developed a framework of exposure to TRAP to guide transparent selection and evaluation of epidemiological studies. Criteria including the pollutant considered, spatial scale, and exposure assessment methods were used to identify studies in which the exposure contrasts were related primarily to traffic emissions.

RESULTS: Meta-analyses were performed in cases where three or more studies were identified for the same exposure and health outcome. Conclusions were based on a modified US National Toxicology Program's Office of Health Assessment and Translation (OHAT) approach and a narrative assessment. The two approaches were considered equally valuable in the Special Report, reflecting the complex issues in determining the level of confidence.

CONCLUSIONS: The review is now well underway, and the methods along with lessons learned during their application will be presented. The systematic review will undergo peer-review, and publication is aimed for late 2021. The new review will be an authoritative update of HEI's most-cited report for use by researchers and policymakers.

Keywords: traffic-related air pollution, systematic review, birth outcomes, cardiometabolic effects, respiratory effects, mortality



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SYMPOSIUM 1

Health Effects of Traffic-Related Air Pollution: Assessing the Evidence in an Evolving and Complex World

Chairs: Barbara Hoffmann, Germany & Fred Lurmann, United States

O-SY-003

Air pollution » Traffic-related

Results of an HEI Systematic Review on the Health Effects of Long-term Exposure to Traffic-Related Air Pollution

Hanna Boogaard¹, Allison P Patton¹, Dan Crouse¹, Eleanne van Vliet¹, Annemoon van Erp¹, Meltem Kutlar Joss², HEI Panel on the Health Effects of Long-Term Exposure to Traffic Related Air Pollution¹

¹Health Effects Institute, Boston, MA

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BACKGROUND AND AIM: After a broad search, the HEI Panel on the Health Effects of Long-Term Exposure to Traffic-Related Air Pollution (TRAP) identified 1100 studies relevant for further screening, 352 of which met the inclusion criteria and are considered in the systematic review. Respiratory effects in children (N=117) and birth outcomes (N=86) were the most common outcomes published in the literature. Slightly fewer studies investigated cardiometabolic effects (N=57), respiratory effects in adults (N=50), and mortality (N=48).

METHODS: The systematic review is undergoing independent peer-review and publication is aimed for late 2021.

RESULTS: The Panel's initial findings were for a moderate to high level of confidence in an association between exposure to TRAP with term low birth weight. They also reported a moderate or high level of confidence in an association between exposure to TRAP and asthma onset in children and adults, and occurrence of acute respiratory infections in children. Furthermore, they found moderate evidence for an association between exposure to TRAP and ischemic heart disease, stroke, and diabetes mellitus. The overall confidence in an association between TRAP exposure and mortality was high for all-cause, circulatory, ischemic heart disease mortality; moderate to high for lung cancer mortality; and moderate for respiratory mortality. For the other health outcomes assessed, the confidence was very low or low for an association with TRAP, and the evaluation was often limited by the small numbers of studies.

CONCLUSIONS: In light of the large number of people exposed to TRAP – both in and beyond the near-road environment, the Panel concluded that the moderate to high confidence in an association between long-term exposure to TRAP and various adverse health effects indicates that exposures to TRAP are an important public health concern and deserve continued targeted policy and broader public focus.

Keywords: traffic-related air pollution, systematic review, birth outcomes, cardiometabolic effects, respiratory effects, mortality



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SYMPOSIUM 1

Health Effects of Traffic-Related Air Pollution: Assessing the Evidence in an Evolving and Complex World

Chairs: Barbara Hoffmann, Germany & Fred Lurmann, United States

O-SY-004

Air pollution » Traffic-related

Knowledge on adverse effects of traffic-related air pollution: have we filled the gap? What more do we need to know?

Francesco Forastiere¹, Fred Lurmann², Hanna Boogaard³, Hei Panel On The Health Effects Of Long-term Exposure To Traffic-related Air Pollution³

¹Imperial College, London, Uk

²Sonoma Technology, Inc., Petaluma, Ca, Usa

³Health Effects Institute, Boston, Ma, Usa

BACKGROUND AND AIM: The Health Effects Institute has conducted a systematic review on the health effects of long-term exposure to traffic-related air pollution (TRAP) and selected adverse health outcomes, with an expert Panel. The findings have provided a moderate or high level of confidence in the presence of an association between long-term exposure to TRAP and various adverse health effects. Although the evidence is already compelling for some of the outcomes investigated, a number of future research opportunities emerged from the results of this report.

METHODS: Critical evaluation of research needs.

RESULTS: NO₂ was the TRAP exposure indicator used most often in the review. There remains a need to gain a better understanding of whether the epidemiological associations found for TRAP are due to direct effects of NO₂, or to another component of TRAP, or to the broader mixture of correlated components indicative of TRAP. There is a need for additional epidemiological studies on an array of traffic pollutants including UFP and non-tailpipe PM indicators, because there were few studies and there are good reasons to suspect they might be health relevant beyond what is already known. Studies have been conducted on populations residing in a wide range of countries, though the majority were done in Europe and North America. Hence there is a need for more health studies in areas outside North America and Europe. Additional studies should evaluate the role of spatially correlated factors that may either confound and/or modify the health effects of TRAP, most notably traffic noise, and factors related to the built environment, such as presence of green space. Finally, various suggestions to improve methods in study design, analysis and evidence synthesis were identified.

CONCLUSIONS: The systematic review helped to identify several important areas for future research.

Keywords: Systematic review, traffic-related air pollution, cardiovascular effects, respiratory effects, mortality



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SYMPOSIUM 1

Health Effects of Traffic-Related Air Pollution: Assessing the Evidence in an Evolving and Complex World

Chairs: Barbara Hoffmann, Germany & Fred Lurmann, United States

O-SY-005

Air pollution » Traffic-related

Key Policy Relevant Questions on Traffic and Health

Chad Richard Bailey

Office of Transportation and Air Quality, National Vehicle and Fuel Emissions Laboratory, 2000
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BACKGROUND AND AIM: The health impacts associated with living, working, or attending school near major roads has been recognized as a public health concern for nearly two decades.

METHODS: Exposures people experience in those locations are determined by a myriad of factors and policies, ranging from individual to national or even global authorities.

RESULTS: While the U.S. Environmental Protection Agency has authorities for engine, vehicle and fuel standards, state and federal departments of transportation, metropolitan planning organizations, and municipal and county governments all play important roles in determining the structure of our transportation system(s).

CONCLUSIONS: This presentation will briefly review the transportation system and identify information needs policy-relevant questions about the intersection of health and transportation.

Note to editors: Policy-related presentation associated with the symposium, "Health Effects of Traffic-Related Air Pollution: Assessing the Evidence in an Evolving and Complex World" chaired by Barbara Hoffmann and Fred Lurmann. I was invited by the symposium planners to present on policy issues, not new or independent research

Keywords: Traffic, transportation, government, roadway, policy, pollution



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 2

Environmental Health Inequalities in Indigenous Communities: Lessons and Opportunities

Chairs: Joseph Siraata Yracheta, United States & Jada L. Brooks, United States

O-SY-006

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

Gene-environmental research in Indigenous communities: sovereignty, data sharing, and community-relevant research

Joseph Siraata Yracheta¹, Ana Nacas Acien², Kate Mcglone West³, Otakuye Conroy Ben⁴

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²Environmental Health and Epidemiology, Columbia University, New York, NY, USA

³Global Health, University of Washington, Seattle, WA, USA

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BACKGROUND AND AIM: American Indians suffer from higher rates of diabetes, chronic kidney disease, cardiovascular disease and disproportionate exposures to metals and/or other hazards. Indigenous people in the rest of the Americas and Polynesia show remarkable similarities. Gene-environmental studies are key to creating interventions for these groups. Increased Indigenous participation is also key. However, trust to participate can only be manifested when research relevance and respect for Indigenous sovereignty are included in community education

METHODS: Due to the limited publication of qualitative research on this type of engagement, a Scoping Review was not feasible. Instead, we conducted a narrative literature review of articles studying genomics using a participatory approach with Indigenous communities between 2012 and the present. We evaluated whether these studies have considered environmental exposures. We also evaluated if environmental studies in Indigenous communities have considered genomics their engagements. Search terms such as environment, genomic and Indigenous were used.

RESULTS: In 2009, the American Reinvestment and Recovery Act (2009) funded a large number of genomic projects. Consequently, databases showed a substantial rise of genomic manuscripts by 2012. The Ethical, Legal and Social Implications (ELSI) of genomics publications showed a similar pattern. Since, many such publications have engaged Indigenous communities about genomic data but few have paired the exposome in their community education or attitude surveys. Moreover, none assessed research participation likelihood if the paired topics could demonstrate the usefulness of combined inquiry.

CONCLUSIONS: Few studies have explained the impact of multifactorial research to communities. Many reasons obligate the genomic environmental researchers to look at Human Health holistically. The Exposome provides the opportunity to jointly study human genomics & systemically biased socio-economic realities that negatively impact Indigenous communities. Successful research recruitment must account for the historic mistrust of Indigenous communities and could be reversed by an explication of interactions that lead to disparity

Keywords: American Indian, Environmental Exposure, Exposome, Amerindigenous, Community Engagement, ELSI



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SYMPOSIUM 2

Environmental Health Inequalities in Indigenous Communities: Lessons and Opportunities

Chairs: Joseph Siraata Yracheta, United States & Jada L. Brooks, United States

O-SY-007

Exposures » Food/nutrition

Geographic and dietary differences of urinary uranium levels in the Strong Heart Family Study

Kevin Patrick Patterson¹, Anne E Nigra¹, Pablo Olmedo², Maria Grau Perez³, Rae O'Leary⁴, Marcia O'Leary⁴, Amanda M Fretts⁵, Jason G Umans⁶, Lyle G Best⁴, Kevin A Francesconi⁷, Walter Goessler⁷, Shelley A Cole⁸, Ana Navas Acien¹

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⁸Texas Biomedical Research Institute, Hyattsville, MD, USA.

BACKGROUND AND AIM: Chronic low-dose exposure to uranium (U) through diet is not well characterized in the US. American Indian (AI) participants in the Strong Heart Family Study (SHFS) have higher urinary uranium concentrations compared to the general US population. This disproportionate exposure might be explained by groundwater contamination in rural and sub-urban regions, or through dietary exposures. The objective of this study was to evaluate differences in urinary uranium concentrations by diet and geography among American Indians from the Northern Plains, the Southern Plains, and the Southwest.

METHODS: We evaluated food frequency questionnaires to determine the major dietary sources of urinary uranium concentrations for 2,170 AI participants in the SHFS, collected during phase IV (2001-2003). We assessed adjusted geometric mean ratios (GMRs) of urinary uranium for an interquartile (IQR) increase in self-reported food group consumption using generalized estimating equations. Exploratory analyses were stratified by gender and study center.

RESULTS: In fully adjusted models, the percent increase (95% confidence interval) of urinary uranium per increase in reported food consumption corresponding to the IQR was 29% (14%, 47%) for organ meat, 9% (1%, 19%) for legumes, and 17% (5%, 32%) for alcohol. In analyses stratified by study center, the associations with organ meat and legumes were only observed for North/South Dakota participants. Consumption of fries and chips [percent increase -16% (-23%, -9%)] and any shellfish - [21% (-0.35%, -4%)] were inversely associated with urinary uranium. Overall, we estimated that self-reported dietary exposures explain 16.8% of variability in urine uranium concentrations.

CONCLUSIONS: Organ meat, legumes, and alcohol contribute to higher uranium exposure in the SHFS population. After stratification, organ meat remained significantly associated with uranium for North



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and South Dakota participants. These findings warrant further investigation into the relative contribution of diet and drinking water to total uranium exposure in American Indian communities.

Keywords: Heavy metals, food/nutrition, environmental epidemiology, environmental disparities



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SYMPOSIUM 2

Environmental Health Inequalities in Indigenous Communities: Lessons and Opportunities

Chairs: Joseph Siraata Yracheta, United States & Jada L. Brooks, United States

O-SY-008

Air pollution » Particulate matter

Air pollution in American Indian vs. Non-American Indian communities

Maggie Li¹, Markus Hilpert¹, Jeff Goldsmith², Jada L Brooks³, Jenni A Shearston¹, Steven N Chillrud⁴, Lyle G Best⁵, Joseph Yracheta⁵, Aaron V Donkelaar⁶, Randall V Martin⁷, Ana Navas Acien¹, Marianthi Anna Kioumourtzoglou¹

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BACKGROUND AND AIM: Fine particulate matter (PM_{2.5}) exposure is associated with increased risk of numerous adverse health outcomes. Prior research shows that PM_{2.5} is disproportionately concentrated in communities of low socioeconomic status and with higher proportions of ethnic and racial minorities. Studies characterizing concentrations in primarily American Indian- (AI-) populated areas are currently lacking. Our aim was to compare fine particle (PM_{2.5}) concentrations in American Indian (AI-) vs. non-AI-populated counties over time (2000 – 2018) in the contiguous US.

METHODS: We used a multi-criteria approach to classify counties as AI- or non-AI-populated. We ran linear mixed effects models to estimate the difference in county-wide annual PM_{2.5} concentrations from monitoring sites and well-validated prediction models (measured and modeled PM_{2.5}, respectively) in AI- vs. non-AI-populated counties, adjusting for population density and median household income. We estimated whether differences in AI- vs. non-AI-populated counties varied over time using interaction terms with calendar year.

RESULTS: We included 3,109 counties in our final analysis, 199 of which were classified as AI-populated (6.4%). On average, adjusted measured PM_{2.5} concentrations in AI-populated counties were 0.79 µg/m³ (95%CI: 0.33, 1.26) lower than in non-AI-populated counties. However, this association was not constant over time; while in 2000, adjusted concentrations in AI-populated counties were 1.83 µg/m³ (95%CI: 1.53, 2.13) lower, by 2018, they were 0.84 µg/m³ (95%CI: 0.53, 1.15) higher. Over the study period, measured PM_{2.5} mean concentrations in AI-populated counties decreased by 2.49 vs. 5.18 µg/m³ in non-AI-populated counties. Results were similar for satellite-based, modeled PM_{2.5}.

CONCLUSIONS: This study highlights disparities in PM_{2.5} trends between AI- and non-AI-populated counties over time, underscoring the need to strengthen air pollution regulations in tribal territories and areas where AI populations live.

Keywords: air pollution, particulate matter, environmental disparities, environmental justice



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SYMPOSIUM 2

Environmental Health Inequalities in Indigenous Communities: Lessons and Opportunities

Chairs: Joseph Siraata Yracheta, United States & Jada L. Brooks, United States

O-SY-009

Air pollution » Particulate matter

Regional and temporal trends in exposure to ambient air pollution: Findings from the Strong Heart Study

Jada L. Brooks¹, Anne Weaver², Maggie Li³, Baiming Zou⁴, Jessica A. Reese⁵, Kimberly Malloy⁵, Ying Zhang⁵, Joseph Yracheta⁶, Ana Navas Acien³, Cavin Ward Caviness², Gail Currin¹, Nora Franceschini⁷, Giselle Corbie Smith⁸

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BACKGROUND AND AIM: Fine particulate matter (PM_{2.5}) pollution exposure is increasingly recognized as a risk factor for cardiovascular disease (CVD), a leading cause of death among American Indians (AIs). PM_{2.5} estimates for AIs, however, remain largely unknown due to sparse monitoring. We describe ambient PM_{2.5} concentrations and regional/temporal trends in the Strong Heart Study (SHS) communities (Arizona [AZ], Oklahoma [OK], and North and South Dakota [ND and SD]) from 2001–2003 and 2006–2009.

METHODS: We used SHS phase IV (2001–2003, n=2,769) and phase V (2006–2009, n=2,478) data. We used an ensemble-based model of daily mean PM_{2.5} concentrations at a 1km² resolution and estimated participants' mean 30-day ambient exposure at the ZIP code-level. We performed descriptive analyses to depict how population-based concentrations of PM_{2.5} vary over the three SHS regions and two phases.

RESULTS: There were significant differences in 30-day PM_{2.5} exposure between study sites. The overall median 30-day PM_{2.5} exposure in the different study sites were as follows: 9.2 µg/m³ (IQR: 2.1) in AZ, 9.1 µg/m³ (IQR: 2.4) in OK, and 5.5 µg/m³ (IQR: 2.8) in ND and SD. We did not detect a seasonal effect on PM_{2.5} exposure in AZ; however, PM_{2.5} in the wintertime was slightly higher in OK and substantially higher in ND and SD. These trends hold over both visit periods and all study sites. Annual median PM_{2.5} remained stable between phases IV and V for the OK and ND and SD regions; in AZ, PM_{2.5} first declined in phase V relative to phase IV but began to increase in 2008–2009.

CONCLUSIONS: Understanding regional and temporal trends in ambient PM_{2.5} concentrations,



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which vary across tribal populations, may help to understand environmental exposures and CVD in AIs. This abstract does not reflect EPA policy.

Keywords: air pollution, American Indian, cardiovascular disease



ABSTRACT E-BOOK

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SYMPOSIUM 3

Maximizing the Contributions of Epidemiologic Research to Policy: Selecting, Designing, and Analyzing Influential Studies

Chairs: Kurt Straif, Spain & David A Savitz, United States

O-SY-010

Policy » Research translation to affect policy and practice

Planning Epidemiologic Research in Anticipation of Future Evaluations

Kurt Straif

ISGlobal, Barcelona, Spain; Boston College, Chestnut Hill, MA, USA

BACKGROUND AND AIM: Epidemiologists seek to conduct studies that will be influential on hazard identification, risk assessment and policy decisions. Individual studies contribute via various forms of evidence synthesis conducted by national and international agencies. The first presentation of this symposium will focus on the identification of promising research topics, followed by presentations on design strategies for generating highly influential studies; conducting analyses and presenting results to maximize contribution to policy; and rounded up by an integrative case study.

METHODS: This presentation will draw particularly on experience with the IARC Monographs process on cancer hazard identification. Each Monograph will inevitably identify new research gaps. However, a Monograph would not spell out research recommendations. Results will draw from lessons learned from Workshops on research gaps and recommendations and Advisory Groups making recommendations on priorities for future evaluations.

RESULTS: Multiple factors need to be taken into account for the identification of promising research topics 1) The strengths and limitations of the current evidence weighed against the criteria for evaluation by stream of evidence and for evidence integration. 2) The timeline for research ideas identified from a new Monograph evaluation or from a workshop on research recommendations is less urgent than for topics identified from “high priorities” for future evaluations. 3) The specific stream of evidence that led to a “high priority” recommendation may be taken into account in a complementary manner. 4) Different epidemiologic designs may contribute to different streams of evidence, e.g., molecular epidemiologic studies may contribute to mechanistic upgrades of the overall evaluation.

CONCLUSIONS: The strategies and concrete ideas for the identification of potentially influential research topics will be followed by presentations on detailed considerations for study design, analyses and reporting. How studies will feed into future evaluations by various programmes will be elaborated in the complementary symposium on principles of evidence synthesis.

Keywords: Causal inference, Policy and practice, Research translation



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SYMPOSIUM 3

Maximizing the Contributions of Epidemiologic Research to Policy: Selecting, Designing, and Analyzing Influential Studies

Chairs: Kurt Straif, Spain & David A Savitz, United States

O-SY-011

Methods » Environmental epidemiology

Design Strategies for Generating Highly Influential Studies

David A Savitz

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BACKGROUND AND AIM: When epidemiologists plan a study, they aspire to make that study as influential as possible when the totality of the research on that topic is assessed. Expert assessments constitute an essential step in the pathway by which research informs policy. Where prior studies are nonexistent or limited, the expectations are lower than for extensively studied topics since the magnitude of contribution is measured in relation to what has come before.

METHODS: In environmental epidemiology, the primary limiting factors and opportunities for marked advancement of knowledge tend to follow a predictable pattern, suggesting where advances are needed and would have substantial influence on the integrated assessment of the evidence if implemented effectively:

RESULTS: 1) Identification of populations with well-defined, large exposure contrasts when most research has considered a narrow range of exposure, illustrated by arsenic and bladder cancer. 2) Selecting a study setting with an atypical confounding structure when previous studies have been unable to fully adjust for strong, difficult-to-measure confounders, illustrated with research on air pollution and pregnancy outcomes in New York City. 3) Conducting studies that examine a clinically significant endpoint when previous studies have largely focused on subclinical outcomes, illustrated with studies of temperature and stillbirth. 4) Demonstrating biological responses associated with low-level exposures that are suspected of causing adverse effects, illustrated with early work on air pollution and cardiovascular disease endpoints.

CONCLUSIONS: It is also useful to note standard strategies that rarely make major contributions such as pure replication, simply making the study larger, refining standard instruments for data collection such as questionnaires, or expanding the array of covariates. Greater attention should be given to the likely influence of a given study, assessing whether what is feasible is what is needed. Flawed studies may be highly contributory and high quality studies may add little depending on the context.

Keywords: Methods environmental epidemiology, Methods methodological study design



ABSTRACT E-BOOK

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SYMPOSIUM 3

Maximizing the Contributions of Epidemiologic Research to Policy: Selecting, Designing, and Analyzing Influential Studies

Chairs: Kurt Straif, Spain & David A Savitz, United States

O-SY-012

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

What Characteristics of Epidemiologic Evidence Correlate with Study Usefulness or Influence? Experiences in Three Settings

Irva Hertz Picciotto

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BACKGROUND AND AIM: Epidemiologic studies play key roles in: 1) environmental chemical risk assessment for setting regulatory standards (US EPA, US states, countries around the globe); and 2) determinations by authoritative bodies (National Academies of Medicine and Science, California Proposition 65 committees, and IARC) that advise on the strength of evidence for present or potential harm to human health and that may be asked to make recommendations. Drawing on experiences in both types of settings, and in an organization that seeks to move environmental health science into the real world, this presentation demonstrates how specific studies become influential. **METHODS:** Concepts are discussed and will be illustrated through examples (pesticides, cadmium, tetrachlorodibenzo(p)dioxin, radiation; cognitive impairment, lung or breast cancer). **RESULTS:** For regulatory agencies, epidemiology can play a role in hazard identification, exposure assessment, risk assessment, and risk characterization. In this context, two key features determine the utility of epidemiologic studies: overall quality and rigor; and presence of quantitative exposure measures linked to health outcomes, preferably allowing estimation of an exposure-response relationship. By contrast, panels of the National Academies, IARC, and California Proposition 65 Committees are generally tasked with reviewing a body of research and reaching consensus on the evidence for causal associations between specific exposures and defined health outcomes or on whether exposure prevalence or levels pose a threat to human health. They may also be mandated to provide recommendations. The last setting, Project TENDR (Targeting Environment and NeuroDevelopmental Risks), is more similar in its purpose to authoritative bodies than to risk assessment, but more similar to risk assessment in being directed towards policy or action. **CONCLUSIONS:** The overarching goals of the program, agency, or panel will determine what study attributes are most valued. The amount, quality and types of evidence will also determine usefulness of epidemiologic studies. Finally, the desirable characteristics may be exposure- or outcome-specific.

Keywords: environmental epidemiology, methodology study design, policy and practice



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SYMPOSIUM 3

Maximizing the Contributions of Epidemiologic Research to Policy: Selecting, Designing, and Analyzing Influential Studies

Chairs: Kurt Straif, Spain & David A Savitz, United States

O-SY-013

Methods » Causal inference

Characteristics of Studies that have influence in policy – examples from PFAS epidemiology

Tony Fletcher

Department of Public Health, Environments and Society, London School of Hygiene & Tropical Medicine, London, UK

BACKGROUND AND AIM: This symposium will focus attention on what characteristics might make studies have more impact on policy. It depends on the context – in my experience if the goal is to set an exposure limit, either a no adverse effect level or regulatory limit, then a few “key studies” tend to emerge. These are studies which stand out as having credible quantitative exposure assessment, good power, and show effects or thresholds at the lowest levels, along with other good design qualities. For hazard assessment more of the literature contributes and this talk aims to consider the place of diverse literature designs, feeding into standard setting for PFAS (perfluorinated compounds).

METHODS: Research on PFAS has exploded in recent years and because of their toxicity and biopersistence many regulators have sought to set exposure limits for the most significant. This talk reviews the design options for identifying risks using the example of PFAS, illustrated with examples from recent studies.

RESULTS: There is wide variation in the choice of key effect or value of exposure limit between different regulators. Different commentators judge the health impacts of PFAS very differently, and this may be understood in terms of different sensitivities to different biases. For example, biomarker studies are persuasive because they have stable individual exposures or unconvincing because biomarker levels reflect personal determinants which may confound. Modelled exposures are persuasive because they avoid individual confounding but models introduce model uncertainty. Geographic studies avoid the above two problems but may be vulnerable to ecologic bias. Where the association is present across these multiple designs, as in the case of cholesterol associations with PFOA, the presence of hazard is persuasive.

CONCLUSIONS: All observational studies have methodological limitations, but in the case of PFAS at least, integration of evidence across diverse designs, or “triangulation” is a powerful tool in hazard assessment.

Keywords: Environmental epidemiology, Policy, Causal inference, PFAS



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)

SYMPOSIUM 4

Hallmarks of Environmental Insults

Chairs: Annette Peters, Germany & Andrea A Baccarelli, United States

O-SY-014

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

Hallmarks of Environmental Insults

Annette Peters¹, Tim Nawrot², Andrea Baccarelli³

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²Hasselt University

³Columbia University

BACKGROUND AND AIM: Environmental insults impair human health around the world. Air pollution, contaminated water, soil and food, occupational and household settings expose humans of all ages to a plethora of chemicals and environmental stressors.

METHODS: The presentation will present the rationales and general introduction into the eight hallmarks of environmental insights and explain their relevance for understanding the mechanisms underlying the impacts of environmental exposures on chronic diseases.

RESULTS: We propose eight hallmarks of environmental insults which include oxidative stress and inflammation, genomic alterations and mutations, epigenetic alterations, mitochondrial dysfunction, endocrine disruption, altered intercellular communication, altered microbiome communities, and impaired nervous system function.

CONCLUSIONS: They provide a framework to understand why complex mixtures of environmental exposures induce aging and disease even at relatively modest concentrations. They enable understanding of interactions of environmental insults on a cellular and organ level. There is an enormous potential to leverage the contribution of environmental insults on human health and disease to advance individualized prevention and therapy as well as to develop sound policies that protect current and future generations from global threats such as air pollution and climate change.

Keywords: Environmental exposures, molecular and cellular mechanisms, ageing



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)

SYMPOSIUM 4

Hallmarks of Environmental Insults

Chairs: Annette Peters, Germany & Andrea A Baccarelli, United States

O-SY-015

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

The Hallmarks of Aging and Environmental Insults: Molecular Mechanisms

Andrea A Baccarelli

Department of Environmental Health Sciences, Columbia University Mailman School of Public Health,
New York, NY, USA

BACKGROUND AND AIM: This presentation, which is part of the symposium “Hallmarks of Environmental Insults”, will highlight the molecular mechanisms of aging impacted by environmental exposures. Specifically, I will review links between molecular mechanisms of aging and the molecular mechanisms underlying the impacts of environmental exposures. Environmental exposures impact the human body throughout life, from conception to old age. They govern gene expression, train and shape the immune system, trigger many physiological responses and, most importantly, determine wellbeing and disease. The presentation will review the state of the art on the roles of multiple mechanisms of aging, including oxidative stress and inflammation, genomic alterations and mutations, epigenetic alterations, mitochondrial dysfunction, altered extracellular communication, and altered microbiome communities. I will also present laboratory approaches to investigating molecular aging, discuss current challenges in the study of the impact of environmental exposures, and review possible future directions. The presentation will provide a framework to delineate how environmental exposures are capable of accelerating molecular mechanisms of aging, worsen biological aging, and increase the risk of age-related disease.

METHODS: Not applicable

RESULTS: Not applicable

CONCLUSIONS: Not applicable

Keywords: Aging, molecular mechanisms, epigenomics, microbiome



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)

SYMPOSIUM 4

Hallmarks of Environmental Insults

Chairs: Annette Peters, Germany & Andrea A Baccarelli, United States

O-SY-016

Outcomes » Childrens environmental health

The Hallmarks of Environmental Insults and early childhood development

Tim Nawrot¹, Dries Martens²

¹Hasselt University, Centre of Environmental Sciences, Hasselt, Belgium; Leuven University, Environment & Health Unit, Leuven, Belgium

²Hasselt University, Centre of Environmental Sciences, Hasselt, Belgium

BACKGROUND AND AIM: Aging is a complex physiological phenomenon. The question why some subjects grow old while remaining free from disease whereas others prematurely die remains largely unanswered. We focus here on the role of air pollution and other environmental factors in biological aging from early life onwards.

METHODS: Some of the hallmarks of aging are overlapping with the hallmarks of environmental insults including three main categories: genomic instability, telomere attrition, and epigenetic alterations leading to altered mitochondrial function and cellular senescence.

RESULTS: During in-utero development, the fetus is susceptible to transplacental exposure to carcinogenic air particles. We proved translocation of black carbon from mother to fetus. Even below European Union air pollution thresholds, exposure to particulate matter is associated with an increased placental mutation rate. This increased mutation rate occurred in concert with epigenetic alterations in key DNA repair and tumor suppressor genes in the placenta. Moreover, at birth, the initial telomere length of the newborn is largely determined by environmental factors including prenatal air pollution, green space exposure, pre-pregnancy BMI as well as by maternal socio-economic factors. Telomere length at birth is a major predictor of later life telomere length and predicts telomere change in the transition from birth to child- and adulthood. Therefore, telomere length related health and disease later in life may be programmed at birth. Understanding the setting of initial telomere length and its environmental determinants may further gain insights in the developmental origins of health and disease.

CONCLUSIONS: The telomere length – mitochondrial axis is a hallmark of environmental insults during gestation. Improved air quality may promote molecular longevity from birth onward.

Keywords: Ageing, telomeres, mitochondria, exposome, DOHaD



ABSTRACT E-BOOK

August 23, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)

SYMPOSIUM 4

Hallmarks of Environmental Insults

Chairs: Annette Peters, Germany & Andrea A Baccarelli, United States

O-SY-017

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

The hallmarks of environmental issues and the brain

Jordi Sunyer

ISGlobal, Barcelona, Catalonia, Spain

BACKGROUND AND AIM: The aim of this presentation is to discuss the knowledge regarding the impact of the hallmark environmental insults on the brain. Air pollution, noise, heat, light at night, industrial chemicals, and lack of green space have been associated with the impairment of brain development and function and higher risk of neurological diseases and neurodegeneration.

METHODS: Several hallmarks (oxidative stress, methylation, endocrine disruption, mitochondrial dysfunction, telomers, intravesicular cells, miRNA, microbiome, autonomous nervous system irritation) have been suggested to underline these relationships via direct and indirect pathways. The nervous system itself controls the body's physiological processes and as such could impair the cardiovascular, metabolic/endocrine, and respiratory systems, among others.

RESULTS: The efforts in understanding the intermediate role of the cellular hallmarks between the exposure and the brain effects is a path to establish causal relationships. For instance, a key development is to discover the windows of greatest sensitivity of structural and functional brain changes to air pollution. The brain has the widest vulnerable window among all systems. Prenatal exposures may have more severe consequences for the brain because brain structures are forming during this period and may cause permanent brain injury and predict cognitive impairment later in life. Supporting the importance of the prenatal period, mice experiments consistently reported that prenatal exposure to fine PM and diesel exhaust could induce inflammatory reactions and structural changes in several brain regions related with the myelination process which has been replicated in humans, in part, through impairing placental function via PM deposition in the placenta or indirectly via several of the hallmarks in peripheral blood and in the placenta itself.

CONCLUSIONS: Hallmarks could be relevant for informing about the persistence or tracking of the effects until later life. It is important to simultaneously study the effect of these hallmarks together on the brain in relation to the exposome.

Keywords: omics technologies, Neurologic and mental health outcomes, air pollution, chemical exposures, climate



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 5

Climate Change, Pollen Exposure Dynamics and Burden of Allergic Disease in North America

Chairs: Lew H Ziska, United States & Amir Sapkota, United States

O-SY-018

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

Evidence for recent climate change and carbon dioxide influence on plant based aero-allergens in the Northern Hemisphere

Lew H Ziska

Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, USA

BACKGROUND AND AIM: Recent and projected assessments of climate change and carbon dioxide may influence plant based aero-allergen characteristics related to pollen load and pollen seasonality

METHODS: Characterization and quantification of allergenic plant species related to growth, phenology and allergenicity in the context of rising temperatures and increased carbon dioxide. Methodologies include chamber and open-air assessments of pollen collection, ELISA and historical records.

RESULTS: Integration of historical and experimental results from controlled chambers to open-air facilities indicate recent (since the 1970s) and projected changes (to 2100) in climate and CO₂, are increasing allergen seasonality and pollen amounts. In addition there is evidence indicating that carbon dioxide per se may increase exine allergen concentration.

CONCLUSIONS: These data overall, show a net influence of recent and projected increases in carbon dioxide and global surface temperatures on temporal aspects of aero-allergen exposure, including pollen load, and potential changes in allergenicity. Such changes have significant health consequences for those in the general population who suffer from seasonal allergic rhinitis and asthma.

Keywords: aeroallergens, climate change, carbon dioxide, pollen



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 5

Climate Change, Pollen Exposure Dynamics and Burden of Allergic Disease in North America

Chairs: Lew H Ziska, United States & Amir Sapkota, United States

O-SY-019

Respiratory and Allergic Outcomes » Allergies

Recent advancements in the use of remote sensing observations to inform ground level pollen dynamics

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BACKGROUND AND AIM: Pollen information (e.g., pollen seasons and concentrations) is highly needed for allergy disease studies. However, in-situ pollen data from stations are still limited. Satellite data with repeated observations and global coverage provide the possibility to inform ground pollen dynamics over large areas. This study aims to improve the understanding of the relationship between vegetation phenology and pollen season, for its potential in developing fine spatiotemporal pollen maps over large areas.

METHODS: We developed a framework to explore the relationship between the onset of vegetation phenology and pollen season. First, we derived pollen indicators using a double-Gaussian function and the collected pollen concentration data at five in-situ pollen stations. Next, we estimated vegetation phenology indicators and their interannual variability using satellite derived vegetation index. Finally, we explored the relationship between the indicators of pollen and phenology, and evaluated the scale effect of the relationship at the five stations during 2001–2015.

RESULTS: Although indicators of pollen season (i.e., start of pollen season, SPS) and the vegetation phenology (i.e., start of season, SOS) vary spatially and temporally over stations, they exhibit consistent temporal trends during 2001-2015. SOS derived from finer Landsat satellite observations outperforms that from MODIS observations with a coarse spatial resolution. Our results indicate that satellite-derived SOS can serve as a proxy for pollen seasons in birch dominated areas.

CONCLUSIONS: In this study, we explored the relationship between satellite-derived vegetation phenology and station-based pollen season at stations. Our results indicate that satellite-derived phenology can be used as an indicator for pollen dynamics over large areas, and therefore provides the possibility to assess the risk of respiratory allergies, especially in highly heterogeneous urban areas with high spatiotemporal satellite observations.

Keywords: Satellite remote sensing, Phenology, Start of Season, Pollen



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 5

Climate Change, Pollen Exposure Dynamics and Burden of Allergic Disease in North America

Chairs: Lew H Ziska, United States & Amir Sapkota, United States

O-SY-020

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

Changes in Timing of Spring Onset, Pollen Exposure, and Burden of Allergic Disease in the Northeastern United States

Amir Sapkota¹, Linze Li², Hyeonjin Song¹, Yuyu Zhou³, Ghassem Asrar⁴

¹Maryland Institute for Applied Environmental Health, University of Maryland School of Public Health, USA

²School of Remote Sensing and Information Engineering, Wuhan University, China

³Department of Geology and Atmosphere Sciences, Iowa State University, USA

⁴Universities Space Research Association, Columbia, USA

BACKGROUND AND AIM: Ongoing climate variability and change is altering the timing of spring onset, a critical event that signifies the start of tree pollen season in North America. There is a paucity of data regarding how such changes in the timing of spring onset impact burden of allergic disease in the Northeast United States.

METHODS: We processed Landsat and MODIS observations for New York and Maryland during 2001-2015 to derive the start of spring (SOS) using double logistic model and aggregated them to county level. We then calculated yearly deviations in SOS for each county for MD and NY from their respective long term median values (2001-2015). These deviations were categorized as very early, early, normal, late and very late. We linked these yearly deviations in SOS with asthma hospitalization for MD and NY during 2001-2015, based on the county of residence. We used general additive (quasi Poisson) and mixed-effect (negative binomial) models to investigate the association between changes in the timing of spring onset and asthma hospitalization.

RESULTS: Very early onset of spring was associated with a 17% increase in asthma hospitalization in Maryland during spring season (incident rate ratio [IRR], 1.17; 95% CI, 1.07-1.28). Likewise late onset of spring was associated with a 7% increase in asthma hospitalization (IRR, 1.07; 95% CI, 1.00-1.15). Adjustments for extreme heat event and particulate matter with aerodynamic diameter less than 2.5 microns (PM_{2.5}) did not change result for very early onset of spring, but late onset was no longer statistically significant. Similar analysis for NY is ongoing and will be covered in the presentation.

CONCLUSIONS: Our findings suggest that early onset of spring that are tied to warming climate may increase burden of allergic disease such as asthma.

Keywords: Climate Change, phenology, asthma, pollen, allergy



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 5

Climate Change, Pollen Exposure Dynamics and Burden of Allergic Disease in North America

Chairs: Lew H Ziska, United States & Amir Sapkota, United States

O-SY-021

Respiratory and Allergic Outcomes » Allergies

A machine-learning Strategy for Generating Pollen Estimates and Forecasts in North America

Fiona Lo, Jeremy J Hess

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BACKGROUND AND AIM: Pollen information is important for risk communication, diagnosis of allergic disease, medical management, and surveillance. Pollen observations are sparse, however, and existing models have relatively low skill in estimating pollen concentrations for certain taxa and locations. The aim of this work is to leverage recently developed supervised Random Forest machine learning models to estimate daily pollen concentrations for multiple allergenic pollen taxa in the continental US.

METHODS: We built upon a previously developed statistical supervised Random Forest machine learning model with demonstrated skill in estimating and forecasting four pollen types (Quercus, Cupressaceae, Ambrosia, and Poaceae) to make retrospective forecasts of seven other allergenic pollen taxa for the contiguous US. Meteorological, vegetation, and web search information were input to the models at city and regional scales and geographic coverage was expanded using data augmentation techniques. The models were further developed to estimate pollen concentrations in locations where there are no observations. Daily pollen concentration estimates were made for each of the 11 taxa.

RESULTS: Daily estimates of pollen concentrations for 11 allergenic taxa for the period 2000 to 2020 were developed. Model forecast skill for the seven newly modeled taxa was assessed and compared with skill for the four previously modeled pollen types and available diagnostics for other pollen forecasting models.

CONCLUSIONS: Weather, vegetation, and web search data can be used to estimate airborne pollen concentrations for prevalent allergenic taxa in the contiguous US. Reanalysis data products may be of use in diagnostic and management activities for people with allergic disease and for epidemiological analyses. Forecast models can be used in risk communication to facilitate exposure avoidance. Model forecasting skill is limited by availability of pollen observations and could be augmented by development of additional observation sites.

Keywords: pollen, random forest machine learning, allergic rhinitis, allergic asthma, forecasting, climate



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)
SYMPOSIUM 6

How will the Covid-19 Pandemic Change Environmental Epidemiology Research?

Chairs: David A Savitz, United States & Manolis Kogevinas, Spain

O-SY-022

Methods » Environmental epidemiology

Changes in the research scope of environmental epidemiology

David A Savitz

Department of Epidemiology, Brown University School of Public Health, Providence, Rhode Island, USA

BACKGROUND AND AIM: The range of topics addressed in environmental epidemiology is always in flux, with some becoming less popular over time (e.g., industrial chemicals) and others becoming much more so (e.g., perfluoro alkyl compounds). The reverberations from the impact of Covid-19 are most obviously going to engage all public health scientists in infectious disease.

METHODS: For environmental epidemiologists, this is likely to include study of the impact of environmental toxicants on susceptibility to the occurrence and severity of infection due to immunologic changes, interaction of environmental toxicants and infectious agents in the development of disease, and the role of global environmental changes in exacerbating or mitigating risks of infection. The causes and consequences of Covid-19 serve as a clear reminder that “environment” extends well beyond what comes out of a factory smokestack, motor vehicle tailpipe, or drinking water tap.

RESULTS: We need to bring our skills to bear on a much broader range of societal influences on environmental health, such as characteristics of housing and other indoor environments, how people distribute themselves in space in microenvironments, population growth and distribution, the urban environment, travel and transportation, and social inequalities. We need to be more versatile in applying our methodological skills outside conventional specialties and explore a much broader range of health determinants than we have in the past. To do so effectively will require extending our array of collaborators beyond the traditional links to biostatisticians, toxicologists, and exposure assessment scientists to include urban planners, civil engineers, economists, demographers, medical anthropologists, and others who work outside the physical and biological sciences.

CONCLUSIONS: The Covid-19 crisis has highlighted the need for a more integrative, comprehensive research agenda which will not only provide knowledge to advance public health but provide more interesting and challenging research opportunities for environmental epidemiologists than following the familiar research avenues.

Keywords: Methods environmental epidemiology, Built environment, Infectious disease



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)
SYMPOSIUM 6

How will the Covid-19 Pandemic Change Environmental Epidemiology Research?

Chairs: David A Savitz, United States & Manolis Kogevinas, Spain

O-SY-023

Methods » Environmental epidemiology

Changes in environmental epidemiology research methods due to COVID-19

Cathryn Tonne

ISGlobal, Barcelona, Spain

BACKGROUND AND AIM: The obligatory pivot to digital research methods during the pandemic has illustrated its advantages in terms of flexibility, efficiency, broader geographic coverage, and lower barriers to participation. Digital research methods are likely to continue to expand in the post-COVID-19 era, although not without challenges and tradeoffs. The digital divide will become an increasingly complex source of selection bias, with important implications for participation of older individuals or those with lower socioeconomic position. For example, online questionnaires used heavily in the early stages of the pandemic, often had limited researcher control over who participated and little information on potentially large selection biases.

METHODS: The pandemic has highlighted the potential of big data for public health protection. High-resolution geo-located data, increasingly available through either top-down (i.e. government surveillance) or bottom-up (i.e. volunteered geographic information) sources, paired with spatial analysis, are providing unprecedented opportunities to monitor complex phenomena such as human mobility and interactions. COVID-19 is proving an important impetus for new methods development to deal with complex spatio-temporal data structures with promising applications in environmental epidemiology.

RESULTS: Research methods during COVID-19 shifted heavily towards remote biological sample collection, influencing the type and volume of samples collected. This shift is pushing development of improved analytical techniques for small volume samples. While remote collection offers several advantages over laboratory tests that could reduce selection bias (e.g. increased convenience and accessibility for participants living far from a lab), there are important challenges in ensuring data quality during the collection and handling of samples.

CONCLUSIONS: In conclusion, the application of methods for conducting research that were a necessity during the COVID-19 pandemic because of the risk of infection can be expected to accelerate. The pandemic has triggered the development of creative, flexible research methods that offer advantages outside of the pandemic context; however, careful consideration of drawbacks is essential.

Keywords: COVID-19, big data, environmental epidemiology



ABSTRACT E-BOOK

August 23, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)
SYMPOSIUM 6

How will the Covid-19 Pandemic Change Environmental Epidemiology Research?

Chairs: David A Savitz, United States & Manolis Kogevinas, Spain

O-SY-024

Methods » International collaboration

New directions in global environmental health

Manolis Kogevinas

Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain

BACKGROUND AND AIM: The COVID-19 pandemic is challenging the world's economic and health systems and exemplifies the degree of global interdependencies, the problems in the governance of global crises and the need of preparedness for global health threats. The outbreak of COVID-19 highlighted the links between the occurrence of new infections, the environment and climate at a global scale and the need for a planetary health perspective and trans-disciplinary approaches. The pandemic brought forward considerable health inequities globally

METHODS: The new post-pandemic global settings bring forward overarching topics that have not been efficiently addressed: research needs for policy development, locally and globally; development of transdisciplinary research; implementation science for long-standing global problems; global ethics; new approaches in global public health governance.

RESULTS: The pandemic has profoundly affected global society in multiple ways, introducing entirely new challenges and accelerating ongoing trends. The pandemic has highlighted the deep interconnections between problems typically studied in isolation or that previously were situated at the periphery of environmental epidemiology. There is a need to develop research and action on multiple levels. For example, air pollution, chemical pollution, or nature-based solutions must be addressed locally in cities. We should also address them at a global level: global air-pollution in relation to decarbonisation, the effects of global pollution and loss of biodiversity on ecosystems and human health. LMICs are disproportionately impacted by environmental pollution because of the lack of environmental policies and export of contaminants from high-income countries. The urgency of responding to the pandemic brought into prominence the need for international collaboration to develop actionable knowledge to emergencies that will require research in understudied populations and understudied thematic areas.

CONCLUSIONS: The dramatic changes occurring in a short time will affect research in environmental epidemiology in the long term and the role of environmental epidemiology on a global scale.

Keywords: global epidemiology, covid-19, international collaboration



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 7

Presentation and Discussion of ISEE Principles for Evidence Synthesis and Evaluation in Environmental Health with Invited Feedback from Speakers of Major National and International Agencies Relying on Evidence Synthesis in Environmental Health - an ISEE Policy Committee Symposium

Chairs: Jonathan M Samet, United States & Kurt Straif, Spain

O-SY-025

Policy » Research translation to affect policy and practice

ISEE principles for evidence synthesis and evaluation in environmental health. An ISEE Policy Committee symposium

Kurt Straif

ISGlobal, Barcelona, Spain; Boston College, Chestnut Hill, MA, USA

BACKGROUND AND AIM: Environmental epidemiology aims to identify environmental risk and preventive factors for health, ultimately aiming to improve public health via primary prevention by evidence informed policies aimed at modifying exposure to environmental determinants of health and via guidelines on individual behavior pertinent to environmental health. Rarely, one single study triggers strong policy measures. Therefore, evidence informed policy relies on evidence synthesis, integration and evaluation. There is a long tradition in public health with frameworks for evidence synthesis specifically developed for different subject matter domains and refined over decades in line with the developing science and methodologies pertinent to their respective fields.

METHODS: Recently, there is a strong ambition from frameworks for evidence synthesis and guideline development primarily originating in clinical medicine (e. g., Cochrane, GRADE) to extend their principles and frameworks to environmental health. Building on last year's ISEE symposium on GRADE, a task group of ISEE started to develop principles for evidence synthesis and evaluation in environmental health.

RESULTS: The process of evidence synthesis and integration involves two phases. We focus here on the first phase, evidence synthesis, and specifically evidence synthesis in epidemiology. However, some of the proposed principles also apply to evidence synthesis in other fields as well to the second phase, evidence integration across different fields. The evolving principles include requirements for 1) strong subject matter expertise covering all necessary fields; 2) full transparency of the process 3) proper and transparent management of real and perceived conflicts of interest; and 4) comprehensive inclusion of pertinent studies, as judged on their scientific merit.

CONCLUSIONS: The ultimate goal of this symposium is to make significant progress towards a broad consensus on principles of evidence synthesis and evaluation in environmental health that would guide future development of existing frameworks to better fit the specifics of environmental epidemiology and policy needs for environmental health.

Keywords: Evidence synthesis, evidence integration, causal inference



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 7

Presentation and Discussion of ISEE Principles for Evidence Synthesis and Evaluation in Environmental Health with Invited Feedback from Speakers of Major National and International Agencies Relying on Evidence Synthesis in Environmental Health - an ISEE Policy Committee Symposium

Chairs: Jonathan M Samet, United States & Kurt Straif, Spain

O-SY-026

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

Comments from the perspective of pertinent committees of the US National Academies of Sciences

Jonathan M Samet

Office of the Dean, Colorado School of Public Health, Aurora, United States of America

BACKGROUND AND AIM: This presentation will comment on the ISEE principles of evidence synthesis and evaluation in environmental health from the perspective of pertinent committees of the US National Academies of Sciences, Engineering, and Medicine (NASEM).

METHODS: Over the last decade, beginning with the Review of the Environmental Protection Agency's (EPA) Draft IRIS Assessment of Formaldehyde, multiple committees have addressed the role and conduct of systematic review within several distinct US regulatory frameworks, including those used under the Toxic Substances Control Act (TSCA) and the Integrated Risk Information System (IRIS). These committees have probed the details of how evidence is evaluated, synthesized, and integrated in these agency processes.

RESULTS: One overarching finding is the lack of a set of harmonized approaches. Additionally, the EPA (and others) are challenged to develop approaches for systematic review for mechanistic and other toxicological research.

CONCLUSIONS: Guidelines for principles of evidence evaluation and synthesis from ISEE could play a critical role as regulatory frameworks for using evidence continue to evolve; benchmarks are needed.

Keywords: principles, evidence synthesis, evaluation, environmental health



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 7

Presentation and Discussion of ISEE Principles for Evidence Synthesis and Evaluation in Environmental Health with Invited Feedback from Speakers of Major National and International Agencies Relying on Evidence Synthesis in Environmental Health - an ISEE Policy Committee Symposium

Chairs: Jonathan M Samet, United States & Kurt Straif, Spain

O-SY-027

Methods » Causal inference

Evidence Synthesis and Integration Methods used in the US Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) Program *Abstract is associated with symposium proposal ID "66" (accepted status)

Kristina Thayer

US Environmental Protection Agency

BACKGROUND AND AIM: US Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) assessments are an important source of toxicity information used by EPA, state and local health agencies, Tribes, other federal agencies, and international health organizations. **METHODS:** IRIS assessments, which include hazard identification and dose-response analyses, are conducted using systematic review methods for identifying evidence, evaluating individual studies, summarizing the relevant evidence (i.e., evidence synthesis), and arriving at summary conclusions regarding the overall body of evidence (i.e., evidence integration). The systematic review approaches used for IRIS assessments were developed through discussions within and outside EPA and informed by multiple reviews by the National Academy of Sciences (NAS).

RESULTS: In brief, the strength of the evidence from the available human and animal health effect studies are summarized in parallel, but separately, using a structured evaluation of an adapted set of considerations first introduced by Sir Bradford Hill in 1965. Relevant mechanistic evidence that informs the biological plausibility and coherence within the available human or animal health effect studies is also considered. The terms associated with the different strength of evidence judgments for the human and animal evidence streams are robust, moderate, slight, indeterminate, and compelling evidence of no effect.

CONCLUSIONS: These judgments are then combined to draw an overall judgment that incorporates inferences across evidence streams, such as the human relevance of findings in animals. The final output is an evidence integration narrative with terms reflecting the summary judgment of evidence demonstrates, evidence indicates (likely), evidence suggests, evidence inadequate, or strong evidence of no effect. The expert judgements made during evidence synthesis and integration are summarized in an evidence profile tables using structured web-forms housed within the EPA's version of Health Assessment Workspace Collaborative (HAWC).

*Abstract is associated with symposium proposal ID "66" (accepted status) ""Presentation and discussion of ISEE principles for evidence synthesis..."

Keywords: Risk assessment, Environmental epidemiology, Toxicology



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 7

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Chairs: Jonathan M Samet, United States & Kurt Straif, Spain

O-SY-028

Methods » Environmental epidemiology

Approach to assessing the certainty of evidence in environment and health – the case of WHO global air quality guidelines

Dorota Jarosinska, Roman Perez Velasco

European Centre for Environment and Health, World Health Organization, Bonn, Germany

BACKGROUND AND AIM: The World Health Organization, through the European Centre for Environment and Health, has coordinated a number of evidence synthesis and guidelines, including the recent work on global air quality guidelines (AQGs). The process, described in the WHO Handbook for Guideline Development, involves several groups of experts and requires adherence to methods and procedures. Central is the approach to assessing the certainty of the evidence, retrieved and synthesized through systematic reviews.

METHODS: For that purpose, and to develop recommendations, WHO uses the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework. GRADE has been developed to standardize the approach to judging the certainty of the effects of interventions. While widely used in clinical medicine, its application in the domain of exposures is challenging. In GRADE, the starting point is the study design, with randomized controlled trials considered the 'golden standard' and the certainty of observational studies is downgraded. For environmental factors, the evidence base is diverse and with few exceptions does not involve a randomized exposure. Another challenge is to summarize the evidence coming from different lines, involving epidemiological, animal, mechanistic and human clinical studies. Although different groups have adapted the approach for exposures, there is no consensus among experts.

RESULTS: Therefore, during the development of the AQGs, a Working Group was established to adapt GRADE to assess the certainty of the evidence from the commissioned systematic reviews. Likewise, another Working Group developed a specific tool to judge risk of bias in individual studies included. The work adaptation benefitted from previous experiences in applying GRADE in occupational and environmental health, as well as specific expertise in air pollution epidemiology.

CONCLUSIONS: These tailored approaches, resulted in the methodological adaptations that enhanced comparability of the judgements, when assessors consider the same arguments in a similar manner. However, further work to fine-tune evidence synthesis methods are warranted.

Keywords: WHO guidelines, environmental exposure, GRADE



ABSTRACT E-BOOK

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SYMPOSIUM 7

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Chairs: Jonathan M Samet, United States & Kurt Straif, Spain

O-SY-029

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

ISEE principles for evidence synthesis and evaluation in environmental health - Perspectives from HEI for an ISEE Policy Committee symposium

Daniel Greenbaum

Health Effects Institute

BACKGROUND AND AIM: There has been growing interest in and attention to the application of more systematic approaches for synthesizing epidemiologic evidence for environmental health assessment and decisions. In general, applying more rigorous approaches can be valuable in ensuring the quality of the reviews and synthesis, and enhancing the credibility of the results. At the same time, the context in which environmental health is investigated – does not lend itself to the classic form of tightly controlled clinical trials common in the medical community – and there has been much effort by those examining environmental health to develop practical but still rigorous approaches to systematic review.

METHODS: The Health Effects Institute (HEI) has recently conducted two systematic reviews of the literature: on health effects of exposure to unconventional oil and gas development (hydraulic fracturing) and the health effects of long term exposure to traffic-related air pollution (TRAP). This talk will describe the approaches used and the strengths and challenges of those approaches.

RESULTS: At the same time, HEI has been actively engaged in informing the US Environmental Protection Agency on its approaches to evaluating the science on air pollution exposure and health as part of its efforts to review the adequacy of the National Ambient Air Quality Standards (NAAQS), a science base which of necessity encompasses a range of toxicologic and mechanistic research as well as systematic reviews of epidemiology and exposure research.

CONCLUSIONS: This talk will describe opportunities for better integrating this full range of science and draw lessons for broader application

Keywords: evidence synthesis, environmental health, air pollution



ABSTRACT E-BOOK

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SYMPOSIUM 7

Presentation and Discussion of ISEE Principles for Evidence Synthesis and Evaluation in Environmental Health with Invited Feedback from Speakers of Major National and International Agencies Relying on Evidence Synthesis in Environmental Health - an ISEE Policy Committee Symposium

Chairs: Jonathan M Samet, United States & Kurt Straif, Spain

O-SY-030

Methods » Environmental epidemiology

ISEE principles for evidence synthesis and evaluation in environmental health: comments from experience on advisory and regulatory committees

Neil Pearce

London School of Hygiene and Tropical Medicine

BACKGROUND AND AIM: This presentation is an individual viewpoint, but draws on my experience serving on various official committees which undertake evidence synthesis, including the UK Industrial Injuries Advisory Council, the UK Committee on Carcinogenicity, and a subcommittee of the European Food Safety Association (EFSA) Scientific Committee.

METHODS: It used to be a 'given' that to decide whether a particular factor, either exogenous or endogenous, can cause a particular disease, and in what order of magnitude, one should consider all reasonably cogent evidence. This approach is being increasingly challenged, both scientifically and politically. The scientific challenge has come from methodologic views that focus on the randomized controlled trial (RCT) as the scientific gold standard, with priority being given, either to evidence from RCTs or to observational studies which closely mimic RCTs. The political challenge has come from various interests calling for the exclusion of epidemiological evidence from consideration by regulatory and advisory committees. This has been particularly motivated by anti-regulation "vested interests" which have disputed a long series of scientific discoveries, ranging from smoking and lung cancer to the reality of climate change.

RESULTS: Recently, these pressures have led to calls for the exclusion of epidemiological evidence from consideration by regulatory and advisory committees, thereby weakening regulatory standards. This approach is typified by the (mis) use of scoring systems such as GRADE and ROBINS-I, which have been used to exclude important epidemiological evidence which does not fit the RCT paradigm.

CONCLUSIONS: We need to return to a more pluralistic and inclusive approach, which considers all of the available evidence.

Keywords: evidence synthesis, environmental health



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 7

Presentation and Discussion of ISEE Principles for Evidence Synthesis and Evaluation in Environmental Health with Invited Feedback from Speakers of Major National and International Agencies Relying on Evidence Synthesis in Environmental Health - an ISEE Policy Committee Symposium

Chairs: Jonathan M Samet, United States & Kurt Straif, Spain

O-SY-031

Policy » Research translation to affect policy and practice

ISEE principles for evidence synthesis and evaluation in environmental health: comments from the perspective of the Cochrane Collaboration

[Lisa Bero](#)

The University of Colorado

BACKGROUND AND AIM: The Cochrane Collaboration is a global producer and publisher of high quality systematic reviews of clinical and public health research. Cochrane has pioneered principles and rigorous standards for systematic review which have evolved to encompass diverse types of evidence and research integrity practices. In addition to producing systematic reviews, Cochrane publishes a Handbook of systematic review methods, provides capacity building for systematic reviews and advocates for the use and understanding of systematic reviews. This presentation is a personal viewpoint, but is based on my experience with diverse types of evidence synthesis and Cochrane. I will discuss the relevance of Cochrane's principles and standards for evidence synthesis in environmental health.

Lisa Bero is an international leader in Research Integrity and meta-research. She is the Senior Editor, Research Integrity for the Cochrane Library where she is initiating Cochrane's research program on research integrity. She is also Public Health and Health System Network Senior Editor and was Co-Chair of the Cochrane Governing Board 2014-18. She is Professor, Medicine and Public Health and Chief Scientist, Center for Bioethics and Humanities, University of Colorado Anschutz Medical Center.

METHODS: Not applicable

RESULTS: Not applicable

CONCLUSIONS: Not applicable

Keywords: exposure assessment, risk assessment, policy



ABSTRACT E-BOOK

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SYMPOSIUM 7

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Chairs: Jonathan M Samet, United States & Kurt Straif, Spain

O-SY-032

Cancer and Cancer-Precursors » Incidence

Fifty years of comprehensive cancer hazard identification: the IARC *Monographs* Programme's systematic review and synthesis across multiple evidence streams

Mary K Schubauer Berigan

Evidence Synthesis and Classification Branch, International Agency for Research on Cancer, Lyon, France

BACKGROUND AND AIM: For the past 50 years, the *Monographs* Programme of the International Agency for Research on Cancer (IARC) has provided the world's most comprehensive compendium of cancer hazard identification. More than 1020 agents have been evaluated by the *Monographs*, selected based on evidence of human exposure and of carcinogenicity. These agents comprise chemicals, physical and biological agents, complex mixtures, occupational exposure circumstances, dietary factors, personal habits, and other exposures of everyday life. The aim of this presentation is to describe the comprehensive evidence synthesis used by the IARC *Monographs*.

METHODS: Expert working groups are assembled by the *Monographs* scientific secretariat, based on expertise with the agent or relevant methodology, freedom from conflicts of interest, and diversity of scientific viewpoints and approaches. These working groups review and synthesize all publicly available evidence in three streams: human cancer, cancer in experimental animals, and carcinogen mechanisms. Evidence from these three streams is synthesized first within and then across streams, to reach an overall conclusion about whether the agent is *carcinogenic*, *probably carcinogenic*, *possibly carcinogenic*, or *not classifiable as to its carcinogenicity* to humans. Exposure information about the agent is also characterized in each *Monograph*.

RESULTS: Exposure settings for agents classified as *carcinogenic to humans* include the environment (e.g., air pollution), workplace (e.g., welding fumes), diet (e.g., processed meat), infections (e.g., human papilloma virus), medicines (e.g., estrogen-progestogen oral contraceptives), and personal habits (e.g., opium consumption). Recent advances made within this unique and influential program include comprehensive and transparent incorporation of systematic review principles, explicit consideration of the impact of exposure assessment quality in human cancer and mechanistic studies, and novel methods for mechanistic evidence evaluation.

CONCLUSIONS: The systematic review process undertaken by IARC *Monographs* working groups is robust and well-accepted. Recent advances to increase transparency of expert decision-making provide a foundation for sound evidence synthesis into the future.

Keywords: Evidence synthesis, carcinogenicity, hazard identification, risk assessment, mechanisms, cancer



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Brooklyn Bridge Hall (Hall 2)
SYMPOSIUM 8

Air pollution and Climate impacts in the Eastern Mediterranean Region
Chairs: Narges Khanjani, Iran & Wael Al-delaimy, United States

O-SY-033

Climate » Temperature extremes and variability

Concurrent heatwaves and extreme Ozone (O₃) episodes: combined atmospheric patterns and impact on human health

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BACKGROUND AND AIM: In the context of the global environmental change, more recurrent and/or intense heat waves and extreme ozone episodes are likely to occur during the next decades. The main purpose of this research is to assess how extreme temperature may trigger the appearance of high ozone levels and how the concurrence of these two extremes could be linked to the synoptic general circulation and impacts human health and wellbeing.

METHODS: We have used surface maximum temperature and ozone observations during extended summers (April–September) in two cities from Morocco: Casablanca and Marrakech, between 2010 and 2019. A percentile-thresholding method was applied to identify heatwaves and ozone episodes and a statistical approach was used to assess the connection between the observed parameters and climate indexes (North Atlantic Oscillation (NAO), Mediterranean Oscillation (MO), and Saharan Oscillation (SaOI)). The weather types behind the concurrence of extremes were identified and Heat and Air Quality Indexes were assessed to determine their combined health risks.

RESULTS: Our findings show that the concurrence of heatwaves and ozone episodes depends both on the specific city and the large-scale atmospheric circulation. The likely synoptic pattern behind the concurrence of these events occurs when the country is under the combined influence of an anticyclonic area in the north and the Saharan trough extending the depression centered in the south. This pattern generates a warm southern flow and may foster photochemical pollution and then impact human health.

CONCLUSIONS: Our study is an attempt to assess extreme temperature and ozone episodes combined features inducing large-scale atmospheric circulation and health effects. It explores the hypothesis that particular weather patterns increase the vulnerability of individuals especially those sensitive to air pollution. This work is a first step to the establishment of an alert system and will help to provide recommendations for coping with concurrent heatwaves and air pollution episodes.

Keywords: Ozone, Temperature extremes, North Atlantic Oscillation, Mediterranean Oscillation, Saharan Oscillation



ABSTRACT E-BOOK

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SYMPOSIUM 8

Air pollution and Climate impacts in the Eastern Mediterranean Region

Chairs: Narges Khanjani, Iran & Wael Al-delaimy, United States

O-SY-034

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

Machine-learning regression for forecasting air pollution

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²General Directorate of Meteorology, Casablanca, Morocco

BACKGROUND AND AIM: Many scientific researches have already confirmed the link between air pollution and many other respiratory and cardiovascular diseases. Air quality forecasting may play an important role in decision making where clean air is still a serious challenge for public health services.

METHODS: This paper examines the ability of supervised machine-learning regression techniques, namely, feed-forward neural network, tree-based ensemble, and generalized linear methods, to anticipate and manage changes in atmospheric pollutant concentrations. In order to infer the performance of the developed models, daily observed data of air quality, Climate Indices and meteorological parameter's collected during the years 2006-2016, have been used.

RESULTS: The analysis stage of the modeling provided clear and intuitive results regarding air quality in Casablanca City. The proposed models achieve comparable results with good generalization performances in forecasting pollutant parameters.

CONCLUSIONS: Results from this work have important implications for understanding and forecasting of air quality parameters in Morocco and showed as promising techniques to be applied in other countries.

Keywords: Air pollution, Ozone, Particulate matter, machine learning



ABSTRACT E-BOOK

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SYMPOSIUM 8

Air pollution and Climate impacts in the Eastern Mediterranean Region
Chairs: Narges Khanjani, Iran & Wael Al-delaimy, United States

O-SY-035

Air pollution » Mixtures

Multiple Air pollutant exposure and lung cancer in Tehran, Iran

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BACKGROUND AND AIM: Lung cancer is the most rapidly increasing malignancy worldwide with an estimated 2.09 million cancer cases in the latest, 2018 World Health Organization (WHO) report. The objective of this study was to investigate the association of air pollution and lung cancer, in Tehran, Iran.

METHODS: Residential area information of the latest registered lung cancers cases that were diagnosed between 2014-2016 (N=1,850) were inquired from the population-based cancer registry of Tehran. Long-term exposure to PM₁₀, SO₂, NO, NO₂, NO_x, benzene, toluene, ethylbenzene, m-xylene, p-xylene, o-xylene (BTEX), and BTEX in 22 districts of Tehran were estimated using land use regression (LUR) models. Latent profile analysis (LPA) was used to generate multi-pollutant exposure profiles. Negative binomial regression analysis was used to examine the relation between air pollutions and lung cancer incidence.

RESULTS: The districts with higher concentrations for all pollutants were mostly in downtown and around the railway. Districts with a higher concentration for NO_x (IRR = 1.05), benzene (IRR = 3.86), toluene (IRR =1.50), ethylbenzene (IRR =5.16), p-xylene (IRR =9.41), o-xylene (IRR =7.93), m-xylene (IRR =2.63) and TBTEX (IRR =1.21) were significantly associated with higher lung cancer incidence. Districts with a higher multiple air-pollution profile were also associated with more lung cancer incidence (IRR =1.01).

CONCLUSIONS: Our study shows a positive association between air pollution and lung cancer incidence. This association was stronger for p-xylene, o-xylene, ethylbenzene, benzene, m-xylene and TBTEX.

Keywords: Air pollution, lung cancer, Iran



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SYMPOSIUM 8

Air pollution and Climate impacts in the Eastern Mediterranean Region
Chairs: Narges Khanjani, Iran & Wael Al-delaimy, United States

O-SY-036

Air pollution » Particulate matter

Potential health and economic benefits of air quality improvements in Morocco: A simulation based on particles during the COVID19 lockdown

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BACKGROUND AND AIM: Several measures have been taken to mitigate the effects of the COVID19 pandemic. In this context, almost all non-essential activities in Morocco have been halted since March 20, 2020. The implementation of these measures has led to a notable improvement in air quality. The main objective of this study is to estimate economic and health benefits caused by the reduction in fine particulate matter (PM2.5) concentrations during the COVID19 scenario in Morocco.

METHODS: This study presents the spatio-temporal evolution of the observed concentrations of PM2.5 by the Modern-Era Retrospective analysis for Research and Applications (MERRA) during the periods 2017-2019 and 2020. Then, these observed concentrations were compared to those predicted by Copernicus Atmosphere Monitoring Service (CAMS). In addition, the health and the economic benefits caused by PM2.5 during the COVID19 lockdown in Morocco were estimated using the Environmental Benefits Mapping and Analysis Program (BenMAP).

RESULTS: According to this study, reducing the concentration of particles can prevent deaths from several diseases, namely pneumonia and asthma. Also, owing to the reduction in air pollution, especially particulate matter, millions of dollars per year were estimated as an economic benefit arising during the study period in Morocco.

CONCLUSIONS: This hypothetical clean air scenario has shown the significant health and economic benefits that could be achieved through transport, climate and environmental strategies and policies that support a robust economic recovery and reduced emissions at the same time.

Keywords: Air pollution, particulate matter, Health co-benefits, COVID19



ABSTRACT E-BOOK

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SYMPOSIUM 8

Air pollution and Climate impacts in the Eastern Mediterranean Region
Chairs: Narges Khanjani, Iran & Wael Al-delaimy, United States

O-SY-037

Birth and Pregnancy Outcomes » Birth outcomes

Environmental Exposure in Lebanese Infants (EELI): A Longitudinal Birth Cohort- Pilot Study

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BACKGROUND AND AIM: The Environmental Exposure in Lebanese Infants (EELI) study is a longitudinal birth cohort designed to assess a wide range of pre- and post-natal environmental exposures and genetic factors underlying the health and development of Lebanese infants in Beirut. The aim of the study is to better understand the origins of complex and often lifelong diseases like asthma, allergies, and other chronic conditions.

METHODS: As part of the EELI study, a sub-cohort study was conducted with pregnant Lebanese women recruited in their third trimester from Hôtel-Dieu de France hospital in Beirut. The mothers, fathers and infants are followed up for 4 months after birth. Upon being recruited, the parents and eventually the infants are screened at critical time points for prospective exposures via standardized questionnaires, clinical tests, and biological samples.

RESULTS: The assessment of early-life exposures in domains such as environmental pollutants, lifestyle habits, maternal stress help to elucidate their effect of the aforementioned exposures on growth and development in the fetal and early childhood stage.

CONCLUSIONS: As a sub-cohort to a larger multi-year study that will potentially involve 500 Lebanese families, this pilot study also aims to test the interest and willingness of the Lebanese population to participate in environmental health research.

Keywords: Air pollution, birth outcomes, children's environmental health, exposure assessment, pregnancy outcomes



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Brooklyn Bridge Hall (Hall 2)
SYMPOSIUM 8

Air pollution and Climate impacts in the Eastern Mediterranean Region
Chairs: Narges Khanjani, Iran & Wael Al-delaimy, United States

O-SY-038

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

Health Hazards of occupational exposure to airborne biological pollutants on workers in Wastewater treatment plant

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BACKGROUND AND AIM: There are many evidences that workers in wastewater treatment plants (WWTPs) occupationally exposed to high concentrations of biological air pollutants. Aim of the present study was determination of the common airborne microorganism in a WWTP, and it's health impacts on occupational exposure workers.

METHODS: Air samples were collected from various locations in a selected WWTP. Airborne bacteria were identified by 16S rRNA gene sequencing technique. Airborne fungi were studied macroscopically and complete identification of fungal isolates were performed by 18S rRNA gene sequencing method. Health risks associated with biological airborne pollutants were estimated based on occupational and medical questionnaires for the workers from the selected WWTP. Pulmonary function test was also done for the included workers. PCR identification of fungi were done for the sputum and blood samples of the workers.

RESULTS: A total of 32 bacterial isolates were collected, sequencing identified 25 different bacterial types. Ten out of the 25 different strains were pathogenic. The frequency of infectious diseases related to the identified bacteria among the workers will be presented in details in the presentation. For airborne fungi, *Aspergillus niger* and *Aspergillus japonicus* were the most hazardous fungi detected in the air samples. The sputum of 43.2% of the workers were positive to *Asperigullus nigar*. However, *Aspergillus fumigatus* the hazardous stain for the respiratory system was not detected in the air samples, 18.5% of the sputum samples of the workers were positive for it. While, only 3.5% of the blood samples of the workers were positive for *Asperigullus fumigatus*, and 35.4% for *Asperigullus nigar*. About 50% of the workers with obstructive lung disease and 41% of those with combined were positive for *Asperigullus nigar*. The explanations will be discussed in detail in the presentation.

CONCLUSIONS: The results would give alarum about hazards of airborne pathogenic biological pollutants in WWTPs.

Keywords: Air Pollution, Airborne bacteria, Airborne Fungi, Exposed workers, Health impacts



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)
SYMPOSIUM 9

Air Pollution Assessment in a Resource Constrained World
Chairs: Adetoun Mustapha, Nigeria & Eric Coker, United States

O-SY-040

Air pollution » General

Leveraging low-cost air quality sensors and machine learning techniques for air pollution assessment and prediction in urban Ghana

A Kofi Amegah

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BACKGROUND AND AIM: In recent times, there has been a proliferation of low-cost air quality sensors (LCS). In Africa, where air quality monitoring systems are very weak, LCS offer a great opportunity for bridging the huge air pollution data gaps in countries.

METHODS: The Ghana Urban Air Quality Project (GHAir) initiated in May 2019 and presently covering five cities of Ghana leverages PurpleAir sensors, clarity nodes, and Real-Time Multi-Pollutant sensors (RAMP) to monitor air pollution in these settlements for epidemiologic research whilst also applying machine learning tools to gleaned insight into the air quality data generated for community advocacy to improve air quality, and influence air pollution control policies.

RESULTS: In this presentation, I would be providing data on the levels and trends of PM_{2.5}, NO₂, SO₂ and ground level ozone in the city of Accra especially and other metropolitan areas for the period May 2019 to July 2021. I would also present results from prediction models depicting future air pollution situation in Accra and outline measures that can be help to mitigate the situation.

CONCLUSIONS: The GHAir project has helped to bridge the air pollution data gap in urban Ghana and should be supported by regional and global clean air interest groups to scale up the project and to share the lessons learnt in other African countries

Keywords: Air pollution, Data science, Ghana, Low cost sensors



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)
SYMPOSIUM 9

Air Pollution Assessment in a Resource Constrained World
Chairs: Adetoun Mustapha, Nigeria & Eric Coker, United States

O-SY-041

Air pollution » General

Application of an ultra-low-cost passive sampler for light-absorbing carbon in India and Mongolia

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BACKGROUND AND AIM: We tested in India and Mongolia an ultra-low-cost passive sampling method for long term average light-absorbing carbon (LAC) air pollution.

METHODS: The passive LAC method estimates the change in reflectance based on digital images of a passively-exposed paper filter. Previous tests in polluted indoor environments in India suggested that the passive LAC method has robust reproducibility and high precision; the present research aimed to calibrate the method and thereafter test its accuracy. We deployed three methods (five monitoring devices) to each of 10 households in Ulaanbaatar, Mongolia: one PurpleAir (PA); two quartz filters for EC-OC (elemental carbon; organic carbon) using a UPAS; and two passive LAC samplers. We compare multiple rounds of 3-week-average measurements from the three methods. The EC-OC filter analysis is the “gold standard” / reference; PA and LAC are proxy-measurements for PM_{2.5} and BC, respectively.

RESULTS: In pilot testing in Mongolia, average concentrations were 266 µg of PM_{2.5} /m³ (PA; uncalibrated) and, 47 µg of BC /m³ (UPAS, EC). LAC measurements in their native, uncorrected, units reflect the rate of change in filter color (pixel intensity/month), which depends on LAC deposition per time; the average value was 2590 PI/month. Preliminary analyses calibrating the LAC to the EC measurement suggest, as a conversion factor, that 1 µg of BC /m³ corresponds to 22 PI/month, on average. Applying that conversion to all measurements, to predict BC concentrations from passive LAC measurements, yields a root-mean-square-error of 16 µg of BC /m³, or ~25% of the average BC concentration.

CONCLUSIONS: Measurements are continuing past this initial pilot stage and likely will shed improved light on the accuracy and precision of the novel passive LAC method employed here.

Keywords: low cost sensors, black carbon, passive black carbon sensor, light absorbing carbon



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ABSTRACT E-BOOK



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)
SYMPOSIUM 9

Air Pollution Assessment in a Resource Constrained World

Chairs: Adetoun Mustapha, Nigeria & Eric Coker, United States

O-SY-042

Air pollution » Particle components

Particulate matter measurement in South Africa: are the right questions being asked?

Oyewale Mayowa Morakinyo

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University of Ibadan, Ibadan, Nigeria

BACKGROUND AND AIM: Particulate matter (PM) is a key indicator of air pollution and a significant risk factor for adverse health effects in humans. High PM levels have been observed in industrialized and urban areas in South Africa. Concerns over the health effects of PM_{2.5} made the South African government to establish the national standard for PM_{2.5} in 2012. Since then, most studies conducted in South Africa have focused on determining the ambient concentration of PM_{2.5} and its health impacts. However, PM_{2.5} is not a self-contained pollutant but a mixture of different compounds including chemical and biological fractions. There is a dearth of studies measuring the relationship between exposure to individual pollutants and the combined effects of multipollutant in PM_{2.5} and adverse health outcomes in South Africa. Also, little is known about the exact constituents of PM responsible for the observed health effects in South Africa. This paper discusses current PM monitoring and assessment methods in use for air pollution studies in South Africa.

METHODS: A literature search using various search engines and (or) keywords was done. Articles selected for review were chosen following predefined criteria, to extract and analyze data.

RESULTS: The results show that the biological and chemical components of inhalable and respirable PM play a significant role in the burden of health effects attributed to PM. In most studies, PM_{2.5} levels were measured with fixed ambient monitoring stations on the assumption that levels of PM_{2.5} recorded by the fixed monitoring station are representative of the total concentration of PM_{2.5} to which the residents within the study area are exposed.

CONCLUSIONS: There is also an overall poor understanding of current novel methods of air quality monitoring and exposure assessment. Efforts geared towards the adoption of novel air quality monitoring and exposure assessment techniques should be instituted in South Africa.

Keywords: Particulate matter, Air monitoring, Exposure assessment, South Africa



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)
SYMPOSIUM 9

Air Pollution Assessment in a Resource Constrained World
Chairs: Adetoun Mustapha, Nigeria & Eric Coker, United States

O-SY-043

Air pollution » Mixtures

Lessons learnt on air pollution assessment around schools in Warri, Nigeria and the policy implications

Adetoun Mustapha

Nigerian Institute of Medical Research

BACKGROUND AND AIM: Nigeria with a population of about 200million people is faced with infrastructural deficit. There is a lack of environmental monitoring stations and research funding for non-communicable disease is sparse. This study discusses how multiple exposure metrics were synthesized to characterize geographical exposure in Warri, Niger Delta region.

METHODS: A cross-sectional questionnaire completed by 1,397 school children in 17 schools assessed self-reported exposure. Traffic counts of cars, mini-buses, trucks and motorcycles during peak hours were taken outside schools and distance of schools to major streets was measured. Measurements of particulate matter and CO were made in schools and in outdoor residential background locations using portable monitors. Associations between various exposures measures were estimated in a linear regression and correlation analyses. Classification of schools in terms of their air pollution characteristics was done using cluster analysis of the raw measures of environmental pollution and using compound factors constructed using principal components analysis.

RESULTS: Many of the measured pollution variables and self-reported exposure measures were correlated. The mean (and SD) CO concentration for schools with >90% of children reported traffic disturbance was 9.92 (9.3) ppm and for the remaining schools was 1.2 (1.6) ppm. Coarse and intermediate particles dominated the PM fraction in all schools. Cluster analyses using two different approaches indicated that schools in the north and rural-schools were the least polluted, while schools in the south were more polluted with main sources being cars and motorcycles.

CONCLUSIONS: Use of multiple methods to assess and cross-validate exposure complimented limited representativeness and potential mis-classification in the single exposure measures and may be useful in areas where possibilities for direct measurement is limited. The exposure measures used may thus give relatively robust indicators of exposure to pollutants mix. Public health improvements policies need to address pollutants mix and multiple exposures in the study area.

Keywords: Air pollution, pollutant mix, multiple exposure, LMIC, policy implications



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August 24, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)
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Air Pollution Assessment in a Resource Constrained World

Chairs: Adetoun Mustapha, Nigeria & Eric Coker, United States

O-SY-044

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

Local design and development of low-cost air sensing and data science methods in sub-Saharan Africa – lessons learnt from Uganda

Engineer Bainomugisha

AirQo, Department of Computer Science, Makerere University, Kampala, Uganda

BACKGROUND AND AIM: Sensing and modelling approaches need to be conceived and designed while taking into account unique local contexts in order to be responsive and effective in addressing the environmental data and evidence gaps for the communities and authorities that need them. We report on experiences of designing, developing, deploying and maintaining a local air quality monitoring, modelling and analysis system in Uganda.

METHODS: The AirQo system includes a citywide air quality monitoring network of monitors developed locally to reduce maintenance frequency in dusty environments, leverage solar power, have capability for near-real time monitoring and transmission of air quality data over cellular networks, support for complementary static and mobile (motorcycle) deployment approaches, and application of machine learning approaches for calibration to improve data accuracy.

RESULTS: The air quality datasets have enabled design and development of data science products that generate evidence to inform awareness, education and policy interventions including: (1) a digital air quality platform targeted at the city governments in Uganda to visualise trends, forecast and spatial variations of air pollution to the local level. (2) public-facing digital channels such as mobile apps and web tools that provide realtime and historical analysis of air pollution in places of interest, for examples, schools. We also report on experiences from community engagement initiatives where citizens can report observed pollution events to the AirQo platform using social media tools such as WhatsApp.

CONCLUSIONS: The lessons from this talk are expected to inform ongoing efforts in other African cities and build local capacity in air quality monitoring monitoring and analysis.

Keywords: air quality, monitoring, modelling and analysis



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Air Pollution Assessment in a Resource Constrained World

Chairs: Adetoun Mustapha, Nigeria & Eric Coker, United States

O-SY-045

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

Satellites, mobile-monitoring, and fixed-site measurements to understand local variations in air pollution, globally: the view from Google

Karin Tuxen Bettman, Nicholas Clinton

Google, Inc.

BACKGROUND AND AIM: Hyperlocal air pollution maps are helpful for cities around the globe to take action on climate and health in the ground in their cities.

METHODS: By combining big data -- from ground measurement, both stationary and fixed, to satellites and other data -- hyperlocal air pollution maps and insights can be produced that help cities identify neighborhood hotspots, plan and design their cities to be more healthy, and monitor progress towards environmental goals.

RESULTS: We'll look at the latest in cloud geospatial computing for air quality mapping, and how cities are already taking action with the data.

CONCLUSIONS: Finally, we'll discuss how this computing can assist global mapping of local air pollution in cities around the world.

Keywords: modeling, big data, cloud computing



ABSTRACT E-BOOK

August 24, 2021 / 11:30 - 13:00 / Empire State Building Hall (Hall 4)

SYMPOSIUM 10

Climate and Health: From Research to Policy in the Context of EU and Belmont Forum Funded Projects

Chairs: Matthew Chersich, South Africa & Vlatka Matkovic, Belgium

O-SY-046

Climate » General

A decade of EU funded Research in Climate, Environment and Health: a review and future perspectives under Horizon Europe

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¹European Commission, Climate, Infrastructure and Environment Executive Agency (CINEA), Belgium

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BACKGROUND AND AIM: The effects of climate change in the environment and health are becoming increasingly apparent and one of the most challenging problem facing society in the European Union (EU). Direct effects mostly occur through changes in extreme weather events, while indirect effects are mainly induced by changes in environmental, social and economic determinants. Facing increasing environmental challenges and needing to protect public health, the EU has established in recent decades an extensive framework of thematic programmes and regulatory actions related to environment and health. These need constant updating and must rely on solid scientific evidence to be credible.

METHODS: The EU has also responded in the last decades by providing increasing financial support for the necessary underpinning research to consolidate scientific knowledge base through its Framework Programmes of Research and Innovation. Acknowledging the importance of scientific support for better understanding environmental and health impacts of global changes, including climate change, this area of research emerged especially in FP7 and Horizon 2020 with increasing EU contribution.

RESULTS: Nineteen research projects focusing environment and/or health impacts from global changes, including climate change, have been funded under Horizon 2020, receiving close to €143 million from the EU. These projects support EU policy-making and provide a good foundation to build upon to go forward with the next Framework Programme- Horizon Europe, which started in 2021.

CONCLUSIONS: Attesting to the continued importance of this science-policy area, the next Framework Programme – Horizon Europe – has identified as two of the first missions to be implemented Climate-neutral and Smart Cities and Adaptation to climate change including societal transformation, both of which acknowledge the protection of human health and wellbeing as an important component and societal benefit of action.

Keywords: climate, environment, policy



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Chairs: Matthew Chersich, South Africa & Vlatka Matkovic, Belgium

O-SY-047

Climate » General

Belmont Forum Climate, Environment and Health Collaborative Research Action: current projects and future perspectives

Caroline Culshaw

Natural Environment Research Council, UK Research and Innovation, UK

BACKGROUND AND AIM: The Belmont Forum, a partnership of over 30 funding organizations, international science councils and regional consortia across five continents, is committed to advancing international transdisciplinary research and providing knowledge for understanding, mitigating and adapting to global environmental change. Since its establishment in 2009, the Forum has supported 134 research projects and represented scientists from over 90 countries.

METHODS: In 2019, the Belmont Forum launched a Collaborative Research Action (CRA) to strengthen and expand the current scientific understanding of links between climate variability and change, the environment and health impacts. The geographical scope was global and welcomed proposals that considered challenges in low- and middle-income countries.

RESULTS: The 'Climate, Environment and Health' CRA supports nine transdisciplinary projects that address one or more of the following topics: 1) heat and health, 2) climate-sensitive infectious disease and 3) food systems and nutrition, with the aim to improve the understanding of the complex pathways between climate variability, the environment and health, and to protect and promote human health and well-being in the face of climate challenges. An important research output is to foster the use of scientific information and climate-related decision support tools to better inform planning and enhance resilience.

CONCLUSIONS: This talk will introduce the research projects and outline future research perspectives, considering the current gaps in knowledge and research priorities.

Keywords: Climate, Environmental epidemiology, Exposures, Policy and practice, Natural disasters, Socio-economic factors



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Chairs: Matthew Chersich, South Africa & Vlatka Matkovic, Belgium

O-SY-048

Climate » General

The ENBEL project: From research findings to policy

Kristin Aunan

CICERO Center for International Climate Research

BACKGROUND AND AIM: The Horizon 2020 ENBEL project (Enhancing Belmont Research Action to support EU policy making on climate change and health) brings together climate change and health research projects from Belmont Forum, EU's Horizon2020 and other international and national funding schemes. The aim is to achieve convergence between climate change and health research and policy making, to optimise research outputs across the projects, standardise epidemiological measures and research approaches, where possible, and contribute to policy advice. ENBEL focuses on three major climate change related health hazards: environmental and occupational heat, air pollution (particularly from wildfires) and climate-sensitive infectious diseases, with specific attention to high-risk groups.

METHODS: The overall concept of ENBEL is a bottom-up approach to networking and cooperation across often separate worlds of climate and health research communities. We aim to mainstream climate change into health conferences and vice versa to increase understanding, knowledge exchange and collaboration and enable integrated and evidence-based policy advice for mitigating impacts of climate change on human health. The network is synthesizing research evidence on climate change and health links and engaging with policymakers to translate science into policies. We will undertake evidence gap analysis of adaptation policies, strategies and measures to identify evidence gaps in Europe and Africa and produce tailor-made knowledge products.

RESULTS: The network is bringing together researchers and experts on climate change and health and contribute to bridge gaps in approaches and methods that can make collaboration difficult, and thereby laying the ground for establishing actionable knowledge on climate change-related health risks.

CONCLUSIONS: ENBEL will formalise a strong network of projects and researchers at the forefront of the climate change and health nexus. The synthesis of knowledge from a broad range of scientific institutions will enable decision-makers to make evidence-based decision to alleviate climate change impacts on health.

Keywords: Climate, Wildfires, Infectious diseases, International collaboration, Research translation to affect policy and practice



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SYMPOSIUM 10

Climate and Health: From Research to Policy in the Context of EU and Belmont Forum Funded Projects

Chairs: Matthew Chersich, South Africa & Vlatka Matkovic, Belgium

O-SY-049

Climate » Temperature

The CHAMNHA project: defining heat impacts on maternal and neonatal health and testing adaptive interventions in Burkina Faso and Kenya

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BACKGROUND AND AIM: Heat exposure increasingly threatens the health of pregnant women, foetuses and neonates, especially in low-resource settings. The CHAMNHA project documents the size and nature of these threats, pathways to impacts, and intervention effectiveness in Africa.

METHODS: We assess heat impacts in pregnancy using systematic reviews and statistical modelling of existing data from birth registries and cohorts. These findings, together with multi-component qualitative enquiries will inform co-design and then testing of facility- and community-level interventions.

RESULTS: More than 100 studies on heat exposure in pregnancy were located, demonstrating clear patterns of heat impacts, though methodological and statistical heterogeneity are considerable. Gaps in existing evidence are being addressed in time-series analyses of pregnancy outcomes and breastfeeding patterns in Burkina Faso and South Africa. While in Sweden, birth outcomes in a countrywide population-level database from 2014-2020 are being correlated with 1x1km² grid exposure data. In qualitative research in urban Ouagadougou and rural sites in Burkina Faso and Kenya, pregnant women, male partners and other key informants have described multiple effects of heat on daily activities, and the health and wellbeing of pregnant women and neonates. In Burkina Faso women recounted a range of heat-related symptoms in themselves and their foetus, and obstacles that extreme heat poses to health facility access and care quality. For women in Kenya, heat exposure and water shortages are inextricably linked, and interventions addressing either hazard in isolation may have limited efficacy. Participatory workshops will advance data interpretation and intervention co-design. Interventions at facility-level in Burkina Faso and with



ABSTRACT E-BOOK

community health workers in Kenya will be implemented and evaluated over nine months.

CONCLUSIONS: The project heighten attention of policy makers and funders to the vulnerabilities of pregnant women to heat exposure and climate change, and the need for commensurate responses at multiple levels.

Keywords: Temperature, Female, Maternal health, neonates, time-series analysis



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Climate and Health: From Research to Policy in the Context of EU and Belmont Forum Funded Projects

Chairs: Matthew Chersich, South Africa & Vlatka Matkovic, Belgium

O-SY-050

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

Protection, Resilience, Efficiency and Prevention (PREP), preparing workers and employers for a changing climate

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BACKGROUND AND AIM: Expensive, often inaccessible, treatment, early death, and economic hardship faces millions of workers in Latin America and Asia due to Chronic Kidney Disease of nontraditional cause (CKDnt). Strenuous work in extreme heat without sufficient rest and hydration is an important driver. We established the Adelante Initiative workplace intervention to prevent CKDnt and kidney injury among workers at a sugarcane mill in Nicaragua. The Initiative focused on heat stress mitigation, hydration and rest systems including electrolyte solutions, mobile tents, rest schedules and education, for workers and management, combined with an organizational assessment to address barriers to implementation.

METHODS: PREP builds on Adelante, investigating: 1) impact of the intervention on workforce health and productivity; 2) economic and social impacts of CKDnt 3) economic burden on health systems; 4) public and private-sector policy gaps and solutions.

RESULTS: Workers with the heaviest workload had a 12-fold higher risk (95%CI=3.93-35.4) of kidney injury than those with lower workload in the same environment. Despite implementation challenges at the mill including inconsistent provision of shade, hydration and mandated rest, there was a 72% (95%CI=50-90%) reduction of incident kidney injury post intervention. Economic burden on households and health systems is considerable. Public and private sector policies are either nonexistent or inadequate to provide guidance for prevention, or to support detection and treatment of CKDnt. However, the inclusion of initial investments in technical assistance for workplace protections within the development sector and some industries is encouraging.

CONCLUSIONS: PREP lays the groundwork to expand to other industries and geographies at-risk for heat stress and CKDnt. Occupational heat stress and resulting CKDnt require increased attention and resources for surveillance, prevention and treatment. Climate change means more extreme temperatures in already impacted regions, and regions further north and south of the equator, putting more workers at risk of CKDnt.

Keywords: Temperature extremes and variability, Health co-benefits, Socio-economic factors, Occupational exposures, Exposure assessment-general



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SYMPOSIUM 10

Climate and Health: From Research to Policy in the Context of EU and Belmont Forum Funded Projects

Chairs: Matthew Chersich, South Africa & Vlatka Matkovic, Belgium

O-SY-051

Climate » Temperature

The role of adaptation measures in contrasting heat-related health effects among vulnerable groups: a review from the EXHAUSTION European project

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BACKGROUND AND AIM: The health burden associated with extreme heat depends on population vulnerability, intensity of the exposure and the population's adaptation capacity. A systematic literature review was conducted in Pubmed and Web of Science, between 1990- 2020, to provide evidence on how adaptation interventions may affect heat-related health effects. **METHODS:** Both MeSH and free-text terms were included in the search. Studies were categorized based on the type of intervention: (1)public health response plans; (2)indoor and outdoor thermal environmental interventions (air conditioning and passive cooling, green spaces); (3)behavioral change interventions. Studies were evaluated considering whether they provided direct or indirect evidence of the intervention in terms of changing health-effect estimates.

RESULTS: Of the 58 studies retained, 75% were based in north America and Europe, and the remaining studies were located in Asia or Australia. Only 5 studies (9%) directly assessed the effect of a specific intervention, through an experimental or a quasi-experimental design, while the remaining 53 studies (91%) were indirect evaluations (21 studies compared effect-estimates before-after the evaluation, 25 studies analyzed the effect modification due to presence/absence of the intervention, and 7 with a cross-sectional approach). 24 studies assessed heat plans, 29 evaluated thermal environment interventions and 5 considered behavioral measures.

Although heterogenous, several studies reported a reduction in heat-related mortality\morbidity over time indirectly related to the introduction of heat plans and warning systems especially among the elderly. Studies also assessed differences by socio-economic status and people with chronic disease most at risk during heat waves. Evidence of beneficial effects of green areas and indoor cooling was promising, but inconsistent. Among workers, changes in work clothing such as cooling vests and working in cooled environments improved productivity and reduced health effects.

CONCLUSIONS: The review provides updated evidence on heat response measures and evaluation methods necessary to enhance public health response and drive policy.

Keywords: Temperature extremes and variability, climate, review



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 11

Advancing Racial Health Equity through Studies of the Environment and Epigenetic Aging

Chairs: Jamaji C Nwanaji Enwerem, United States & Kristen Malecki, United States

O-SY-052

Exposome » External exposome

Embracing a “Compound” Exposome Approach to Better Understand Environment and DNA Methylation Age Relationships

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BACKGROUND AND AIM: DNA methylation-based measures of aging remain a promising focus of research because they offer the possibility of detecting adverse changes in human physiology before the onset of clinical disease. This is particularly important in the context of environmental pollutants, because exposure to toxicants can often be intervened upon.

METHODS: In a series of studies using data from male VA Normative Aging Study (NAS) and Mars-500 mission participants, we evaluated relationships of long-term environmental exposures with blood leukocyte measures of DNA methylation age.

RESULTS: In NAS participants, an IQR increase in one-year PM_{2.5} ($\beta = 0.64$ -years, 95%CI: 0.20, 1.09, $P = 0.005$), sulfate ($\beta = 0.51$ -years, 95%CI: 0.28, 0.74, $P < 0.0001$), and ammonium ($\beta = 0.36$ -years, 95%CI: 0.02, 0.70, $P = 0.04$) were associated with increases in DNA methylation age. These relationships were significantly modified by endothelial function variant scores, mitochondrial haplogroups, and miRNA-processing alleles. In Mars-500 participants, mission duration was associated with decreases in DNA methylation aging ($\beta = -5.41$ -years, 95%CI: $-8.70, -2.12$, $P = 0.003$).

CONCLUSIONS: Still, it remains unclear if these relationships apply to all persons. Adopting an exposome approach that facilitates more comprehensive exposure-disease pathway characterizations across domains including the social exposome and neighborhood factors remains an important step to better understanding these and other DNA methylation age relationships with environmental factors. Exposome-centered study designs should also be supported with efforts to increase the recruitment and retention of racially diverse study populations and researchers, and further “compounded” with efforts to improve the use and interpretation of race throughout the publication and dissemination process. Such a “compound” exposome approach expands the ability of research to identify DNA methylation-based aging biomarkers that explicate racial disparities in health. A compound exposome approach also better positions the environmental research community to contribute to the elimination of racial health disparities.



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Keywords: Epigenetic Aging, Exposome, Equity, DNA Methylation Age



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Advancing Racial Health Equity through Studies of the Environment and Epigenetic Aging

Chairs: Jamaji C Nwanaji Enwerem, United States & Kristen Malecki, United States

O-SY-053

Omics Technologies » Epigenomics

Neighborhood deprivation and epigenetic aging

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BACKGROUND AND AIM: Recent research suggests widening socioeconomic disparities in life expectancy in the United States. Both individual-level and small-area socioeconomic status factors, such as living in a socioeconomically disadvantaged neighborhood, are independently associated with early onset of age-related disease, reduced life expectancy and all-cause mortality. Neighborhood deprivation may increase the risk of early onset of age-related disease, reduced life expectancy, and all-cause mortality. Mechanisms linking neighborhood deprivation and age-related disease are multifactorial and complex. Residence in a deprived neighborhood can lead to poor health behaviors, increased toxicant exposures, lack of access to health services, and low social cohesion. Living in a deprived neighborhood can also lead to chronic stress and induce biological weathering on endocrine and inflammatory systems.

METHODS: Emerging evidence suggests epigenetics may be implicated in biological mechanisms underpinning this relationship. DNA methylation is the most well-understood epigenetic factor and involves the addition of a methyl group to DNA, typically at the 5-carbon of cytosine at cytosine-guanine (CpG) dinucleotides. Recently developed 'epigenetic clocks' are a class of biological age predictors that use DNA methylation at predetermined CpG sites to measure biological variation among those with the same chronologic age. These clocks are better at predicting chronologic age than other markers including telomere length and may be a more sensitive measure of biologic aging.

RESULTS: This presentation will focus on recent findings of the association between neighborhood deprivation and epigenetic measures of age acceleration from the Sister Study, a prospective breast cancer cohort study.

CONCLUSIONS: Findings from this study suggest that residing in a neighborhood with higher deprivation is associated with methylation-based markers of aging. African American/Black women in the U.S. may be more likely to live in disadvantaged neighborhoods. Planned research focused on methylation patterns in African American/Black individuals will allow researchers to evaluate how neighborhood disadvantage and methylation changes contribute to health disparities.

Keywords: 'Advancing racial health equity through studies of the environment and epigenetic aging', neighborhood environment, epigenetics, aging



ABSTRACT E-BOOK

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SYMPOSIUM 11

Advancing Racial Health Equity through Studies of the Environment and Epigenetic Aging

Chairs: Jamaji C Nwanaji Enwerem, United States & Kristen Malecki, United States

O-SY-054

Built environment » General

Epigenetic Predictors of Mortality and Neighborhood Disadvantage

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BACKGROUND AND AIM: Neighborhood characteristics are strongly associated with mortality even in geographically restricted urban areas, i.e. within a single city. Accelerated epigenetic aging and mortality risk present a lens through which to quantify impacts of the neighborhood environment on health and wellness. These biomarkers may also be useful indicators of sensitivity to environmental **METHODS:** We examined associations between the built environment and epigenetic biomarkers of aging and mortality risk in an urban, majority Black population of Detroit, MI. Associations were adjusted for relevant confounders, evaluated in sex-stratified models, and examined for alteration by study participant's perception of their neighborhood. We examined greenspace as a possible beneficial neighborhood factor. In separate analyses, we examined if epigenetic aging biomarkers are indicators of sensitivity to air pollution in an urban population of central North Carolina.

RESULTS: We observed significant associations between the built environment in each neighborhood and multiple epigenetic biomarkers of aging. These associations indicated that residence in disadvantaged neighborhoods accelerated the aging process and increased mortality risk. Associations were often stronger amongst women than men and were not impacted by individual neighborhood perception. Greenspace appeared to be a protective factor. In separate analyses, we observed that accelerated epigenetic aging increases health risks from traffic-related air pollution.

CONCLUSIONS: Neighborhood environmental characteristics are determinants of longevity and this may be reflected in aging biomarkers. These biomarkers have the potential to serve as both early indicators of health deterioration and indicators of beneficial environmental interventions, such as increasing greenspace. As these biomarkers may also be indicators of elevated environmental health risks, they may be indicative of relationships between neighborhood environmental factors whereby negative built environmental factors accelerate epigenetic aging thereby increasing both mortality risks and sensitivity to other environmental exposures such as air pollution. This abstract does not necessarily represent EPA policy.

Keywords: built environment, epigenetics, disadvantaged neighborhoods, social determinants of health, epigenetic aging, mortality biomarkers



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 11

Advancing Racial Health Equity through Studies of the Environment and Epigenetic Aging

Chairs: Jamaji C Nwanaji Enwerem, United States & Kristen Malecki, United States

O-SY-055

Omics Technologies » Epigenomics

Nasal DNA Methylation Architecture of the *ACE2* gene and Epigenetic Aging

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BACKGROUND AND AIM: Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has led to the global coronavirus disease 2019 (COVID-19) pandemic. SARS-CoV-2 enters cells via angiotensin-Converting Enzyme 2 (ACE2) receptors, highly expressed in nasal epithelium with parallel high infectivity. The nasal methylome is in direct contact with the environment and might serve as biomarker of COVID-19 disparities by reflecting social and environmental influences on *ACE2* regulation.

METHODS: We collected nasal swabs from anterior nares of 547 children, measured DNA methylation (DNAm) using the Illumina EPIC array, and tested differences at 15 *ACE2* CpGs by sex, age, race/ethnicity and epigenetic age. We hypothesized that sex, age and race would influence DNA methylation of nasal cells serving as proxy for *ACE2* receptors which in turn might be partially influenced by the social and chemical environment.

RESULTS: *ACE2* CpGs were differentially methylated by sex with 12 sites having lower DNAm (mean=12.71%) and 3 sites greater DNAm (mean=1.45%) among females relative to males. We observed differential DNAm at 5 CpGs for Hispanic females (mean absolute difference=3.22%) and lower DNAm at 8 CpGs for Black males (mean absolute difference=1.33%), relative to white participants. Longer DNAm telomere length was associated with greater *ACE2* DNAm at 11 and 13 CpGs among males (mean absolute difference=7.86%) and females (mean absolute difference=8.21%), respectively.

CONCLUSIONS: Nasal *ACE2* DNAm differences could contribute to our understanding COVID-19 severity and disparities reflecting upstream environmental and social influences. Findings need to be confirmed among adults and patients with risk factors for COVID-19 severity.

Keywords: Epigenetics, Disparities, COVID-19



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 11

Advancing Racial Health Equity through Studies of the Environment and Epigenetic Aging

Chairs: Jamaji C Nwanaji Enwerem, United States & Kristen Malecki, United States

O-SY-056

Omics Technologies » Epigenomics

Shift Work, DNA methylation and Epigenetic Age

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BACKGROUND AND AIM: Shift work has been associated with increased risk of age-related morbidity and mortality. Biological age, estimated using DNA methylation, may quantify the biological consequences of shift work on the risk of age-related disease. We examined whether prior employment in shift-working occupations was associated with epigenetic age acceleration.

METHODS: In a sample of non-Hispanic white women ages 35-74 (n=2,574), we measured DNA methylation (DNAm) using the Illumina Infinium Human450 BeadChip and calculated DNAm age using three established epigenetic clocks. Age acceleration metrics were derived by regressing DNAm age on chronological age and predicting the residuals. Using linear regression, we estimated associations between shift work history and age acceleration. We also conducted an epigenome-wide association study (EWAS) using robust linear regression models corrected with false discovery rate (FDR) q-values.

RESULTS: Approximately 7% of women reported any shift work. Higher age acceleration was observed for a one-year increase in overall ($\beta=0.11$, 95% CI: 0.02-0.21) and night-specific shift work ($\beta=0.12$, 95% CI: 0.03-0.21). The association was strongest for ≥ 10 years of night shift work ($\beta=3.16$, 95% CI: 1.17-5.15). From the EWAS, years of overall and night shift work were associated with DNAm at 66 and 85 CpG sites (FDR<0.05), respectively. Years of night shift work was associated with lower methylation of a CpG in the gene body of ZFH3 (cg04994202, q=0.04), a gene related to circadian rhythm.

CONCLUSIONS: Shift work was associated with differential CpG site methylation and with differential DNAm patterns, measured by epigenetic age acceleration, consistent with long-term negative health effects.

Keywords: biomarkers of exposure, epidemiology, molecular epidemiology, socio-economic factors



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 11

Advancing Racial Health Equity through Studies of the Environment and Epigenetic Aging

Chairs: Jamaji C Nwanaji Enwerem, United States & Kristen Malecki, United States

O-SY-057

Omics Technologies » Epigenomics

Neighborhood Disadvantage, Environmental Justice, Mental Well-Being and Epigenetic Markers of Biological Aging Across Urban and Rural Context

Kristen Malecki

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BACKGROUND AND AIM: Recently neighborhood disadvantage research shows increasing evidence for a potential link of altered age-related patterns of between place and health. However, the mechanisms, including mental health and stress are less well understood and, few, if any of these studies integrate chemical pollutants into their assessment of neighborhood disadvantage. As such, it is uncertain the role that environmental exposures may play in exacerbating or mediating these associations. Further, most, if not all studies are examining associations in largely urban environments. The goals of this presentation are to examine how context, race and social determinants intersect to shape mental health, unequal environmental exposures and accelerated biological aging in diverse population.

METHODS: Principal components analyses were used to generate urban and rural specific metrics of residential disadvantage and correlated with land use regression-based air pollution modeled data and drinking water source. Associations with three different epigenetic clocks (e.g. PhenoAge, GrimAge) and epigenome wide association analyses (EWAS) were conducted to identify specific mechanisms by which disadvantage correlates with disadvantage relative to environmental exposures and potential mediation by mental health.

RESULTS: In a region of the United States with extreme historical neighborhood segregation and structural racism, urban metrics of neighborhood disadvantage are highly correlated with air pollution exposures ($p < .001$). In rural context, private well water and filter use are correlated. Neighborhood stress, >3 + experiences of everyday discrimination, current smoking and body mass index are the strongest predictors of accelerated aging ($p < .001$) in univariate analyses. In adjusted analyses, experiences of discrimination are no longer significant.

CONCLUSIONS: More work is needed to better understand urban rural differences in neighborhood disadvantage. Neighborhood perceptions of disadvantage are more predictive of accelerated epigenetic “clocks” than census derived metrics, suggesting that mental health and well-being play important roles in biological aging.

Keywords: Methods, Environmental Justice Omics, Epigenomics



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 12

Public Health Emergency Response During COVID-19 and Beyond: Empowering Epidemiologic Science Through Data Coordination, Funding, Academic Networks, and Implementation Science

Chairs: Richard Kwok, United States & Aubrey Miller, United States

O-SY-058

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

NIH DR2: Facilitating Harmonization of COVID-19 Epidemiologic Research Through the Availability of Research Tools and Common Measures

Richard Kwok, Aubrey Miller

National Institute of Environmental Health Sciences (NIEHS), North Carolina, USA

BACKGROUND AND AIM: The National Institute of Health's (NIH) Public Health Emergency and Disaster Research Response (DR2) Program leads the nation in building the research infrastructure for executing timely and complex studies that respond to disasters and emerging threats to public health.

METHODS: The NIH's response to the COVID-19 crises include innovative large-scale efforts to promote critical epidemiologic research through a multifaceted approach that includes: leveraging extramural research centers, networks, and ongoing studies to access study populations; providing targeted funding opportunities; promoting common data measures to facilitate data harmonization and integration that includes creating data warehouses of select research areas. Research conducted in the wake of a disaster can provide information to help mitigate health consequences, support future recovery efforts, and improve resilience.

RESULTS: The NIH Disaster Research Response (DR2) program was created to better position research in the midst of disaster response scenarios. With the recent COVID-19 pandemic, the DR2 program served as a central repository for new instruments, protocols and tools that were developed specifically to address this disaster.

CONCLUSIONS: The efforts of the NIH DR2 Program, which provides a suite of resources, including data collection tools, research protocols, institutional review board guidance, and training materials will help improve the timeliness, quality, and value of future disaster-related data collection and research studies.

Keywords: The National Institute of Health's (NIH) Public Health Emergency, Disaster Research Response (DR2), COVID-19



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 12

Public Health Emergency Response During COVID-19 and Beyond: Empowering Epidemiologic Science Through Data Coordination, Funding, Academic Networks, and Implementation Science

Chairs: Richard Kwok, United States & Aubrey Miller, United States

O-SY-059

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

Leveraging the Fire Fighter Cancer Cohort Study: Evaluating the association of PFAS exposures with COVID-19 symptoms and antibody response

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University of Arizona, Tucson, Arizona, United States

BACKGROUND AND AIM: Exposure to per- or polyfluoroalkyl substances (PFAS) is associated with reduced immune response, but its effect on COVID-19 is not well understood.

METHODS: Firefighters are occupationally exposed to PFAS from use of certain class B aqueous film-forming foams and other sources, and also have frequent occupational exposures to the SARS-CoV-2 virus. Supported by a time-sensitive R21 grant from the National Institute of Environmental Health Sciences (NIEHS), the current study builds on the Fire Fighter Cancer Cohort Study, a prospective multicenter cohort study.

RESULTS: Within the cohort, firefighters from two fire departments with mean serum levels of two PFAS compounds higher than the national average were identified and offered participation in the PFAS and COVID-19 study.

CONCLUSIONS: At study completion, we will have documented the effects of PFAS exposure on COVID-19 symptom severity in a highly exposed population, as well as effects of PFAS exposure on the subsequent immune response persistence.

Keywords: per- or polyfluoroalkyl substances (PFAS), COVID-19, immune response



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 12

Public Health Emergency Response During COVID-19 and Beyond: Empowering Epidemiologic Science Through Data Coordination, Funding, Academic Networks, and Implementation Science

Chairs: Richard Kwok, United States & Aubrey Miller, United States

O-SY-060

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

COVID-19 Testing for Underserved and Vulnerable Populations: The NIH Rapid Acceleration Of Diagnostics (RADx) Initiative, Experiences from the field

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³Department of Biochemistry and Molecular Medicine

BACKGROUND AND AIM: Disparities in COVID-19 are stark: in California, incidence and mortality rates in Hispanics range from 50% higher to triple those of non-Hispanic whites. In fall, 2020, the US National Institutes of Health funded existing Centers to address these gaps domestically, under the RADx-UP program (Rapid Acceleration of Diagnostics for Underserved Populations), which focuses on COVID testing in underserved or vulnerable communities. In collaboration with community organizations, our aim is to overcome barriers to testing among Hispanics in four California counties, increase testing, and reduce viral spread.

METHODS: Community members identified barriers and strategies were devised to address them. The UC Davis RADx-UP team deployed mobile COVID antigen test sites, targeting predominantly Hispanic areas in the California central valley. All tests are free, drop-ins are welcome, and no health insurance information is collected, addressing economic, internet, and uninsured status barriers. A majority bilingual UCD staff and members of trusted community organizations open testing on weekends and evenings, when most test sites are closed. The rapid antigen test provides results within 15 minutes, which vastly increases potential to curtail asymptomatic spread by the recent contacts of an individual who tests positive. We also provide public health education, post-test counselling, and referrals for services.

RESULTS: During ramp-up we conducted 744 tests, with 82% Hispanic, 53% females, and a mean age of 39, range: 1 to 89. Current positivity rate is 4.6%, with one-fourth being asymptomatic. On two occasions, one person tested positive and called family and friends who showed up to be tested, thereby identifying clusters of cases. We are also partnering with vaccine providers and encouraging vaccine uptake.

CONCLUSIONS: Targeted testing and education is expected to help narrow the disparities in COVID-19 incidence and mortality. With the vaccine roll-out, continued efforts will strive to reduce the disproportionate casualties among Hispanics.

Keywords: Disaster response, health disparities, community partnerships



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 12

Public Health Emergency Response During COVID-19 and Beyond: Empowering Epidemiologic Science Through Data Coordination, Funding, Academic Networks, and Implementation Science

Chairs: Richard Kwok, United States & Aubrey Miller, United States

O-SY-061

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

The NIEHS DR2 Network: Addressing COVID-19 Environmental Health Issues Through a Multi-Institution Academic Community of Practice

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¹University of Kentucky

²University of Washington

BACKGROUND AND AIM: The National Institute of Environmental Health Sciences (NIEHS) Disaster Response Research (DR2) Network is a network of collaborative investigators across the United States representing multiple NIEHS funded centers and programs with expertise in disaster response science. The network was established to advance the field of DR2 by promoting the coordinated, ethical, and timely collection, analysis, and dissemination of environmental health research following a disaster or other extreme event.

METHODS: The Network rapidly developed a COVID-19 SARS-CoV-2 Environmental Health Research Agenda. Using a modified Delphi approach, the Network rapidly convened 26 subject matter experts to identify 28 environmental health sciences research priorities. The Network also brought together environmental health sciences researchers and NIEHS staff through monthly meetings to share information and provide feedback on data collection protocols and assessment tools. With the need for rapid dissemination of COVID-19 research data, the DR2 Network organized a virtual symposium for investigators to share their ongoing research to advance environmental health science related to COVID-19.

RESULTS: The Network has identified 28 COVID-19 environmental health science research priorities. The Symposium provided an outlet and dissemination mechanism for the state of the science on: routes of transmission and exposure mitigation; mental health impacts on workers; addressing COVID-19 challenges with community partners; and environmental justice.

CONCLUSIONS: The Network is an effective collaboration among investigators from across the US representing multiple NIEHS funded centers and programs which as able to provide timely feedback on COVID-19 protocols, identify and environmental health science research agenda, and rapidly assemble a virtual platform for sharing ongoing research.

Keywords: Natural disasters, community outreach, environmental justice



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 12

Public Health Emergency Response During COVID-19 and Beyond: Empowering Epidemiologic Science Through Data Coordination, Funding, Academic Networks, and Implementation Science

Chairs: Richard Kwok, United States & Aubrey Miller, United States

O-SY-062

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

Implementation challenges of a climate-disease monitoring system in the Amazon

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BACKGROUND AND AIM: Implementation science (IS) has emerged as an important approach to achieving scale-up and policy adoption of evidence-based research. The majority of IS approaches have been in non-environmentally driven applications, such as HIV, cervical cancer, and nutrition. The use of environmental data in disease monitoring remains limited and has yet to be fully integrated into surveillance and stakeholder decision-making.

METHODS: In this presentation, we highlight the unique aspects of using climate and environmental data in an implementation science framework by drawing on challenges we have encountered in the development of a malaria early warning system (MEWS) for the Amazon that was validated in Peru.

RESULTS: Although the MEWS achieved >90% sensitivity and >90% specificity in predicting malaria outbreaks 8-12 weeks in advance, the challenges to implementation have been difficult to overcome, particularly the non-traditional use of environmental data in disease surveillance.

CONCLUSIONS: We will present the methods used to develop the system, which includes the development of a hydrometeorological model to produce high-resolution estimates of over 20 environmental variables related to malaria transmission, a population at risk model, and data synthesis of community-level weekly malaria surveillance with human and environmental data. We will also present the major challenges we have faced in the implementation of this project and outline recommendations for other climate-related health applications to achieve implementation goals.

Keywords: malaria early warning system (MEWS), Implementation science (IS), climate-disease monitoring system



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 13

The Dual Bottom Line: Case Studies of the Health and Climate Benefits of Active Mobility

Chairs: Matthew Raifman, United States & Patrick Kinney, United States

O-SY-063

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

Health impacts of electric micro-mobility transitions in Barcelona: a scenario analysis

Ines Lopez Doriga¹, Guillem Vich¹, Sarah Koch¹, Oriol Marquet², Carolyn Daher¹, Carme Miralles², Mark Nieuwenhuijsen¹, Natalie Mueller¹

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BACKGROUND AND AIM: Mobility in cities is changing with the appearance of new, electric (e-) micro-mobilities, such as e-scooters, e-motorcycles and e-bikes. The shared use of these vehicles is increasingly becoming popular as it enables users to have easy, individual, short-duration access to transport without the burdens of ownership. Given the foreseen long-term increase in micro-mobilities and the link between transport and health, it is relevant to understand the health implications of these new, often-shared, personal e-mobility vehicles (PMVs).

METHODS: We conducted a health impact assessment study, using transport statistics and NewMob data, a project studying the fundamentals of micro-mobility use related to user profile, environmental and social impacts in Barcelona, Spain. We applied the comparative risk assessment framework to study the impacts of these new e-PMVs on health in Barcelona. Specifically, through two scenarios, assuming a long-term 5% and 10% increase in e-PMVs, we modelled the change in exposure to physical activity, air pollution and traffic hazards for users switching from conventional modes of transport and estimated the preventable premature mortality and mental health burden.

RESULTS: We found that with the uptake of these new forms of e-PMVs related increases in physical activity resulted in 12 (95% CI: 9-17) and 24 (95% CI: 17-34) premature deaths avoidable each year for the 5% and 10% e-PMV increase scenario, respectively, most likely outweighing risks associated with user exposure to air pollution and traffic hazards.

CONCLUSIONS: Long-term increase in uptake of e-PMVs is expected in cities and these forms of mobility can provide considerable health benefits, especially through increases in physical activity. Moreover, e-PMVs can additionally create common good by providing affordable access to all, high maintenance and safety standards, and the overall reduction of car vehicle fleets and associated adverse externalities, such as air and noise pollution and public space uptake.

Keywords: air pollution, health impact assessment, mental health, mortality, electric personal mobility vehicle, physical activity



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 13

The Dual Bottom Line: Case Studies of the Health and Climate Benefits of Active Mobility

Chairs: Matthew Raifman, United States & Patrick Kinney, United States

O-SY-064

Policy » Policy research

Mortality Implications of Increased Active Mobility for a Proposed Regional Transportation Emission Cap-and-Invest Program

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²Harvard T.H. Chan School of Public Health, Boston, MA, USA

BACKGROUND AND AIM: The transportation sector is now the primary contributor to greenhouse gas emissions in the USA. The Transportation Climate Initiative (TCI), a partnership of 12 states and the District of Columbia currently under development, would implement a cap-and-invest program to reduce transportation sector emissions across the Northeast and Mid-Atlantic region, including substantial investment in cycling and pedestrian infrastructure. The health impacts from investing in active mobility could be substantial.

METHODS: Using outputs from an investment scenario model and the World Health Organization Health Economic Assessment Tool methodology, we estimate the mortality implications of increased active mobility and their monetized value for three different investment allocation scenarios considered by policymakers. We conduct these analyses for all 378 counties in the region, accounting for potential increased traffic fatalities.

RESULTS: We find that even for the scenario with the smallest investment in active mobility, when it is fully implemented, the Transportation Climate Initiative could result in hundreds of fewer deaths per year across the region, with monetized benefits in the billions of dollars annually. Under all scenarios considered, the monetized benefits from deaths avoided substantially exceed the direct infrastructure costs of investment. These potential mortality benefits are like to be highly concentrated in urban areas.

CONCLUSIONS: We conclude that investing proceeds in active mobility infrastructure is a cost-effective way of reducing mortality, especially in urban areas, providing a strong motivation for investment in modernization of the transportation system and further evidence of the health co-benefits of climate action.

Keywords: physical activity, transportation, active mobility, urban policy



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 13

The Dual Bottom Line: Case Studies of the Health and Climate Benefits of Active Mobility

Chairs: Matthew Raifman, United States & Patrick Kinney, United States

O-SY-065

Air pollution » Traffic-related

The effect of super-sized passenger vehicles on walking and cycling

Alistair Woodward, Kirsty Wild

University of Auckland, New Zealand

BACKGROUND AND AIM: Passenger vehicles are putting on weight world-wide. We aim to estimate the effects of this trend on the safety and attractiveness of walking and cycling in cities, focussing especially on the spectacular rise of the light truck (known as a double cab ute in New Zealand).

METHODS: Review of relevant literature, analysis of secondary data sets including new vehicle sales, the New Zealand Household Travel Survey and manufacturer data sheets, police crash data, thematic analysis of advertising and product promotion, ad hoc roadside survey.

RESULTS: Light truck and SUV sales are increasing rapidly in most countries. Mostly these vehicles are promoted for carrying, towing and exploring off road. Travel surveys show that in fact most trips are not work-related and do not require special towing and carrying capacity. On the whole these vehicles seldom go off-road but are commonly used in cities for car-like trips, with higher emissions of NO_x and CO₂. With increasing mass and power, injury rates amongst occupants are falling, but the risk to other road users may be increasing: a pedestrian struck at ≥ 50 kph by a ute or SUV in New Zealand is 2.3 times more likely to be fatally injured than if struck by a car. The most popular ute in New Zealand (the Ford Ranger) occupies 30% more road space than the most popular car, and therefore more commonly obstructs footpaths and bike lanes and leaves a smaller gap when passing on narrow city streets.

CONCLUSIONS: Passenger vehicles in New Zealand and many other countries are super-sizing: increased pollution, greater injury risk, and domination of road space make it even more difficult to promote walking and cycling in cities.

Keywords: active transport, physical activity, injury



ABSTRACT E-BOOK

August 24, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 13

The Dual Bottom Line: Case Studies of the Health and Climate Benefits of Active Mobility

Chairs: Matthew Raifman, United States & Patrick Kinney, United States

O-SY-066

Built environment » General

Early results from Te Ara Mua Future Streets: an equity-focused active travel intervention study

Alexandra Kathryn Macmillan

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BACKGROUND AND AIM: A growing body of evidence supports the hypothesis that a just, healthy response to climate change will require a shift from car use to walking, cycling and zero carbon public transport. Further, that to achieve this, investments in safe, attractive street changes are needed, alongside a range of regulatory policies to constrain motor vehicle freedoms. Most of the previous research has focused on inner city urban environments in a limited number of cultural/colonial contexts, with a dearth of research in suburban environments and very little focus on social and health equity by income and ethnicity. *Te Ara Mua Future Streets* aims to address this gap.

METHODS: *Te Ara Mua Future Streets* is a controlled before-after intervention study of suburban street changes for walking, cycling and place-making, in a community who have long experienced health-harming transport and urban planning injustices. The intervention was co-designed between the research team, community representatives and the regional transport agency. It included footpath improvements, changes to parks, cycling infrastructure, lighting and place-making elements linked to the cultural wellbeing and history of the indigenous Maori subtribes with historical connection to the area. A series of before and after measures aim to assess changes in a wide range of health and social outcomes, as well as greenhouse gas emissions

RESULTS: I will present results from the early follow-up measures, including analyses relating to actual and perceived safety, mode shift and social perceptions. These will be placed in the context of public and political discourse about the project and active travel infrastructure.

CONCLUSIONS: The results, when put together with the dominant politics and economics of transport raise important questions for epidemiologists with an interest in urban change-making in response to health, equity and climate imperatives, particularly in neoliberal colonial contexts.

Keywords: active travel, health and social equity, climate change, built environment, cities



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 14

Innovative Methods for Identifying Perinatal Critical Windows with Mixtures

Chairs: Ander Wilson, United States & Marianthi-Anna Kioumourtzoglou, United States

O-SY-067

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

Critical Windows of Exposure: why do they exist and what do they tell us?

Robert O. Wright

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BACKGROUND AND AIM: This is part of symposium 22 entitled “Innovative Methods for Identifying Perinatal Critical Windows with Mixtures”

The concept of critical exposure windows is often equated with developmental origins of disease, although the concept is found in multiple disciplines such as cognitive sciences i.e. language development. In reality, critical exposure windows are the intersection of developmental biology and exposure science, in which time varying environments coincide with age varying biological development.

METHODS: When time dependent environment and age dependent biological processes intersect, they create dose response curves that differ in slope uniquely from the slopes derived at other life stages. Critical exposure windows inform mechanisms as discovering them provides insights to both the biological effects of an environmental exposure and the complex age dependent processes that are being modified by that exposure.

RESULTS: With regards to mixtures, consideration should also be given to the biological matrix in which exposures are measured, as the half lives and rates of excretions for different exposures vary in blood and urine and other tissues, creating potential biases in results. Variations of even a few months in exposure timing may also introduce bias if the life stage reflects accelerated growth and development (i.e. fetal life).

CONCLUSIONS: Finally, from a public health perspective, knowing critical exposure windows means knowing when to intervene and has benefits to creating targeted interventions that are both more effective and more cost efficient. In this talk, we will discuss these issues and the developmental biology principles that underlie these phenomena, while also considering how time varying phenotype expression affects results.

Keywords: critical windows, developmental biology, exposure timing, bias



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 14

Innovative Methods for Identifying Perinatal Critical Windows with Mixtures

Chairs: Ander Wilson, United States & Marianthi-Anna Kioumourtzoglou, United States

O-SY-068

Methods » Modeling

Bayesian Kernel Machine Regression Distributed Lag Models

Ander Wilson¹, Hsiao Hsien Leon Hsu², Yueh Hsiu Mathilda Chiu², Robert O Wright², Rosalind J Wright², Brent A Coull³

¹Colorado State University

²Icahn School of Medicine at Mount Sinai

³Harvard T. H. Chan School of Public Health

BACKGROUND AND AIM: Exposures to environmental chemicals during gestation can alter health status later in life. Most studies of maternal exposure to chemicals during pregnancy focus on a single chemical exposure observed at high temporal resolution. Recent research has turned to focus on exposure to mixtures of multiple chemicals, generally observed at a single time point. We consider statistical methods for analyzing data on chemical mixtures that are observed at high temporal resolution.

METHODS: We propose a novel method, Bayesian kernel machine regression distributed lag model (BKMR-DLM), that simultaneously accounts for nonlinear associations and interactions among time-varying measures of exposure to mixtures. BKMR-DLM uses a functional weight for each exposure that parameterizes the window of susceptibility corresponding to that exposure within a kernel machine framework that captures non-linear and interaction effects of the multivariate exposure on the outcome.

RESULTS: In a simulation, we show that the proposed method can better estimate the exposure-response function and, in high signal settings, can identify critical windows in time during which exposure has an increased association with the outcome. Applying the proposed methods to data from a birth cohort, we found evidence of a negative association between OC and birth weight and that nitrate modifies the OC, EC, and sulfate exposure-response functions.

CONCLUSIONS: BKMR-DLM can estimate nonlinear association and higher-order interactions between repeated measures of exposure to a chemical mixture. It can be used to identify critical windows to components of a mixture.

Keywords: Air pollution, Birth outcomes, Mixtures, Modeling, Pregnancy outcomes



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 14

Innovative Methods for Identifying Perinatal Critical Windows with Mixtures

Chairs: Ander Wilson, United States & Marianthi-Anna Kioumourtzoglou, United States

O-SY-069

Methods » Modeling

Bayesian distributed lag interaction models using spike and slab priors

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BACKGROUND AND AIM: Distributed lag models are useful in environmental epidemiology as they allow us to investigate the time periods at which exposure to a pollutant adversely affects health outcomes. Recent studies have focused on estimating the health effects of a large number of environmental exposures on health outcomes. It is important to understand which of these environmental exposures affect a particular outcome, while simultaneously understanding the time periods that are most associated with changes in an outcome.

METHODS: We propose a Bayesian model to estimate the temporal effects of a large number of exposures on an outcome. We utilize spike and slab priors to identify which exposures affect the outcome, and semiparametric functions to estimate the distributed lag curves for exposures that affect the outcome. Further, we allow for interactions between all of the exposures, again using spike and slab priors to identify important interactions.

RESULTS: We find that the proposed methodology is able to flexibly estimate distributed lag surfaces while simultaneously selecting which exposures are associated with an outcome. A modification to the prior distribution is able to increase the power to detect important exposures while ensuring that false discovery rates are not overly inflated.

CONCLUSIONS: We apply our proposed methodology to a study of the effects of a mixture of air pollutants on birth weight and find that a subset of the exposures, which includes temperature and PM_{2.5}, have a negative association with birth weight.

Keywords: Distributed lag models, Bayesian inference, exposure selection, air pollution



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 14

Innovative Methods for Identifying Perinatal Critical Windows with Mixtures

Chairs: Ander Wilson, United States & Marianthi-Anna Kioumourtzoglou, United States

O-SY-070

Methods » Environmental epidemiology

Estimating Perinatal Critical Windows to Environmental Mixtures via Structured Bayesian Regression Tree Pairs

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BACKGROUND AND AIM: Maternal exposure to environmental chemicals during pregnancy can alter birth and children's health outcomes. Research seeks to identify critical windows, time periods when exposures can change future health outcomes, and estimate the exposure-response relationship. Existing statistical approaches that allow for high temporal resolution (e.g. weekly throughout pregnancy) exposure measurements primarily account for a single environmental chemical. Extending to multiple chemicals observed at high temporal resolution poses a dimensionality problem and statistical methods are lacking.

METHODS: We propose a regression tree-based model for mixtures of exposures observed at high temporal resolution. The proposed approach uses an additive ensemble of tree pairs that define structured main effects and interactions between time-resolved predictors and performs variable selection. In simulation, we show the tree-based approach performs better than existing methods for a single exposure and can accurately estimate critical windows in the exposure-response relation for mixtures. Software is made available in the R package `dlmtree`.

RESULTS: We apply our method to estimate the relationship between five exposures measured weekly throughout pregnancy and resulting birth weight in a Denver, Colorado birth cohort. We identified critical windows during which fine particulate matter (PM_{2.5}), sulfur dioxide, and temperature are negatively associated with birth weight and an interaction between PM_{2.5} and temperature.

CONCLUSIONS: In this work we proposed a method to estimate the association between mixtures of environmental exposures observed at high-temporal resolution on birth and children's health outcomes. Our analysis is the first analysis to identify critical windows to a mixture observed at high-temporal resolution within a distributed lag mixture model framework. As the size and resolution of the exposure data available continues to grow, our method fills a critical research gap in statistical methods for epidemiology and environmental health in being able to estimate the effects of time-resolved measures of a mixture on a continuous or binary health outcome.

Keywords: air pollution, Bayesian additive regression trees, birth outcomes, critical windows, distributed lag models



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 14

Innovative Methods for Identifying Perinatal Critical Windows with Mixtures

Chairs: Ander Wilson, United States & Marianthi-Anna Kioumourtzoglou, United States

O-SY-071

Methods » Environmental epidemiology

Critical Window Variable Selection for Mixtures: Estimating the Impact of Multiple Air Pollutants on Stillbirth

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BACKGROUND AND AIM: Understanding the role of time-varying pollution mixtures on human health is critical as people are simultaneously exposed to multiple pollutants during their lives. For vulnerable sub-populations who have well-defined exposure periods (e.g., pregnant women), questions regarding critical windows of exposure to these mixtures are important for mitigating harm. **METHODS:** We extend Critical Window Variable Selection (CWVS) to the multipollutant setting by introducing CWVS for Mixtures (CWVSmix), a hierarchical Bayesian method that combines smoothed variable selection and temporally correlated weight parameters to (i) identify critical windows of exposure to mixtures of time-varying pollutants, (ii) estimate the time-varying relative importance of each individual pollutant and their first order interactions within the mixture, and (iii) quantify the impact of the mixtures on health.

RESULTS: Through simulation study, we show that CWVSmix outperforms competing methods in each of these categories. We use these approaches to investigate the impact of exposure to multiple gas and particulate ambient air pollutants on the risk of stillbirth in New Jersey, 2005-2014. We find consistent elevated risk in gestational weeks 2, 16-17, and 20 for non-Hispanic Black mothers, with pollution mixtures dominated by ammonium (weeks 2, 17, 20), nitrate (weeks 2, 17), nitrogen oxides (weeks 2, 16), PM_{2.5} (week 2), and sulfate (week 20).

CONCLUSIONS: CWVSmix is a useful tool for quantifying the impact of time-varying mixtures on health when there is interest in identifying critical windows of exposure. The method is available in the R package CWVSmix (<https://github.com/warrenjl/CWVSmix>).

Keywords: Bayesian variable selection, Correlated weights, Pollution mixtures, Reproductive health.



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 14

Innovative Methods for Identifying Perinatal Critical Windows with Mixtures

Chairs: Ander Wilson, United States & Marianthi-Anna Kioumourtzoglou, United States

O-SY-072

Methods » Environmental epidemiology

Lagged Weighted Quantile Sum Regression

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BACKGROUND AND AIM: We aim to develop a method for identifying critical exposure windows relating exposure to environmental mixtures and health outcomes that may differ by subject characteristics (e.g., sex). We extend weighted quantile sum (WQS) regression with its variations (e.g., stratified interaction WQS regression) to a lagged version that accommodates heterogeneous exposure times for each subject.

METHODS: Briefly, time-specific weights are estimated and the weighted index calculated (i.e., $WQS(t)$) across the time frame with at least moderate sample sizes. Then a reverse distributed lagged model (rDLM) is similarly parameterized and estimated using a nonlinear mixed model. The rDLM allows for different exposure times per subject while correcting for within-subject correlated observations. Critical windows are identified where the family-wise confidence intervals for the association parameter(s) exclude zero.

RESULTS: The approach is illustrated using perinatal exposures measured in shed teeth with later life health effects in a lagged stratified interaction WQS model.

CONCLUSIONS: Identifying environmental chemicals of concern in critical exposure windows, that may vary by subject characteristics, may be useful in intervention strategies to protect public health.

Keywords: chemical exposures, mixtures, critical windows



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Times Square Hall (Hall 3)

SYMPOSIUM 15

Pathways to Healthy and More Equitable Cities: Results from Vancouver, London, Accra, and Beijing

Chairs: Jill Baumgartner, Canada & Raphael Arku, United States

O-SY-073

Exposures » Environmental disparities

Spatial modelling and inequalities in community noise in Accra, Ghana

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BACKGROUND AND AIM: Noise pollution is a growing environmental health concern in rapidly urbanising sub-Saharan African (SSA) cities. Yet mapping levels and variations of environmental noise in SSA cities has been scarce.

METHODS: We measured outdoor sound levels at 146 locations in a city-wide measurement campaign from April 2019 to June 2020 with combined yearlong and weeklong measurements. We used these data together with geospatial predictors to develop land use regression models to estimate noise pollution metrics across the Greater Accra Metropolitan Area (GAMA, 1500 km²), Ghana. Predictor variables included land use, road networks, locations of human activity and the airport, population and building density, and vegetation. We selected the final parsimonious models through a stepwise procedure. We used separate day and night-time models to estimate equivalent continuous sound levels (LAeq1hr (dBA)) for each hour of the day. As a secondary analysis, we modelled a metric which represents sound intermittency (intermittency ratio, % of sound energy from events). We overlaid model predictions with census data to estimate population levels of, and potential area-level socioeconomic inequalities in, noise levels in Accra Metropolis at the census enumeration-area level.

RESULTS: Variables representing road-traffic and vegetation explained the most variation in noise levels and intermittency. Predicted day-evening-night (Lden) noise levels were highest in the city-core (median: 64 dBA) and near major roads (median: 68 dBA). In the more urbanised Accra Metropolis, 99% of the population lived in areas with average Lden and night-time noise (Lnight) that surpassed international guidelines for road-traffic noise (Lden <53; Lnight <45). The poorest areas in Accra also had significantly higher median Lden and Lnight compared with the wealthiest ones, at a difference of 3 dBA.



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Health, New York, US



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CONCLUSIONS: Considering that outdoor noise levels surpassed international health-based guidelines almost everywhere in the GAMA, noise management and control should be prioritised in the city.

Keywords: Noise, Traffic-related, Exposure assessment, Spatial statistics, Socio-economic factors



ABSTRACT E-BOOK

August 24, 2021 / 19:00 - 20:30 / Times Square Hall (Hall 3)

SYMPOSIUM 15

Pathways to Healthy and More Equitable Cities: Results from Vancouver, London, Accra, and Beijing

Chairs: Jill Baumgartner, Canada & Raphael Arku, United States

O-SY-074

Built environment » General

Identifying vulnerable urban neighbourhoods and their environmental, density, and housing characteristics in Accra, Ghana using census and remote sensing data

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BACKGROUND AND AIM: Identifying vulnerable urban communities, commonly known as slums, can facilitate targeted policies to reduce urban economic and social inequities in cities, but these data are rarely available. We aimed to identify vulnerable urban neighbourhoods and their environmental and housing characteristics in Accra, Ghana using available training data on the city center (Accra Metropolitan Area - AMA) applied to the Greater Accra Metropolitan Area (GAMA).

METHODS: We accessed the following enumeration area (EA)-level data for Greater Accra: slum classification available for a subset of 2,418 EAs in the AMA from the Accra Metropolitan Assembly and UN-Habitat 2011 report; housing conditions from the most recent Ghana Census (2010); and environmental quality attributes from remote sensing data provided by the United States Geological Survey and National Aeronautics and Space Administration. We fitted a Bayesian logistic regression model to evaluate associations between housing, density, and environmental attributes with vulnerable area classification of EAs in the AMA. We then applied the model to predict the probability of each urban EA in GAMA as being vulnerable.

RESULTS: We estimated that approximately one-fifth of EAs in the GAMA had a vulnerable area probability greater than 80%, corresponding to a population of 752,367 likely living in suboptimal conditions. The variables associated with a higher probability of an EA being vulnerable included greater use of public toilet facilities [OR: 3.51 (95% credible interval (CI): 1.55,7.53)], higher population density [OR: 5.72 (95% CI: 3.85,8.65)], lower use of improved wall materials [OR: 0.11 (95% CI: 0.03,0.43)], lower elevation [OR: 0.45 (95% CI: 0.35, 0.58)], lower use of indoor piping as a drinking water source [OR: 0.50 (95% CI: 0.25,0.99)], and lower vegetation abundance [OR: 0.25 (95% CI: 0.16,0.39)].

CONCLUSIONS: Our approach can be used in future studies to identify geographic clusters of vulnerable areas where interventions are warranted to improve housing and environmental conditions.

Keywords: Built environment, Socio-economic factors, Epidemiology



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SYMPOSIUM 15

Pathways to Healthy and More Equitable Cities: Results from Vancouver, London, Accra, and Beijing

Chairs: Jill Baumgartner, Canada & Raphael Arku, United States

O-SY-075

Outcomes » Mortality

The change in life expectancy inequality in London

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BACKGROUND AND AIM: Gains in life expectancy in England have stalled, and even decreased in some regions for females, over the past decade. However, the London region has been resilient to these decreases, although city-wide estimates fail to capture the socioeconomic and environmental inequalities present in London at short distances.

METHODS: We estimated mortality for small areas (1000-3000 people) in London from 2002-2018 using a Bayesian hierarchical model.

RESULTS: Life expectancy in the poorest areas in London experienced a slowdown from 2010, whilst progress was unimpeded for more affluent areas. Inequality within London districts increased over the study period.

CONCLUSIONS: These estimates reveal stark (and widening) life expectancy inequalities for both sexes within London and within London districts.

Keywords: Mortality, Modeling



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SYMPOSIUM 15

Pathways to Healthy and More Equitable Cities: Results from Vancouver, London, Accra, and Beijing

Chairs: Jill Baumgartner, Canada & Raphael Arku, United States

O-SY-076

Outcomes » Mortality

Geographic variation of life expectancy and all-cause mortality in Beijing

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BACKGROUND AND AIM: Life expectancy may vary substantially within Beijing, a globalized city with highly heterogeneous physical and social environment. Small-area analysis helps reveal geographical variation. We aim to investigate geographic variation of life expectancy and all-cause mortality at the township level in Beijing.

METHODS: All cause death counts in 2017 and 2018 by 5-year age group, sex and township were obtained from Beijing Center for Disease Control and Prevention. Population data for each township were from Beijing statistical yearbook, with weights for age and sex obtained from district-level population. We used a Bayesian spatial models to estimate age-specific mortality and life expectancy for 309 townships in Beijing, separately for men and women.

RESULTS: The median of age-standardized all-cause mortality at township level was 445.3/10 0000 (interquartile range [IQR], 217.5/10 0000) for men and 329.5/10 0000 (IQR, 186.3/10 0000) for women in Beijing in 2017-2018. The relative geographic gap defined as 80th-to-20th percentile ratio of mortality was higher in women than in men (2.0 vs. 1.8). Townships with high mortality were primarily found in the northern and southwestern outskirts for both genders. The median of township life expectancies at birth in Beijing was 80.6 years (95% credible interval [CrI]: 79.1–82.0) for men and 85.3 years (CrI: 82.7–87.9) for women. The inequality across townships, measured as the difference between the 20th and 80th percentiles of township life expectancies, was 8.5 years for men and 8.8 years for women, respectively. The geographic pattern of life expectancy was similar in men and women and townships with high life expectancy were concentrated in central urban areas for both genders.

CONCLUSIONS: Life expectancy and all-cause mortality varied substantially across townships in Beijing. Studies by small area may aid the development of local policies to reduce health inequalities.

Keywords: Life expectancy, Health inequalities, Bayesian spatial analysis, Small-area analysis



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SYMPOSIUM 15

Pathways to Healthy and More Equitable Cities: Results from Vancouver, London, Accra, and Beijing

Chairs: Jill Baumgartner, Canada & Raphael Arku, United States

O-SY-077

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

Quantifying within-city inequalities in child mortality across neighbourhoods in Accra, Ghana

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BACKGROUND AND AIM: Countries in sub-Saharan Africa suffer the highest rates of child mortality worldwide. Urban areas tend to have lower mortality than rural areas, but these comparisons likely mask large within-city inequalities. We aimed to quantify variation in child mortality across neighbourhoods of Accra – Ghana’s capital city.

METHODS: We accessed data on >700,000 women aged 25-49 years living in the Greater Accra Metropolitan Area (GAMA) using the most recent Ghana census (2010). We summarised counts of child births and deaths by five-year age group of women and neighbourhood (n=406) and applied indirect demographic methods to convert the summaries to yearly probabilities of death under-five years of age. We fitted a Bayesian spatio-temporal model to the neighbourhood child mortality probabilities to obtain estimates for 2010, and examined the correlation with indicators of neighbourhood environmental and socio-economic conditions.

RESULTS: Child mortality varied almost five-fold across neighbourhoods in the GAMA in 2010, ranging from 28 (95% credible interval (CrI): 8-63) to 138 (95% CrI: 111-167) deaths per 1000 live births. Child mortality was highest in the urban core and industrial districts, with a neighbourhood average of 95 deaths per 1000 live births. Peri-urban neighbourhoods performed better, on average, but had greater within-district variation (up to 3.8-fold). Child mortality was negatively correlated with multiple



ABSTRACT E-BOOK

indicators of improved living and socio-economic conditions among peri-urban neighbourhoods. Among urban neighbourhoods however, correlations were weaker or in some cases reversed, including with neighbourhood median household consumption and levels of women's schooling.

CONCLUSIONS: We found substantial child mortality inequalities between and within GAMA's districts and identified urban neighbourhoods being left behind in child mortality reductions. Improved neighbourhood environmental and socioeconomic conditions in the inner city did not correspond to lower levels of child mortality. Universal access to quality healthcare services can mitigate mortality inequalities where children are born into different circumstances.

Keywords: Mortality, Children's environmental health, Spatial statistics, International collaboration



ABSTRACT E-BOOK

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SYMPOSIUM 15

Pathways to Healthy and More Equitable Cities: Results from Vancouver, London, Accra, and Beijing

Chairs: Jill Baumgartner, Canada & Raphael Arku, United States

O-SY-078

Outcomes » Mortality

A spatiotemporal analysis of inequalities in life expectancy and 20 causes of mortality in sub-neighbourhoods of Metro Vancouver, Canada, 1990-2016

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BACKGROUND AND AIM: There is limited evidence on the magnitude and contributing causes of intra-urban inequalities. Spatially varying baseline data are needed to better understand geographical health inequalities as a first step in identifying and acting upon determinants.

METHODS: Mortality data (1990-2016) in British Columbia (BC), Canada were linked to three national and provincial demographic data sources and assigned to 20 Global Burden of Disease Study cause categories with further cause differentiation for neoplasms and cardiovascular diseases. All data were restricted, aggregated and merged to 368 Census Tracts (CTs) in Metro Vancouver. Bayesian small area, mixed-effects estimation models were used to estimate life expectancy (LE) at birth and 20 cause-specific and age-standardized mortality rates by sex and year.

RESULTS: Over the 27-year period, the gap in LE for CTs in the 90th percentile (P90) and 10th percentile (P10) for both males and females ranged from 6.9 years to 9.5 years. The two largest increases in percentage of total deaths from 1990-2016 were neurological diseases (10.0%) and other non-communicable diseases (3.7%). Relative inequality increased for almost all causes, especially for HIV and sexually transmitted infections, maternal and neonatal disorders, and neoplasms (especially pancreatic cancer in females and prostate cancer in males), whereby CTs in the P90 were 17.4 (P90: 1.2/100,000; P10: 0.2/100,000), 10.0 (16.4; 1.3), and 3.8 (367.7; 95.9) times higher, respectively, compared to CTs in the P10.

CONCLUSIONS: Spatial heterogeneity and clusters of cause-specific deaths were observed in one of the healthiest cities in Canada, with widening inequality in more recent years. These results and application of similar methodology to other locations can be used to support more in-depth analysis and prioritisation of policies and programs to advance urban sustainability and health equity.

Keywords: Health equity, small area analysis, life expectancy, cause-specific mortality, urban health, spatial analysis



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SYMPOSIUM 15

Pathways to Healthy and More Equitable Cities: Results from Vancouver, London, Accra, and Beijing

Chairs: Jill Baumgartner, Canada & Raphael Arku, United States

O-SY-079

Air pollution » Particulate matter

Land use regression modelling of ambient PM_{2.5} air pollution in Accra, Ghana

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BACKGROUND AND AIM: Ambient air pollution is a growing public health concern in sub-Saharan African (SSA) cities. Yet, effective air quality management is hampered by limited data and modelling of spatial trends.

METHODS: We measured outdoor weekly gravimetric (filter-based) concentrations of PM_{2.5} at 146 locations in a city-wide measurement campaign from April 2019 to June 2020 comprising of 10 yearlong and 136 weeklong sites. We used these data together with geospatial predictors to develop land use regression (LUR) models to estimate log transformed PM_{2.5} concentrations across the Greater Accra Metropolitan Area, Ghana. Geospatial predictor variables included land use, road networks, locations of human activity and the airport, population and building density, vegetation, elevation, and temporal predictors included temperature, rainfall, relative humidity, and month of the year. We selected the final parsimonious model through a stepwise forward selection procedure. We examined model external predictive accuracy with 10-fold 10% random site hold-out cross-validation and computed the R² and Mean Absolute Error (MAE).

RESULTS: PM_{2.5} concentrations exceeded the WHO's annual average guideline of 10 µg/m³ at all measurement sites ranging from 15 to 80 µg/m³. In the LUR models, predictor variables representing weather conditions, vegetation, and population density explained the most variation in PM_{2.5} concentrations with a cross-validation R² of 0.79 and MAE of 0.28 log(µg/m³). Predicted PM_{2.5} concentrations were highest in Accra central, the port city of Tema to the east, and in the highest-density residential areas, including some of Accra's slums.

CONCLUSIONS: Considering that ambient PM_{2.5} concentrations surpassed WHO health-based guidelines almost everywhere in the GAMA, ambient air pollution management and control should be prioritized in the city.

Keywords: Air pollution, Particulate Matter, Environmental Disparities



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 16

Health Effects of Glyphosate Herbicide Exposure: Experimental and Epidemiologic Evidence Across the Lifespan

Chairs: Paul J Mills, United States & Jose Ricardo Suarez Lopez, United States

O-SY-081

Chemical exposures » Pesticides

The Ramazzini Institute studies on Glyphosate based herbicides: pilot phase results and state of the art of Global Glyphosate study

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BACKGROUND AND AIM: Glyphosate (G) is set for re-approval in the European Union in late 2022 and the full risk posed by glyphosate-based herbicides (GBHs) is still unclear. The Ramazzini Institute (RI), with other independent Institutes in EU and USA, has launched in 2017 a pilot study to assess experimental procedures and in 2019 started the most comprehensive study (main project) ever on G and GBH. The study is named the Global Glyphosate Study: <https://glyphosatestudy.org/>.

METHODS: In the pilot study (90 days) G alone and a commercial brand of GBH, were administered in drinking water at 1.75 mg/kg bw/day (US ADI) to dams starting from GD 6 up PND 120. The main study cover: genotoxicity, prenatal-developmental toxicity, neurotoxicity, multi-generational effects, endocrine disruption and microbiome effects, and, in the long term, carcinogenicity, on SD rats administered with G and GBHs in drinking water at concentration of 0; 0.5 (ADI Europe); 5; 50 mg/kg/bw/day.

RESULTS: Preliminary results of the pilot study have already been published. In particular GBH shows: genotoxicity, adverse effect on reproduction-development and on microbiome, at exposure levels that are currently considered safe and legally acceptable. The full results of the pilot study can be found in our study website. The results were also presented at the European Parliament in 2018. Study design, conduct of the experiment of the main arm study, encompassing about 5,000 animals observed from prenatal life for the lifespan, are presented during the Conference.

CONCLUSIONS: The possible endocrine disruptive effects of glyphosate are one of the main focuses of the main study - the research team is going to fully analyze and process all samples in this part of the study by the Spring of 2022. Proven endocrine disruptive effects of a chemical can lead to a ban on that specific chemical under European law.



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ABSTRACT E-BOOK

Keywords: Endocrine disrupting chemicals, pesticides, microbiome, toxicology



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 16

Health Effects of Glyphosate Herbicide Exposure: Experimental and Epidemiologic Evidence Across the Lifespan

Chairs: Paul J Mills, United States & Jose Ricardo Suarez Lopez, United States

O-SY-082

Chemical exposures » Pesticides

Associations of Glyphosate with Testosterone, Cortisol, DHEA, and Estradiol in Ecuadorian Adolescents

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BACKGROUND AND AIM: Recent studies suggest that glyphosate has many characteristics of an endocrine disrupting chemical (EDC) through alteration of the hypothalamus-pituitary axis and cellular-signaling, evidenced in in vitro studies of human cell lines and rat models. We assessed the relationship between urinary concentrations of glyphosate with adrenal and gonadal hormones in Ecuadorian adolescents living in an agricultural community.

METHODS: We examined 522 adolescents (ages: 11-17y, 50.7% female, 78% Mestizo or White) living in Pedro Moncayo, Ecuador in the summer of 2016 (The ESPINA study), a non-peak pesticide spray season, and measured urinary glyphosate concentration using mass-spectrometry and salivary hormone concentrations using enzymatic methods (dehydroepiandrosterone [DHEA], testosterone, cortisol, and estradiol [the last in boys only]). Saliva was collected upon awakening. Glyphosate was detected in 98% of participants. We conducted pooled and gender stratified multivariate general linear models to assess the relationship between ln-glyphosate and ln-hormone concentrations. Models adjusted for age, race, BMI-for-age z-score, sexual maturation, sample collection time after awakening and ln-creatinine. Estimates were then transformed to present percent difference in hormone concentration per 10% increase in pesticide metabolite concentrations (β).

RESULTS: The median glyphosate concentration was 0.87 ng/mL (range: 0.41-1.80 ng/mL, detectable in 98%). In pooled (boys and girls) analyses, a 10% increase in glyphosate concentration was associated with a 0.81% (95% CI: 0.33%, 1.30%) increase in testosterone. This association was stronger in boys (β =1.04% [0.34%, 1.74%]) than girls (β =-0.02% [-0.52%, 0.48%]). Glyphosate was also positively associated with cortisol concentration in boys (β =1.38% [0.45%, 2.32%]) and borderline negatively associated with concentration in girls (β =-0.57% [-1.25%, 0.10%]). No associations were seen for DHEA or estradiol.

CONCLUSIONS: Urinary glyphosate was positively associated with concurrent testosterone and cortisol concentrations among male adolescents. Our findings provide some of the first epidemiological data to support prior in-vitro and in-vivo findings that have characterized glyphosate as an EDC.



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ABSTRACT E-BOOK

Keywords: Pesticides, Endocrine Disrupting Chemicals, Environmental Epidemiology



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SYMPOSIUM 16

Health Effects of Glyphosate Herbicide Exposure: Experimental and Epidemiologic Evidence Across the Lifespan

Chairs: Paul J Mills, United States & Jose Ricardo Suarez Lopez, United States

O-SY-083

Chemical exposures » Pesticides

Human glyphosate exposure changes over 25 years and implications for liver health

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University of California, San Diego

BACKGROUND AND AIM: The use of glyphosate-based herbicides has increased significantly over the past 25 years. Globally, they are now the most widely used pesticides. Few studies have documented human rates of glyphosate exposure nor potential linkages with liver disease. We present findings of 2 studies conducted by the UC San Diego Herbicide Awareness and Research Project.

METHODS: Study 1: Among 100 randomly selected participants of the UC San Diego longitudinal Rancho Bernardo Study we measured urinary glyphosate concentrations at 5 time points between 1993 and 2016. Study 2: Glyphosate excretion was examined in the context of incidence of non-alcoholic liver disease (NAFLD) and nonalcoholic steatohepatitis (NASH) among 100 patients from the UC San Diego NAFLD Research Center. For each study, urine samples were analyzed using high-performance liquid chromatography coupled with mass spectrometry. Limits of detection (LOD) for glyphosate were 0.03 µg/L; assays were linear up to 50 µg/L. Analyses were normalized to each sample's specific gravity, thereby accounting for dilution or concentration effects due to variability in water intake and age-related or other differences in renal function.

RESULTS: Study 1: Mean glyphosate exposure increased >1000% over the period. From 1993-1996 to 2014-2016, mean sample values increased from 0.024 µg/L to 0.314 µg/L (p<0.001) and mean rates of exposure increased from 0.120 to 0.700 (p<0.001), respectively. Study 2: Glyphosate excretion was significantly elevated in patients with NASH as compared with patients without NASH (p=0.01) and in patients with more severe liver fibrosis (p=0.01).

CONCLUSIONS: Glyphosate exposure has increased significantly since GM crops were first introduced into the US food supply in the early 1990s. Consistent with over 8 animal feeding studies, in humans, chronic exposure to glyphosate may be associated with incidence of fatty liver disease, an epidemic in the US.

Keywords: pesticides, other (liver disease)



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SYMPOSIUM 16

Health Effects of Glyphosate Herbicide Exposure: Experimental and Epidemiologic Evidence Across the Lifespan

Chairs: Paul J Mills, United States & Jose Ricardo Suarez Lopez, United States

O-SY-084

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Residential proximity to agricultural glyphosate use and neurobehavior in the CHAMACOS study

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BACKGROUND AND AIM: Glyphosate herbicides are the most widely used pesticides in the world. In California, agricultural use and total sales of glyphosate have more than doubled in the past 20 years. However, few studies have evaluated the human health effects of exposure. Our aim was to assess the relationship of agricultural glyphosate use within 1 km of residences with cognition and behavior in adolescence and young adulthood.

METHODS: We collected residential history information during pregnancy and childhood in the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) birth cohort. Using California Pesticide Use Report data, we estimated agricultural glyphosate use within 1 km of residences during the prenatal period and from 0-5 years of age, weighted for wind direction. We estimated associations with: Full-scale Intelligence Quotient, Verbal Comprehension, Working Memory, Processing Speed and Perceptual Reasoning from the Wechsler Intelligence Scale for children, 4th edition at 7 and 10.5y; internalizing (anxiety and depression) and externalizing behaviors (hyperactivity and attention) from the Behavior Assessment System for Children-2 at 16 and 18y; and police encounters, delinquent acts, and risk-taking behaviors at 18y.

RESULTS: A two-fold increase in glyphosate use within 1 km of postnatal residences was associated with more youth-reported depression ($\beta=1.3$, 95% Credible Interval (CrI): 0.2, 2.5), and maternal-reported internalizing behaviors ($\beta=1.3$, 95% CrI: 0.2, 2.7), driven by associations with anxiety ($\beta=1.2$, 95% CrI: 0.2, 2.3) at 16 and 18y. Residential proximity to glyphosate use during pregnancy or early childhood was not associated with other behavioral or cognitive domains.

CONCLUSIONS: Though we observed associations of early childhood residential proximity to agricultural glyphosate use with a slight increase in internalizing behaviors, overall associations were null for most cognitive and behavioral outcomes. Future studies of neurodevelopment and glyphosate biomarkers would integrate exposure from diet, agricultural and home use.

Keywords: glyphosate, agriculture, cognition, behavior, children, adolescents



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Health Effects of Glyphosate Herbicide Exposure: Experimental and Epidemiologic Evidence Across the Lifespan

Chairs: Paul J Mills, United States & Jose Ricardo Suarez Lopez, United States

O-SY-085

Chemical exposures » Pesticides

Glyphosate exposure and neurobehavioral outcomes in farmworkers from Zarcero County, Costa Rica

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BACKGROUND AND AIM: Animal studies have shown neurotoxic effects of glyphosate and glyphosate-based herbicides. However, only a few studies have examined the neurotoxicity of glyphosate in humans. We examined associations of glyphosate exposure with neurobehavioral outcomes from a cross-sectional study of 300 farmworkers from Zarcero County, Costa Rica.

METHODS: Glyphosate was measured in urine samples collected from farmworkers at one or two time points between May and August 2016. We assessed five neurobehavioral domains (i.e., language, working memory, attention, executive function, and motor function) using nine neurobehavioral tests and examined symptoms of neurological and psychological distress using the Brief Symptom Inventory (BSI). We examined outcomes from neurobehavioral tests as continuous scores; BSI domain-specific and Global Severity Index (GSI) scores were normalized to gender-specific T-scores (mean=50, standard deviation (SD)=10) and dichotomized using a cut-off T-score of ≥ 63 . We fitted linear or logistic regression models adjusted for age, sex, education, and psychometrician to examine associations of average urinary glyphosate concentrations (modeled continuously and in tertiles) with the neurobehavioral outcomes of interest.

RESULTS: Glyphosate was detected above the limit of detection (LOD) in 86% of samples. Median (P25-P75) specific gravity-corrected urinary glyphosate concentrations were 0.48 (0.28-0.83) ng/mL. Almost 31% of participants had clinically significant symptoms of psychological distress based on the GSI score. We observed mostly null associations of urinary glyphosate concentrations with neurobehavioral outcomes. Glyphosate concentrations in the highest tertile were associated with slightly decreased scores on the Digit Span Backward test, a measure of working memory, compared to the lowest tertile ($\beta = -0.4$; 95% CI: -0.8, 0.1). No differences were observed in the odds of psychological distress in association with glyphosate exposure.



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CONCLUSIONS: We observed largely null associations of glyphosate exposure and neurobehavioral outcomes among farmworkers in Costa Rica. Given the widespread use of glyphosate, additional epidemiologic studies are needed to evaluate its safety.

Keywords: glyphosate, farmers, pesticides, neurobehavioral outcomes, Costa Rica



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SYMPOSIUM 16

Health Effects of Glyphosate Herbicide Exposure: Experimental and Epidemiologic Evidence Across the Lifespan

Chairs: Paul J Mills, United States & Jose Ricardo Suarez Lopez, United States

O-SY-086

Neurologic and Mental Health Outcomes » Neurodevelopmental outcomes

Associations of herbicides and DEET repellent metabolites with neurobehavioral performance in adolescents

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BACKGROUND AND AIM: Herbicides are the most used class of pesticides worldwide, and insect repellents are widely used in most countries worldwide. Yet, there is a dearth of studies characterizing the associations between these chemical groups and neurobehavioral performance. Some data in rodents and poultry suggests that herbicides such as glyphosate and 2,4-Dichlorophenoxyacetic acid (2,4-D) can affect neurobehavior and cholinergic and glutamatergic pathways in the brain.

METHODS: Among 519 participants of ages 11-17 years living in agricultural communities in Ecuador (The ESPINA study), we measured urinary concentrations of glyphosate, 2,4-D, and two N,N-Diethyl-meta-toluamide (DEET) insect repellent metabolites (3-[diethylcarbamoyl]benzoic acid, 3[ethylcarbamoyl]benzoic acid). We assessed neurobehavioral performance using 11 subtests across 5 domains (Attention/Inhibitory Control, Memory/Learning, Language, Visuospatial Processing and Social Perception). We characterized the associations using generalized estimating equations and multiple imputation for metabolites below detection limits. Models adjusted for demographic, anthropometric, creatinine and sexual maturation. Mediation analyses by salivary cortisol, dehydroepiandrosterone, estradiol and testosterone were assessed using structural equation modeling.

RESULTS: The mean neurobehavioral domain scores ranged from 7.0 - 8.7 (SD range: 2.0 - 2.3). The detectability of metabolites were: glyphosate: 98%, 2,4-D: 66%, 3-[diethylcarbamoyl]benzoic acid: 62%, 3[ethylcarbamoyl]benzoic acid: 34%. 2,4-D was negatively associated with all neurobehavioral domains, but the strongest and significant associations were observed with Attention/Inhibition (score difference per 50% increase in metabolite concentration [β]=-0.19, $p=0.002$), Language ($\beta=-0.14$, $p=0.015$) and Memory/Learning ($\beta=-0.11$, $p=0.065$). Glyphosate had significant negative associations only with Social Perception ($\beta=-0.08$, $p<0.001$). DEET metabolites were not associated with neurobehavior. Sex and adrenal hormones did not mediate these associations.

CONCLUSIONS: These are among the first population-based human studies to describe neurobehavioral performance decreases associated with herbicide exposures. Replication of our



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findings among other pediatric and adult populations is needed. Caution is advised with the use of these pesticides.

Keywords: Herbicides, Insect repellents, neurodevelopment, Environmental epidemiology, adolescents, agriculture



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SYMPOSIUM 17

Pathway to Equity in Water, Sanitation and Hygiene (WASH) in Africa Challenges and Opportunities

Chairs: Firdu Zawide, United States & Adetoun Mustapha, Nigeria

O-SY-087

Methods » International collaboration

Pathway to equity in water, sanitation and hygiene (WASH) in Africa challenges and opportunities

Firdu Zawide

Jimma University Institute of Health Sciences Department of Environmental Health and Sciences
Jimma Ethiopia

BACKGROUND AND AIM: Water and sanitation has been part of the global development agenda for over fifty years. Over the years a series of declarations and resolutions were passed by the United Nations including the recent Sustainable Development goal which commits member states to build resilient pathways to ensure that "no one is left behind". The aim of the study is to assess the progress made toward universal access to WASH in Africa and catalyze advocacy to address the challenges and opportunities to meet the needs of the African people.

METHODS: A systematic review and synthesis of country sector reports and case studies in implementing WASH projects, data collection and analysis from global monitoring system and field experience.

RESULTS: Generally there is a steady progress in reducing inequalities in WASH services between the unserved and under-served urban and rural population. Access to adequate sanitation is by far lower in rural areas compared to water supply.. Case studies showed the contributing factors for the steady increase in coverage were a shift to sector wide integrated and participatory approach, the development of pro-poor policies and financial mechanism to boost investment supported by legal, regulatory and institutional reforms.. The decentralized approach has created opportunity for all stake holders to play a role, promote innovation, strengthen partnership and coordination.. However with three hundred million people still unserved and twenty three percent practicing open defecation, WASH remains a major threat to health, education and economic opportunity.. Progress is hampered by rapid population growth, industrialization urbanization, climate change increasing water scarcity, limited resources and poverty. Addressing these constraints is a major challenge to the African countries.

CONCLUSIONS: The international collaboration has enabled African countries to make progress. However tremendous amount of work needs to be done to mobilize huge resources to achieve the goal of universal access to WASH.in Africa.

Keywords: i, environmental disparity, water quality



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SYMPOSIUM 17

Pathway to Equity in Water, Sanitation and Hygiene (WASH) in Africa Challenges and Opportunities

Chairs: Firdu Zawide, United States & Adetoun Mustapha, Nigeria

O-SY-088

Methods » International collaboration

Innovative Approach in Response to the Challenges of Equity to Water, Sanitation and Hygiene (WASH) in Ethiopia

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Department of Environmental Health Science & Technology, Jimma University, Jimma-Ethiopia

BACKGROUND AND AIM: Inadequate access to WASH in households, schools, and health facilities in rural villages impact health and educational outcomes of children. In respect to this challenge Ethiopia has made significant efforts over the past decade to reduce the inequalities in WASH services. This study aims to explore and present how the WASH programme became successful and impacted the health and education of children in the COVID-19 pandemic era.

METHODS: A gray literature based study was conducted to document secondary analysis of national and international reference publications on WASH from 1999 to present time.

RESULTS: In Ethiopia rural areas are among the most poorly served in WASH, which comprises about 80.5 million out of the total 110 million population. In 1999 about 13% of the rural population was served with safe water and only 6% had access to adequate sanitation. In 2017 access to safe water increased to 56% and sanitation to 24%. There had been significant improvement in WASH services in rural health facilities and schools although there is more to be done, in areas affected by drought and water scarcity. The major contributing factor to this achievement was the launching of the ONE WASH National Programme by the government in 2013. Under this programme the equitable and sustainable supply of safe drinking water and adequate sanitation for the neglected population was brought under one management with full participation of all stakeholders by creating consolidated WASH account where funds allocated for WASH by government and external partners were kept and disbursed on priority basis. New innovative approach for community training and education was introduced and the application of low cost water and sanitation technology was promoted.

CONCLUSIONS: The delivery of WASH under one management in partnership with government, external partner, the private sector and the communities has proven to be effective and innovative.

Keywords: Environmental justice, community outreach, Ethiopia



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Pathway to Equity in Water, Sanitation and Hygiene (WASH) in Africa Challenges and Opportunities

Chairs: Firdu Zawide, United States & Adetoun Mustapha, Nigeria

O-SY-089

Exposures » Water quality

Environmental pollution and water sanitation and hygiene challenges in Nigeria: can it be solved?

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University of Ibadan, Ibadan Nigeria

BACKGROUND AND AIM: Increasing population and industrialization had led to high rate of environmental pollution with effect on water quality and hygiene in Nigeria. Previous studies in Nigeria had focused on evaluating the effect of environmental pollution and release of associated potentially toxic metal on public health. This paper discusses various challenges that exist in environmental pollution and water sanitation and hygiene in Nigeria.

METHODS: A literature search using various keywords was done. Articles selected for review were chosen following predefined criteria, to extract and analyze data.

RESULTS: The results revealed that the hygienic condition of most locality found within Nigeria are in an unacceptable level when assessed with the nation's and international regulations and this had led to various environmental health issues. In the waters (ground and surface), nearly all potentially toxic metals (arsenic, lead, mercury and cadmium) observed were due to various human activities such as artisanal mining, indiscriminate disposal of wastes, un-channeled water discharge, uncontrolled release of organic wastes, etc causing environmental pollution and their concentrations were found to be above the Nigerian and WHO permissible standards. This invariably lead to various health challenges observed part of which happened in 2013, were over nine hundred children died from exposure to lead in Zamfara, Nigeria. The need to reduce the concentration of these metals in the environment made the government to establish various environmental laws on the mode of emission of these metals.

CONCLUSIONS: Environmental pollution and water sanitation challenges which had increased public health issues are mainly from different human activities in Nigeria. More stringent regulations must be in place to avert these challenges and make the environment healthier.

Keywords: Environmental pollution, Water sanitation and Hygiene, Toxic metals.



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Chairs: Firdu Zawide, United States & Adetoun Mustapha, Nigeria

O-SY-090

Methods » International collaboration

Overview of Regional and International Collaboration on Water, Sanitation and Hygiene in Africa

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BACKGROUND AND AIM: The current level of investment for water, sanitation and hygiene (WASH) in Africa remains totally inadequate to meet the sectoral needs of the countries resulting in the lowest service coverage and annual deaths of about one hundred forty-three thousand children. The supply of WASH is also threatened by other factors including water scarcity, rapid population growth, urbanization and industrialization. Over eighty percent of the countries have been unable to achieve their national WASH goal due to insufficient funds, The aim of the study is to assess the current financing mechanism and the regional disparities for WASH service delivery and identify evidence based intervention that will harmonize the role of the development partners.

METHODS: A review of relevant literature, reports on WASH financing from government and external financing agencies, regional inter sectorial framework, country case studies.

RESULTS: As African countries get started to meet the Sustainable Development goal, lack of adequate financial resources are being magnified. A water sector infrastructure and investment framework in South Africa found that only half of the required fund for WASH project is available for the next ten years. In the past less than one percent of lending was targeted to Sub-Saharan Africa. We find household expenditure and capital investment for sanitation far below compared to drinking water. New strategy for the sector financing should consider grants, loans, community cost sharing, and repayable finances from external support agencies. As part of this effort, accountability and cost reduction need to be prioritized while strengthening alliance with development partners.

CONCLUSIONS: Much effort is needed by the countries to optimize the mobilization of all possible resources to direct solutions to the critical financial need to achieve the goal of universal access to WASH in Africa.

Keywords: Environmental disparity, international collaboration, WASH



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SYMPOSIUM 17

Pathway to Equity in Water, Sanitation and Hygiene (WASH) in Africa Challenges and Opportunities

Chairs: Firdu Zawide, United States & Adetoun Mustapha, Nigeria

O-SY-091

Methods » Ethics

Pathway to equity in water, sanitation and hygiene (WASH) in Africa: Ethical Implications

Adetoun Mustapha

Nigerian Institute of Medical Research

BACKGROUND AND AIM: Clean drinking water and sanitation have been recognized as essential to the realization of all human rights by the United Nations General Assembly on 28 July 2010, through Resolution 64/292. Sustainable Development Goal (SDG) 6, committed countries to ensure the availability and sustainable management of water and sanitation for all by 2030. The 2018 Africa Sustainable Development Report finds that access to safe drinking water and improved sanitation remains very low in Africa by global standards, there are wide disparities between and within countries, and 43% of Africa's rural population has access to basic drinking water services compared to 82% of the urban population. What kinds of ethical reasoning need to be considered in the pathway to equity in water, sanitation and hygiene (WASH) in Africa within the context of growing population, industrialization, rapid urbanization and emerging challenges such as climate change, droughts, floods and mismanagement of waste water? What challenges and opportunities do the COVID-19 pandemic portends to the progress of availability and sustainable management of water and sanitation in Africa? How do we achieve the most good for the most people at the least cost? This talk will address these and the ethical dimensions of studies discussed in this session.

METHODS:

RESULTS:

CONCLUSIONS:

Keywords: Ethics, water and sanitation, Africa



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SYMPOSIUM 18

Climate Change and Maternal and Neonatal Health Outcomes: New Methods to Address Heat Impacts in Vulnerable Populations

Chairs: Kristie Ebi, United States & Anthony Ngugi, Kenya

O-SY-092

Climate » Temperature extremes and variability

Systematic review of the effect of ambient heat on maternal health outcomes

Matthew Chersich¹, Sari Kovats², Cherie Part², Louisa Samuels³, Shakoor Hajat², Ijeoma Solarin¹, Britt Nakstad⁴, Veronique Filippi⁵, Stanley Luchters⁶, Nathalie Roos⁷

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BACKGROUND AND AIM: Though pregnant women have recently been identified as a vulnerable group for heatwave health protection action plans, there is much concern about the effect of high ambient temperatures on pregnancy outcomes. The CHAMNHA project previously reviewed studies of heat effects on preterm birth, stillbirth, low birth weight and congenital anomalies (n=83 studies). Here we examine associations between high ambient temperatures on maternal outcomes.

METHODS: As part of a systematic mapping review of heat-health linkages, using searches in Pubmed and Web of Science, we screened 19373 titles and abstracts in duplicate to locate studies on the impact of ambient temperature on maternal health complications. The study was limited to epidemiological papers that quantified associations between maternal outcomes and meteorological variables. We also assessed the quality of the studies and the risk of bias.

RESULTS: After single reviewer data extraction, 32 studies were located, almost all from high-income countries. Thirteen assessed hypertension disorders in pregnancy, nine documenting heat impacts, with the remainder having negative or non-significant findings. Five studies linked heat exposure with premature rupture of membranes, and three with group B streptococcus infection. Four studies noted increased placental abruption or antenatal haemorrhage following periods of high temperatures. Five studies documented poor glucose control during periods of extreme heat, with higher risks for gestational diabetes. Overall study quality was limited by poor assessment of exposure, especially timing of exposure, and lack of control for seasonal factors. One study assessed effects of heat on wellbeing. No studies assessed impacts on maternal mortality.

CONCLUSIONS: Overall, most studies documented associations between high ambient temperatures and adverse maternal health outcomes. Evidence was conflicting for some outcomes, in contrast to



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more robust evidence for adverse newborn outcomes. There is some evidence that heatwaves and high temperatures have implications for maternal health and wellbeing.

Keywords: Temperature, Climate, Environmental epidemiology, Female, Outcomes



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SYMPOSIUM 18

Climate Change and Maternal and Neonatal Health Outcomes: New Methods to Address Heat Impacts in Vulnerable Populations

Chairs: Kristie Ebi, United States & Anthony Ngugi, Kenya

O-SY-093

Climate » Temperature

Effects of ambient temperature on maternal behaviour and health-related functioning in Burkina Faso

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BACKGROUND AND AIM: High ambient temperature is associated with reduced work capacity, disrupted sleep, and increased anxiety, which may impact on maternal caregiving behaviours and health-related functioning. We explored the effects of heat on normal daily activities and wellbeing in a cohort of pregnant and postpartum women in southern Burkina Faso.

METHODS: We undertook secondary analysis of data collected during structured interviews with 868 pregnant and postpartum women (aged 14–47 years), on 3 occasions (between November 2013 and November 2014), in the commune of Bobo-Dioulasso. Temperature data for Bobo-Dioulasso were obtained from Tutiempo.net. Multilevel linear regression models were used to estimate the effects of daily mean temperature on women's sleeping behaviour, mental health (Kessler Psychological Distress Scale), and time spent (minutes per typical day) on professional, household, social, and caregiving activities. Models were stratified by residential area (urban/rural), and controlled for season, pregnancy history, marital status, number of infants born, infant status (alive, absent, dead) and/or age, where appropriate.

RESULTS: The population experienced year-round high temperatures (intra-annual range: 23.2°C - 33.7°C). With every 1°C increase in daily mean temperature, exclusive breastfeeding decreased by 2.0 minutes per day (95% CI -4.3 to 0.3), family care decreased by 1.9 minutes per day (-4.1 to 0.2), and childcare increased by 0.5 minutes per day (-0.04 to 1.0). Associations were statistically significant at the 10% level. We found no evidence of association between temperature and time spent on professional or social activities, housework, sleeping, or mental health. Temperature-outcome associations did not differ between urban and rural settings.



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ABSTRACT E-BOOK

CONCLUSIONS: This study suggests that very high temperatures may not limit work-related behaviours when individuals have little option to rest. As infants become thirstier in hot weather, it is concerning that they may be breastfed for a shorter duration when temperatures rise.

Keywords: Temperature, Female, Outcomes, Mental health outcomes



ABSTRACT E-BOOK

August 25, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)

SYMPOSIUM 18

Climate Change and Maternal and Neonatal Health Outcomes: New Methods to Address Heat Impacts in Vulnerable Populations

Chairs: Kristie Ebi, United States & Anthony Ngugi, Kenya

O-SY-094

Climate » Temperature

Heat stress and risk of preterm birth: A case-crossover study from Sweden 2014 to 2019

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BACKGROUND AND AIM: Pregnancy is increasingly recognized as a vulnerable period during hot weather. Using the Swedish Pregnancy Register, we aim to investigate the relationship between short-term exposure to elevated ambient temperature and preterm birth risk.

METHODS: All pregnant women with singleton live births between 2014-2019 identified in the Swedish Pregnancy Register were included. Daily mean air temperature was estimated at 1-km spatial resolution across Sweden using a spatiotemporal machine learning methodology incorporating data from monitoring stations, satellite Land Surface Temperature, meteorological reanalysis data, and land-use predictors (vegetation indexes, climate zones, land cover features). Each woman was assigned daily air temperature exposure based on residential address and delivery date. We will apply a case-crossover design with distributed-lag models (CC-DLM) to investigate the association between daily mean air temperature and preterm birth (<37 gestational weeks) during June-August (defined as the warm season). Further analyses will include other study outcomes (spontaneous and medically indicated preterm birth, gestational age quantiles) and definitions of warm season.

RESULTS: We included 568,924 singleton live births during 2014-2019, of which 152,826 (26.9%) occurred during June-August. The spatiotemporal exposure model was able to capture 97% of air temperature variability in held-out monitoring stations (stations not used for model building), therefore providing very accurate exposure estimations even at residential addresses without



ABSTRACT E-BOOK

monitors. Mean (SD) of ambient temperature at the residence of the included subjects was 16.8°C (3.0°) during June-August.

CONCLUSIONS: We collected data on a large population of pregnant women in Sweden, and were able to assign daily air temperature exposure at their residential addresses. Using advanced epidemiological methods (CC-DLM) we will estimate the shape and temporal latency of the exposure-response function between heat and preterm birth, even in areas lacking monitoring data. This approach can be particularly useful in data poor settings, such as Sub-Saharan African countries.

Keywords: Preterm birth, Pregnancy outcomes, Climate, Short-term exposure, Temperature extremes, Exposure assessment



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SYMPOSIUM 18

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Chairs: Kristie Ebi, United States & Anthony Ngugi, Kenya

O-SY-095

Birth and Pregnancy Outcomes » Pregnancy outcomes

Extreme heat experienced by pregnant subsistence farmers in The Gambia: impact on maternal physiology and fetal distress

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BACKGROUND AND AIM: Global heating will result in increased severity, duration and frequency of extreme heat in many parts of the world. Those at most risk of adverse health effects due to heat include infants, the elderly, pregnant women and outdoor labourers. In Sub-Saharan Africa women make up approximately 50% of the agricultural workforce and often work throughout pregnancy. The impact of heat on the physiology of pregnant women and fetal physiology are largely unknown. This study assessed the direct heat exposure of pregnant farmers in The Gambia, the rate of heat strain or heat illness symptoms and the impact on fetal distress by measuring placental blood flow and fetal heart rate. **METHODS:** This was an observational cohort study of pregnant subsistence farmers in rural Gambia who farmed during their pregnancy. Exposure was directly measured in the field. Participants wore an Equivital TM device that measured heart rate, skin temperature, respiratory rate and tri-axis accelerometry. In the field, fetal monitoring was achieved using a portable doppler device (UmbiFlow M) and portable fetal heart rate monitor.

RESULTS: 92 participants completed at least one field visit prior to delivery. Mean age of participants was 30.0 years, median gravida was 4.5 (range 1-12) and median parity was 3 (range 0-10). Only 2/92 (2%) participants experienced a rise in core temperature to >38°C. 62/92 (67%) participants experienced at least one symptom of heat illness during their field visit. 6/92 (7%) participants demonstrated placental insufficiency at baseline according to UmbiFlow TM umbilical doppler scan, with 29/86 (33.7%) demonstrating acute fetal distress in the field. Development of placental insufficiency correlated with Wet Bulb Globe Temperature exposure.



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CONCLUSIONS: This study gives preliminary evidence of the impact of maternal heat exposure on placental blood flow.

Keywords: fetal distress, Temperature extremes, Pregnancy outcomes



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SYMPOSIUM 18

Climate Change and Maternal and Neonatal Health Outcomes: New Methods to Address Heat Impacts in Vulnerable Populations

Chairs: Kristie Ebi, United States & Anthony Ngugi, Kenya

O-SY-096

Climate » General

Association between maternal exposure to extreme heat and the risk of preterm birth in China: a sibling-matched study

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BACKGROUND AND AIM: Extreme heat exposure during pregnancy may increase the risk of adverse birth outcomes. This study examines the association between extreme heat and preterm birth (PTB) using the novel sibling-matched design which has the potential to eliminate the effects of unknown and unmeasurable confounders.

METHODS: Using a large population-based birth cohort across 16 counties in China, we collected 10,826 sibling pairs (21,652 singleton live births) from March 2013 to December 2018. Daily mean temperature was collected in each county and extreme heat was defined as temperatures above the 90th percentile of trimester- and location-specific mean temperature. Conditional logistic regression models were used to estimate the effects of extreme heat exposure during each trimester and for the entire pregnancy on PTB. Stratified analyses were performed by regional characteristics, birth order, prenatal care status, inter-pregnancy interval, and delivery mode.

RESULTS: Of the 21,652 births (10,826 pairs) included in the study, 804 (3.71%) cases were PTB, and 29 sibling pairs were both PTB. Contrasting with normal temperature exposure, heat exposure during the 3rd trimester and entire pregnancy was associated with PTB risk, with Odds Ratios (ORs) of 2.34 (95% CI: 1.65, 3.33) and 3.21 (95% CI: 2.23, 4.61), respectively. Women who lived in areas with lower levels of health services had a higher risk of PTB (OR: 4.28, 95% CI: 1.72-12.72). Heat-related PTBs were also more likely to be observed for first-borns and for second-born neonates with an inter-pregnancy interval of less than 18 months; ORs (95% CIs) were 4.59 (3.39, 6.22) and 3.43 (2.16, 5.40), respectively. Insufficient prenatal care also increased the risk of PTB associated with heat exposure.

CONCLUSIONS: Using a sibling-matched design, our research strengthens the evidence that extreme heat exposure during pregnancy increases the risk of PTB. Our findings for susceptible subgroups could also help to improve guidance for prenatal care in China.

Keywords: Climate, Temperature extremes, Birth outcomes, Environmental epidemiology



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SYMPOSIUM 19

What Does It Mean to Think Causally About Mixtures Epidemiology?

Chairs: Thomas F Webster, United States & Marc G Weisskopf, United States

O-SY-097

Methods » Causal inference

Mixtures and the Table Two Problem

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BACKGROUND AND AIM: Development of statistical methods for mixtures epidemiology is of great current interest, but the distinction between predictive and causal models is often not made. Here we examine this issue using the framework of a “Table Two Problem”: when effect estimates for an exposure and other covariates are presented—typically after describing the study population, hence the name—there is a tendency to interpret them all as causal. Similarly, when there are multiple exposures in a mixture there is a tendency to put them all in a model and interpret results for all causally.

METHODS: We analyzed a number of different simple binary mixture scenarios using directed acyclic graphs and linear regression models, the basis of many mixtures methods. We examine one component of a mixture at a time, determining the set of other variables that must be controlled and not controlled to derive the correct causal estimates and then compare the sets between exposures.

RESULTS: Mixtures epidemiology often uses exposure biomarkers such as blood or urine concentrations. In one particularly interesting scenario familiar from pharmacology, one exposure affects the pharmacokinetics of another. Scenarios can then be constructed where there is no single regression model that produces the correct causal estimates for both exposures. Simply regressing on all exposures and other covariates produces biased results.

CONCLUSIONS: To obtain correct causal estimates for exposures in a mixture, care must be taken in the choice of variables to regress, particularly when exposure biomarkers are used.

Keywords: mixtures, causal inference, biomarkers, DAGs, methods



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SYMPOSIUM 19

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O-SY-098

Methods » Causal inference

What do we mean by the effect of a mixture as a whole?

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BACKGROUND AND AIM: The analysis of health effects of exposure mixtures is a critically important issue in human epidemiology. One element of mixtures epidemiology that we may want to know is the causal effect of a mixture as a whole. While seemingly a straightforward question, there are nuances that complicate it. Here we present issues that arise in forming causal questions about mixtures as a whole.

METHODS: We use Directed Acyclic Graphs (DAGs) and the math of linear regression to discuss the conceptualization of a mixture as a whole and implications for causal inference both when assumptions about residual bias are met and when they are not.

RESULTS: How a mixture as a whole is conceptualized and thus represented in a regression model modifies the causal question being addressed. For example, the concentration of each of several correlated toxicants in blood (component parts mixture) vs. the level of the (typically external) source of the toxicants that is responsible for their correlation (whole mixture). Under relatively simple data structures with no confounding these two conceptualizations are similar, but still not the same. When residual confounding of the individual component parts may be present, analyzing the external whole mixture effect has advantages over analyzing the sum of the component parts; in turn interpreting the sum of the component parts has advantages over interpreting the components separately. However, some confounding structures for the components of a mixture are intractable to typical statistical approaches to mixtures analyses, although extensions of g-computation may help.

CONCLUSIONS: How one conceptualizes a mixture has implications for the interpretation of analytic results and identifying causal effects that could underlie interventions. Careful consideration of potential biased pathways related to the components of a mixture is critical and has implications for analyzing the data and interpreting the results.

Keywords: mixtures, causal inference, exposome, interventions, statistical analysis



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SYMPOSIUM 19

What Does It Mean to Think Causally About Mixtures Epidemiology?

Chairs: Thomas F Webster, United States & Marc G Weisskopf, United States

O-SY-099

Methods » Causal inference

Models are a nuisance

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BACKGROUND AND AIM: Three recently developed software tools to evaluate associations between exposure mixtures and health outcomes have all converged on the same default estimate of the joint effect of multiple exposures. This is not a coincidence.

METHODS: I discuss why this estimate is reasonable in the context of correlated exposure mixtures. I show that these methods are just convenient tools for a general approach to analyzing health effects of mixtures. This approach unifies the seemingly disparate frameworks of dimension reduction (e.g. PCA), clustering (e.g. K-means), and regression (e.g. kernel machine regression).

RESULTS: Simulations demonstrate that different approaches to estimating the same joint effect are useful under different scenarios. They also help illustrate how statistical assumptions can be used to drive model choice, which can decouple the study question from the statistical approach. Simulations also demonstrate some potential pitfalls of this approach.

CONCLUSIONS: This work gives an objective basis for comparing and choosing methods when one is interested in joint effects of multiple components of a mixture.

Keywords: Causal inference, exposure mixtures, machine learning, PCA



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SYMPOSIUM 19

What Does It Mean to Think Causally About Mixtures Epidemiology?

Chairs: Thomas F Webster, United States & Marc G Weisskopf, United States

O-SY-100

Methods » Causal inference

Applying a potential outcomes framework to estimate policy-relevant effects of exposure mixtures

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BACKGROUND AND AIM: Interest in understanding the joint effects of multiple exposures (i.e., mixtures) is rapidly increasing, with a related proliferation of statistical methods for estimating these effects. However, commonly applied approaches to estimate effects of exposure mixtures often yield results that are difficult to interpret and are not easily mapped to public health actions.

METHODS: By applying a potential outcomes framework for causal inference, investigators can ask questions about exposure mixtures that simulate effects of real-world interventions on sources of mixtures components. I discuss how to frame policy-relevant questions on sources of mixture components, and compare the interventions implied by common supervised and unsupervised analytic approaches. I also describe Bayesian g-computation, a promising statistical framework for estimating health effects of interventions on sources of exposure mixture components.

RESULTS: Many common statistical approaches to address exposure mixtures yield results in the form of complex exposure-response surfaces or independent effects that do not acknowledge real-world correlation. In contrast, g-computation explicitly specifies a causal question and compares the expected outcome under exposure distributions that would occur with and without a hypothetical intervention on an exposure source. Applying a Bayesian approach to g-computation is useful to address common statistical challenges that occur in mixtures analyses such as high correlation and sparse data.

CONCLUSIONS: Framing mixtures questions as potential interventions can improve causal inference and has the advantage of more directly informing potential environmental health practices, programs, and policies.

Keywords: Causal inference, Environmental epidemiology, Mixtures analysis



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 20

Civic Engagement by Scientists in North America: Experiences and Opportunities

Chairs: George D Thurston, United States & Paul Villeneuve, Canada

O-SY-101

Policy » Research translation to affect policy and practice

Scientist Civic Engagement and the US Ozone Standards in 2020

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BACKGROUND AND AIM: In 2020, the United States Environmental Protection Agency (EPA) proposed to retain, without revision, its national primary and secondary ozone National Ambient Air Quality Standards (NAAQS). As exposure scientists and environmental epidemiologists, we recognized that this decision may not have reflected the most updated research on ozone and population health effects. We thus aimed to inform the EPA of the state-of-the-science through official channels.

METHODS: Within the North American Chapter (NAC) of the International Society for Environmental Epidemiology (ISEE), the Policy Committee worked as a team to gather, synthesize, and communicate evidence on ozone effects on population health. For the ozone NAAQS, one member attended the oral comment sessions and led the effort to draft and submit a written comment to the EPA.

RESULTS: At the ISEE NAC Policy Committee, we recognized a proposed ruling that would have affected air quality in the US. We effectively organized to engage government stakeholders and communicate the latest research on ozone and population health. These actions entered into the public record a statement aimed at a general audience on the effects of ozone along with supporting scientific articles. Such materials could be considered in a court of law if and when a decision on the ozone NAAQS is contested.

CONCLUSIONS: Environmental exposure and epidemiology research have the potential to inform policy decisions. The ISEE NAC Policy Committee provides an avenue for scientists to gain experience in communicating the research implications to decision-makers.

Keywords: Ozone, Research translation, Science communication, Policy



ABSTRACT E-BOOK

August 25, 2021 / 15:30 - 17:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 20

Civic Engagement by Scientists in North America: Experiences and Opportunities

Chairs: George D Thurston, United States & Paul Villeneuve, Canada

O-SY-102

Policy » Research translation to affect policy and practice

Scientist Civic Engagement and the US 2020 Fine Particulate Matter Standards

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BACKGROUND AND AIM: In 2020 the US Environmental Protection Agency (EPA) decided to retain the National Ambient Air Quality Standards (NAAQS) for fine particles (PM_{2.5}), despite very strong evidence of an association between long- and short-term exposure to PM_{2.5} and numerous adverse health outcomes below the current standard. The ISEE North American Chapter (NAC) submitted a public comment in strong opposition to this EPA decision. Furthermore, ISEE NAC members also scheduled a teleconference with the Office of Management and Budget at the White House to express our continued concern about the unwarranted changes the EPA made to the Clean Air Scientific Advisory Committee and the NAAQS review process.

METHODS: ISEE NAC and the NAC Policy Committee have set up a rigorous process to prepare and submit public comments in response to proposed EPA rules. One or two Policy Committee members prepare the first draft of the comment. Subsequently, the full Policy Committee edits and approves. Finally, the ISEE NAC Executive Council reads, edits, and approves the comment. A member of the Policy Committee submits the approved comment accompanied with pdfs of papers referenced in the comment.

RESULTS: In June 2020, ISEE NAC submitted a four-page comment on EPA's decision to retain the PM_{2.5} standards. This decision was contrary to the state of the science and EPA's Integrated Science Assessment (ISA), which clearly demonstrates that deaths and cardiovascular events, such as heart attacks, are produced by PM_{2.5} below 12 µg/m³ (the previous standard) and, hence, the Administrator's decision violated the Clean Air Act requirement to use the "best available science" and set standards "to protect public health with an adequate margin of safety."

CONCLUSIONS: In this case study, we will describe the process activities and issues raised by the ISEE NAC Policy Committee during the EPA setting of the US PM_{2.5} standard in 2020 and future prospects.

Keywords: Particulate Matter, Policy, Air Pollution



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SYMPOSIUM 20

Civic Engagement by Scientists in North America: Experiences and Opportunities

Chairs: George D Thurston, United States & Paul Villeneuve, Canada

O-SY-103

Policy » Research translation to affect policy and practice

Scientist Civic Engagement and the US EPA's "Strengthening Transparency in Regulatory Science" Rule

George D Thurston

New York University Grossman School of Medicine

BACKGROUND AND AIM: For decades, vested interests, including tobacco and oil companies, have sought access to data used by observational epidemiologists, even when involving private health data. This has included attacks on environmental epidemiology, calling it "Secret Science", in tandem with efforts to push legislation through the US Congress. History has shown that vested industries have abused such data access, and the legislation failed. More recently, the Trump Administration attempted a regulatory "end around" of Congress, via the so-called "Strengthening Transparency in Regulatory Science" rule.

METHODS: The North American Chapter (NAC) Policy Committee participated in preparing and presenting written and oral testimony to the US EPA and Office of Management and Budget (OMB) during hearings and requested meetings. These submissions are online at our web page: <https://isee-northamerica.github.io/isee-nac/policy.html>. These records documented the many problems with the proposed regulation, including: increased potential for compromise of medical record confidentiality; a loss of intellectual property; imposition of a government unfunded mandate; likely abuse of the research data to inappropriately undermine science credibility; and, damage to future scientific research recruitment efforts.

RESULTS: The ISEE NAC Policy Committee recognized the above noted dangers to scientific research, and especially environmental epidemiology and took action, via civic engagement with the government, to put in place a record of those problems for future consideration by the courts in likely later legal efforts to overturn the ill-conceived regulation. At the same time, these government meetings, along with those by other scientific societies, slowed the progress of this potential regulation. In addition, scientists worked with lawyers to prepare legal challenges to the regulation. Ultimately, these efforts succeeded in delaying the regulation long enough for it to be successfully revoked by the incoming Biden Administration.

CONCLUSIONS: The ISEE NAC Policy Committee provides a means for our member scientists to successfully influence government decision-making through civic engagement.

Keywords: Policy, Research translation, Science communication, Transparency, Civic engagement



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SYMPOSIUM 20

Civic Engagement by Scientists in North America: Experiences and Opportunities

Chairs: George D Thurston, United States & Paul Villeneuve, Canada

O-SY-104

Policy » Policy research

Indoor radon regulation in Canada: Civic engagement of concerned scientists

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BACKGROUND AND AIM: The World Health Organization recommends 100 Bq/m³ as a reference level for indoor radon. However, Canada's federal guideline remains at 200 Bq/m³, even though a significant number of lung cancer cases are predicted to occur below this level. The study reviews current radon reference levels in industrialized countries and explores the role that scientist engagement, application of environmental epidemiology and public advocacy play in shaping the regulatory landscape. **METHODS:** Review of policy documents and public consultations, and peer-reviewed articles. **RESULTS:** Over the past ten years, new dosimetric modeling studies and occupational cohort evidence have added to the body of evidence with regard to radon's carcinogenic potential. This new evidence highlights the danger posed by living and working in buildings with even in relatively low levels of radon. In Europe, many countries have established limits that reflect this evidence, although the North American policy landscape has seen little change. Some of the drivers of European policy change include the engaged role of scientists in knowledge translation and the centralized nature of the European Union's regulatory framework.

CONCLUSIONS: New scientific evidence continues to affirm the dangers of radon gas exposure at low levels and North American governments should reassess their current regulatory landscape in response. More engaged knowledge translation by scientists may help bridge the gap between evidence and policy in North America.

Keywords: Radon, Canada, Civic engagement,



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SYMPOSIUM 20

Civic Engagement by Scientists in North America: Experiences and Opportunities

Chairs: George D Thurston, United States & Paul Villeneuve, Canada

O-SY-105

Policy » Research translation to affect policy and practice

Stepping Out Of The Lab: Civic Engagement Across Scientific Societies and the Broader Scientific Community in Recent Years

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BACKGROUND AND AIM: Researchers in science, technology, engineering, math, and medicine (STEMM) have historically been disengaged from policy debates in many instances. However, an uptick in engagement of the scientific community in federal policy has been observed in recent years.

METHODS: In the last five years, for example, many scientific societies and public interest groups have developed new or expanded programs to help train researchers and facilitate engagement opportunities, including meetings with Congressional staff, public comment writing for the federal docket, and direct engagement with the media on policy issues. Engagement also increased in other metrics, including scientist sign-on letters, participation levels in federal rulemaking, experts donating their time and expertise to provide independent science advice to decisionmakers, and the level of interest in policy conversations at scientific society meetings.

RESULTS: Importantly, what was the effect of such engagement? Has there been positive impact of more technical experts engaging in policy process? Will such high levels of engagement be sustained through current and future presidential administrations? This talk will explore the real-world outcomes observed following meaningful engagement of STEMM experts in federal policy, using a few recent case studies. Examples will include instances of broad scientific community opposition to problematic policy proposals at the US Environmental Protection Agency, scientific community contributions to scientific priority setting under the Biden administration, and significant engagement from key experts on the National Ambient Air Quality Standards for particulate matter.

CONCLUSIONS: Finally, a forward-looking perspective will be offered, including the potential for sustained heightened engagement levels and upcoming federal policy engagement opportunities for scientific researchers. Discussion of how engagement of STEMM experts can be sustained at the individual and institutional levels will also be raised.

Keywords: policy, scientific societies, engagement, activism, science advice, science policy



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SYMPOSIUM 21

Inferential Challenges and Methodological Solutions in Air Pollution Epidemiology Studies

Chair: Tarik Benmarhnia, United States

O-SY-106

Methods » Environmental epidemiology

Estimating the effect of long-term exposure to PM_{2.5} on mortality in Canadian Community Health Survey Cohort using parametric g-computation

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BACKGROUND AND AIM: Numerous epidemiological studies reported the adverse health impact of long-term exposure to fine particulate matter (PM_{2.5}) on mortality across populations. However, previous studies mostly utilized traditional outcome regression approaches, which may fail under certain circumstances (e.g., if exposure-confounder feedback exists). We aim to explore this health impact using g-computation, which could validate traditional regression approaches and refine the effect estimates by considering more complex circumstances in the identification.

METHODS: We utilize a cohort of ~540,000 respondents to the Canadian Community Health Survey from 2001 to 2012, whose death records and residential history were ascertained till 2016. Annual postal code specific three-year average PM_{2.5} concentration with one-year lag was derived from satellite measurements and linked to cohort respondents, with quintiles of exposure calculated for each calendar year. We apply parametric g-computation with pooled logistic regression adjusted for socio-economic, behavioral, and time-varying covariates to estimate 1) the effect on mortality by changing the long-term PM_{2.5} exposure level from the higher quintiles to the lowest quintile; and 2) the effect on mortality by reducing the long-term PM_{2.5} exposure levels from the observed values to below the national standard. We also evaluate the influence of exposure-confounder feedback and discuss whether other identification assumptions hold in assessing health impacts of air pollution.

RESULTS: Our preliminary results confirm an increase in the risk of premature mortality in relation to long-term exposure to PM_{2.5}.

CONCLUSIONS: These results provide evidence on the effect of long-term exposure to PM_{2.5} on mortality in the presence of time-varying exposures and confounders. It also provides an alternative analytical strategy highly useful to air pollution epidemiological research, especially for evaluating specific intervention strategies.

Keywords: g-computation, casual inference, chronic exposure to PM_{2.5}, mortality



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SYMPOSIUM 21

Inferential Challenges and Methodological Solutions in Air Pollution Epidemiology Studies

Chair: Tarik Benmarhnia, United States

O-SY-107

Methods » Causal inference

A discussion of competing events in epidemiologic studies of air pollution

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BACKGROUND AND AIM: Adverse health impacts of air pollution are well-documented in epidemiologic studies. However, one inferential challenge in estimating the effect of air pollution on chronic conditions arises from competing events. In observational studies, other health outcomes may preclude or “compete” with the outcome of interest. Although a variety of approaches and frameworks to consider competing events have been described in epidemiologic literature, they are underutilized in studies of air pollution. This research aims to present case studies demonstrating competing events and provides solutions to address inferential questions.

METHODS: Three approaches were demonstrated to account for competing events, each with unique assumptions and target estimands. First, a controlled direct effect, not mediated by the competing event, was estimated with a cause-specific hazard ratio. Next, the total effect, including pathways through the competing event was estimated with a subdistribution hazard ratio. Finally, inverse probability weights were applied to correct for time-varying informed censoring due to a competing event and estimate a weighted cause-specific hazard ratio. Various sensitivity analyses will also be discussed.

RESULTS: Findings from this study underscore the limited consideration of competing events in epidemiologic studies of air pollution and highlight three approaches to account for competing events.

CONCLUSIONS: Consideration of competing events will allow for more robust inferences from epidemiologic studies. We provide recommendations for future investigators considering competing events in epidemiologic studies of air pollution and chronic conditions.

Keywords: Air pollution, epidemiology, causal inference



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 21

Inferential Challenges and Methodological Solutions in Air Pollution Epidemiology Studies

Chair: Tarik Benmarhnia, United States

O-SY-108

Methods » Causal inference

Causal Inference and Machine Learning approaches to discover de novo sub-populations with heterogeneous air pollution health effects

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BACKGROUND AND AIM: In environmental health sciences, it is critically important to identify subgroups of the study population where a treatment (or exposure) has a notably larger or smaller causal effect on an outcome compared to the population average.

METHODS: In this paper, we propose a new causal rule ensemble (CRE) method that: 1) discovers de novo subgroups with significantly heterogeneous treatment effects (i.e., causal rules); 2) ensures interpretability of these subgroups because they are defined in terms of decision rules; and 3) estimates the causal effect for each of these newly discovered subgroups with small bias and high statistical precision. We also introduce a new sensitivity analysis to unmeasured confounding bias.

RESULTS: We apply the proposed CRE method to the Medicare data to study the heterogeneous effects of long-term exposure to PM_{2.5} on 5-year mortality. The population consists of Medicare beneficiaries in New England regions in the United States between 2000 and 2006. The treatment is whether the two-year (2000-2001) average of exposure to PM_{2.5} is greater than 12 μ g/m³. The outcome is five-year mortality measured between 2002-2006. We found that younger than 80 years old and not eligible for Medicaid are significantly less vulnerable than the baseline subgroup. Results were not sensitive to unmeasured confounding bias.

CONCLUSIONS: We introduce a new method for studying treatment effect heterogeneity that notably improves interpretability in terms of causal rules. The proposed CRE methodology provides a more stable approach to discover and estimate heterogeneous effects while maintaining high levels of interpretability.

Keywords: Air pollution, causal inference, mortality, methodological study design



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SYMPOSIUM 21

Inferential Challenges and Methodological Solutions in Air Pollution Epidemiology Studies

Chair: Tarik Benmarhnia, United States

O-SY-109

Methods » Environmental epidemiology

Changes in residential exposure to ambient fine particulate matter due to relocation and long-term survival in Canada: a quasi-experimental study

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BACKGROUND AND AIM: Despite significant advances in understanding the health burden of hypothetical changes in ambient fine particulate matter (PM_{2.5}), less is known how actual changes in PM_{2.5} levels may influence its long-term adverse effects, especially on mortality. We aimed to conduct a quasi-experiment to evaluate the association between mortality and changes in PM_{2.5} in Canada.

METHODS: We identified movers from a national cohort of Canadian census respondents (>10 million) who were aged 25-89 years, had a history of either high or low exposure to PM_{2.5} before census day, and moved within the following five years, yielding two cohorts. Exposures were ascertained using satellite-derived PM_{2.5} measurements based on movers' postal-code addresses since five years before the census day. To assess the relationship between changes in PM_{2.5} and mortality, we conducted a propensity score matching analysis with Cox proportional hazards model including various covariates. We did various sensitivity analyses, such as considering multiple imputation.

RESULTS: Residential mobility yielded a decline in annual PM_{2.5} exposure from ~10 µg/m³ to 7.4 µg/m³ and to 5.0 µg/m³ in the high to intermediate (or low) movers. Conversely, annual PM_{2.5} increased from ~4.6 µg/m³ to 6.7 µg/m³ and to 9.2 µg/m³ in the low to intermediate (or high) movers. Over five years after the move, we observed a 6.8% reduction in mortality among individuals whose PM_{2.5} exposures decreased from high to intermediate levels (95% confidence interval: 1.7%-11.7%). A greater decline in mortality was observed among individuals with a larger reduction in exposures. These results were consistent in sensitivity analyses. Additionally, we found an increase in mortality with elevated PM_{2.5} exposure.

CONCLUSIONS: Decreases in PM_{2.5} were associated with lowered mortality whereas increases in PM_{2.5} were associated with elevated mortality in Canada. These results were found at the PM_{2.5} levels considerably lower than many other countries, providing support for continuously improving air quality.

Keywords: quasi-experiment, fine particulate matter, mortality



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

SYMPOSIUM 22

Air Pollution and Human Reproduction: What Do We Know and Where Do We Go From Here?

Chairs: Amelia Wesselink, United States & Sabah Quraishi, United States

O-SY-110

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

Air Pollution and Reproduction: A focus on the clinical perspective

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BACKGROUND AND AIM: Air pollution is widely known to affect human cardiopulmonary health, but only recently has research begun to focus on understanding the association between ambient air pollution and reproduction.

METHODS: In this 15-minute symposia presentation, I will provide a basic overview of relevant potential biological mechanisms after air pollution exposures on reproductive physiology. The physiology of human reproduction and the pathophysiology of infertility, clinical aspects in relation to outcome definitions, exposure assessment, and will be discussed using literature review and clinical experience. Key papers will be discussed within the clinical context of reproductive endocrinology and infertility with a focus on early embryo development and the uterine micro-environment.

RESULTS: Human reproduction requires gametogenesis, fertilization, implantation, and post-fertilization fetal development. Ambient in-vitro and in-vivo embryo growth environments will be compared in relation to gaseous concentrations, including oxygen and carbon dioxide. Existing research on air pollution and reproduction will be discussed in relation to clinical aspects of gamete development and embryo culture environments.

CONCLUSIONS: Air pollution exposures have been studied in the clinical fertility centers as well as at a population level. Air pollution exposures, broadly defined, have an impact on human reproduction, though much is still yet to be determined. Using a physiological basis, including embryo development and the uterine air pollution exposures and reproductive outcomes.

Keywords: air pollution, gametogenesis, fertilization, implantation, post-fertilization development



ABSTRACT E-BOOK

August 25, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

SYMPOSIUM 22

Air Pollution and Human Reproduction: What Do We Know and Where Do We Go From Here?

Chairs: Amelia Wesselink, United States & Sabah Quraishi, United States

O-SY-111

Air pollution » General

Air pollution and fecundability in two preconception cohort studies

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BACKGROUND AND AIM: Increasingly, epidemiologic studies have indicated an association between air pollution and reduced fertility. However, most studies have been conducted in small, selected populations, among couples receiving fertility treatment, or have used residential distance to roadways as a proxy for air pollution exposure. In this symposium presentation, we will review the literature on air pollution and fertility, and present new results from two preconception cohort studies based on improved exposure estimation.

METHODS: We conducted parallel analyses in two internet-based cohorts in North America (Pregnancy Study Online [PRESTO], n=3,812) and Denmark (Snart Gravid/Snart Foraeldre [SG/SF], n=10,183). Eligible women were aged 18-45 years and attempting to conceive without fertility treatment. Participants completed a baseline questionnaire on socio-demographic, medical, reproductive, and behavioral factors. They were followed every two months until pregnancy or up to twelve months. We geocoded time-varying residential addresses from the year before baseline until conception or censoring. In PRESTO, we used spatio-temporal models to estimate monthly concentrations of NO₂, O₃ and PM_{2.5} (2013-2017), and in SG/SF monthly concentrations of NO₂, NO_x, CO, O₃, SO₂, PM_{2.5} and PM₁₀ (2007-2019). We used proportional probabilities models to compute fecundability ratios (FR) and 95% confidence intervals (CI), adjusting for potential individual- and neighborhood-level confounders and co-pollutants.

RESULTS: Preliminary analyses in PRESTO suggested a slight reduction in fecundability at higher average annual PM_{2.5} concentrations (≥ 10 vs. < 6 $\mu\text{g}/\text{m}^3$: FR=0.87, 95% CI: 0.70-1.07) with little evidence of a linear association; analyses of NO₂ and O₃ are ongoing. In SG/SF, PM_{2.5} concentrations were also associated with slightly reduced fecundability (≥ 13.0 vs. < 8.0 $\mu\text{g}/\text{m}^3$: FR=0.84, 95% CI: 0.62-1.14); other pollutants were not appreciably associated with fecundability.

CONCLUSIONS: Higher estimated exposure to PM_{2.5} was associated with slightly lower fecundability in North American and Danish cohorts, after controlling for multiple potential confounders and other pollutants.

Keywords: air pollution, PM 2.5, fecundability, fertility, preconception cohort



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August 25, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

SYMPOSIUM 22

Air Pollution and Human Reproduction: What Do We Know and Where Do We Go From Here?

Chairs: Amelia Wesselink, United States & Sabah Quraishi, United States

O-SY-112

Birth and Pregnancy Outcomes » Pregnancy outcomes

Opportunities and challenges in studying air pollution and pregnancy loss

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BACKGROUND AND AIM: Pregnancy loss is common (spontaneous abortion/miscarriage: 30%, stillbirth: 1%) but its cause is largely unknown. Air pollution has a wide range of reproductive health effects but its effects on pregnancy loss is unclear. We summarize current epidemiologic research and highlight key challenges and opportunities for future research on this important but understudied topic.

METHODS: A comprehensive literature review of original epidemiologic studies (before March 2021) on ambient air pollutants and pregnancy loss at all gestational age (i.e., miscarriage, spontaneous abortion, stillbirth) was performed. We excluded studies that a) did not focus on specific outdoor pollutants (i.e., indoor smoke) or b) assessed occupational exposures.

RESULTS: Thirty-five (n=35) epidemiologic studies were identified, most of which were conducted in the US (35%), China (17%), and Iran (11%); and estimated air pollution exposures using fixed air stations near maternal residence (66%). The majority of the studies evaluated stillbirths ≥ 20 weeks (n=19). Pollutants including SO₂, PM₁₀, and PM_{2.5}, CO, NO₂, and O₃ are positively associated with both spontaneous abortion/miscarriage and stillbirth. Critical windows of exposure are unclear but both acute (prior week) and chronic exposures (average over the gestational length and trimester specific) have been suggested. Major challenges include a) lack of personal exposure or data on residential mobility/daily activities, b) exclusion of early losses in retrospective data, c) small clinical samples seeking infertility treatment, d) inconsistent definition of the outcome, e) lack of information on time of event, and f) confounding.

CONCLUSIONS: There is growing evidence suggesting that exposures to ambient air pollution, even in areas with moderate concentrations, may increase the risk of pregnancy loss. While awaiting larger preconception studies to address current challenges and further understand mechanisms of effects, it is prudent to minimize exposures among pregnant women and those trying to conceive.

Keywords: air pollution, pregnancy loss, pregnancy outcomes, stillbirth, spontaneous abortion



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Air Pollution and Human Reproduction: What Do We Know and Where Do We Go From Here?

Chairs: Amelia Wesselink, United States & Sabah Quraishi, United States

O-SY-113

Reproductive Outcomes » Female reproductive outcomes

The unique opportunities and obstacles when integrating personal air pollution monitoring into studies of human fertility

Audrey J Gaskins

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BACKGROUND AND AIM: Exposure to air pollution has been associated with increased risk of infertility and pregnancy loss; however, the majority of research to date has relied on indirect measurements of air pollution which may have significant limitations due to the temporal and spatial variability of outdoor air pollution and the limited time that people spend outdoors. Directly measuring personal exposure to air pollution is a growing topic of interest, particularly in reproductive epidemiology, given the relatively short time windows of exposure susceptibility.

METHODS: The Air Pollution, In Vitro Fertilization (IVF), and Reproductive Outcomes (AIR) Study recruited women undergoing a fresh, autologous IVF cycle at the Massachusetts General Hospital Fertility Center. On the first day of ovarian stimulation, women were instructed to wear a personal particulate matter (PM) air pollution monitor (AirBeam2©), which measures three size fractions of particulate matter (PM₁, PM_{2.5}, and PM₁₀), temperature, humidity, and GPS location, and complete a time-activity diary for the following 72-hour period.

RESULTS: Between September 2018 and November 2019, 14 (out of 31 eligible) women enrolled in the AIR Study. The majority (71%) of women who did not enroll began ovarian stimulation on the weekend, when study staff were not regularly in clinic. 10 women successfully collected air pollution data for a median (minimum, maximum) of 41.5 (8.4, 64.5) hours during ovarian stimulation. The median (interquartile range) exposure to PM₁, PM_{2.5}, and PM₁₀ was 0.7 (4.1), 2.1 (5.5), 3.2 (8.3) µg/m³, respectively. During this 72-hour window, women spent the majority of their time (72%) inside at home. Among the 4 women who were unsuccessful with the air monitors, limited battery life and frequent connection issues were cited as the main issues.

CONCLUSIONS: Personal air pollution monitors can be utilized to characterize short-term exposure and, when applied appropriately, may greatly enhance our understanding of how air pollution affects human reproduction.

Keywords: air pollution, particulate matter, reproductive outcomes, short-term exposure, exposure assessment



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Air Pollution and Human Reproduction: What Do We Know and Where Do We Go From Here?

Chairs: Amelia Wesselink, United States & Sabah Quraishi, United States

O-SY-114

Air pollution » General

Air pollution and environmental health disparities: how disadvantaged communities may be particularly susceptible to poor reproductive outcomes

Anjum Hajat

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BACKGROUND AND AIM: Disadvantage communities face differential exposure to high levels of air pollution and other environmental hazards. In addition to having fewer resources and several co-occurring risk factors such as increased psychosocial stress, fewer opportunities for health promoting behaviors and less access to high quality health care, they also have less access to protective factors. These factors drive differential susceptibility across population subgroups and can explain why disadvantaged populations suffer disproportionately from the negative health effects of air pollution. The aim of this presentation is to describe different models that frame differential exposure and susceptibility and provide evidence to support these phenomenon specifically among pregnant people and those who may become pregnant.

METHODS: I will present three frameworks/conceptual models that are rooted in theory and capture the way social and environmental factors interact to produce environmental health disparities.

RESULTS: The social production of disease model, the integrated social-environmental model of health and well-being, and the stress-exposure-disease model will be discussed. I will highlight the important contributions of each. Shared mechanistic pathways such as those involved with the stress response system (i.e., allostatic load), the inflammatory and sympathetic nervous systems will be emphasized. Lastly, I will present empirical evidence to support the theorized mechanisms and upstream social and contextual factors that contribute to environmental health disparities, with a specific emphasis on race and socioeconomic status, in reproductive health.

CONCLUSIONS: The use of conceptual frameworks rooted in theory can strengthen environmental health disparities research.

Keywords: air pollution, environmental health disparities, conceptual models, reproductive health



ABSTRACT E-BOOK

August 26, 2021 / 11:30 - 13:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 23

Coordination and Harmonisation of Occupational Cohorts, the international OMEGA-NET Network

Chairs: Ingrid Sivesind Mehlum, Norway & Michelle Turner, Spain

O-SY-115

Methods » Occupational epidemiology

Network on the Coordination and Harmonisation of European Occupational Cohorts (OMEGA-NET)

Ingrid Sivesind Mehlum¹, Maria Albin², Merete Drevvatne Bugge¹, Alex Burdorf³, Gemma Castaño⁴, Manolis Kogevinas⁴, Henrik Kolstad⁵, Raquel Lucas⁶, Damien Mcelvenny⁷, Neil Pearce⁸, Susan Peters⁹, Vivi Schlünssen¹⁰, Roel Vermeulen⁹, Michelle C Turner⁴

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BACKGROUND AND AIM: Employment is an essential component of adult life, and occupation is a major determinant of health. However, there has been little coordinated occupational health research in Europe and globally. Europe has many valuable occupational, industrial, and population cohorts. There is a need for integration of these cohorts to facilitate their exploitation, essential to underpin evidence-based interventions and policy.

METHODS: OMEGA-NET (omeganetcohorts.eu) is a COST Action network (2017–2021), funded by EU, currently involving researchers from 40 European, near neighbour and international partner countries. The overarching concept is to create a network to advance i) collaboration of existing cohorts, ii) coordination and harmonisation of occupational exposure assessment, and iii) facilitation of an integrated research strategy for occupational health in Europe.

RESULTS: OMEGA-NET is currently building two online searchable inventories: Inventory of Occupational Cohorts (presented in this mini-symposium), and Inventory of Exposure Assessment Tools. Working Groups are doing harmonisation of occupational exposure and health outcome information, as well as developing standardised protocols for future occupational exposure and health outcome information, some in the form of position papers. Harmonisation of occupational health outcomes currently include Burnout, Musculoskeletal disorders, Allergies and Cancer. Topics of the protocols or position papers include Healthy ageing and work participation, Working hours, Employment patterns in the young including young employed mothers, Occupational skin diseases, Work-related psychosocial determinants on mental health, Precarious employment (presented in this



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mini-symposium) and Migrant workers. OMEGA-NET also includes opportunities for networking, leadership and training for early career researchers in occupational epidemiology and exposure assessment, and visits to other research institutions, as well as stakeholder engagement.

CONCLUSIONS: Collaboration through OMEGA-NET will enhance the scientific occupational health research, recently demonstrated through EU funding of the EPHOR project (Exposome Project for Health and Occupational Research). OMEGA-NET is promoting much needed global collaboration on occupational health.

Keywords: International collaboration, Occupational epidemiology, Occupational exposures, Outcomes



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SYMPOSIUM 23

Coordination and Harmonisation of Occupational Cohorts, the international OMEGA-NET Network

Chairs: Ingrid Sivesind Mehlum, Norway & Michelle Turner, Spain

O-SY-116

Methods » Occupational epidemiology

OMEGA-NET Inventory of Occupational Cohorts

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BACKGROUND AND AIM: Existing cohort studies in Europe capturing some type of occupational information enrol tens of millions of persons. There are few large-scale analyses systematically combining cohorts from this extraordinary resource. To some extent this is due to the absence of systematic organization of data available. In the OMEGA-NET project we created an inventory of cohorts with occupational information in Europe and implemented an online interactive tool with detailed information on these cohorts. The inventory aims to collect information that facilitates collaboration across cohorts to explore occupation, work related exposures and health relationships.

METHODS: The inventory includes cohorts, case-control studies nested within cohorts and intervention studies that: (i) are active or can substantiate that their data are potentially accessible; (ii) collect data on occupation and/or industry or at least one occupational exposure; and (iii) have at least one follow-up either already conducted or planned. Information is collected using a web-based OMEGA-NET Inventory Questionnaire. The published version of the inventory is stored in a searchable web database.

RESULTS: To-date the inventory includes information on > 120 cohorts in more than 20 countries. Information is collected on: (i) Identification and basic description; (ii) Follow-up; (iii) Occupational Exposures (methods and specific exposures); (iv) Outcomes evaluated; (v) Biological samples and analysis; (vi) Other information e.g. Sociodemographic.

CONCLUSIONS: The OMEGA-NET inventory will continue to identify and invite cohorts both in Europe and worldwide ensuring the quality of submitted information. The inventory does not incorporate primary cohort data, rather only cohort meta-data, and seeks to capture the majority of available cohorts with information on occupational exposures, many of them being non-occupational in their primary aim. The development of an inventory of occupational cohorts is a first and important prerequisite for an exploitation of the extensive information that has been collected worldwide on occupation and health.

Keywords: Occupational epidemiology, Occupational exposures, International collaboration



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SYMPOSIUM 23

Coordination and Harmonisation of Occupational Cohorts, the international OMEGA-NET Network

Chairs: Ingrid Sivesind Mehlum, Norway & Michelle Turner, Spain

O-SY-117

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

Precarious employment - a theoretical framework for research in occupational health

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BACKGROUND AND AIM: The objective was to 1) review previous research on precarious employment (PE) and occupational health; 2) develop a theoretical framework that characterizes PE in relation to interconnected concepts and important contextual factors; and 3) identify gaps in current research on precarious employment and health.

METHODS: The authors met online on several occasions leading up to a two-day face-to-face conference in Stockholm in March 2019, after which a position paper was published in SJWEH 2019 (doi:10.5271/sjweh.3860).

RESULTS: There was a consensus that the lack of a common theoretical framework of PE prevents it from becoming a recognized part of occupational and public health research. While there are unresolved issues regarding the operationalization of PE in surveys and registers, we propose that conceptualization and measurement of PE must focus at the level of the employment relationship. We specifically embed the PE construct within other relevant levels of analysis—including antecedents to (e.g., globalization) and consequences of (e.g., experiences of job insecurity) PE—while also noting the important role of social and policy contexts in modifying the PE-health relationship.

CONCLUSIONS: A generally accepted definition of PE based on a multidimensional construct is of highest priority within occupational and public health research. Future studies should aim to develop operationalizations of PE based on the character of employment relations. Further, we call for studies that employ a multilevel perspective, especially testing possible mechanisms and modifying contexts, in order to understand the complexity of pathways between PE and health and to inform health-protective policy.

Keywords: Precarious Employment, Employment Arrangements, Occupational Health



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Coordination and Harmonisation of Occupational Cohorts, the international OMEGA-NET Network

Chairs: Ingrid Sivesind Mehlum, Norway & Michelle Turner, Spain

O-SY-118

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

COVID-19 and the Workplace

Lode Godderis¹, Jean Baptist Du Prel², Damien Mc Elvenny³, Susan Peters⁶, Vivi Schlünssen⁴, Ingrid Sivesind Mehlum⁵, Kurt Straif⁷, Michelle Turner⁸

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BACKGROUND AND AIM: The SARS-CoV-2 virus pandemics has raised several challenges at the workplace.

METHODS: Within the omega-net COVID-19 taskforce, we developed standardized COVID-19 questionnaires for occupational research, a multi-country COVID-19 Job Exposure Matrix, and research on COVID-19 as an occupational disease.

RESULTS: The compiled questionnaire resource covers all key aspects of the COVID-19 pandemic, including: COVID-19 diagnosis & prevention, Health and demographic, Use of personal protective equipment, Health effects, Work-related effects, Financial effects, Work-based risk factors, Psychosocial risk factors, Lifestyle risk factors, and Personal evaluation of the impact of COVID-19. For each of the domains additional questions are available. A second questionnaire (in a short and along version) focusses on occupational risk factors for SARS-CoV-2 infection and COVID-19 disease. The questionnaires are available online at <https://omeganetcohorts.eu/news/covid19-questionnaires-omeganet/>. The JEM was developed by experts from three European countries (Denmark, the Netherlands, UK), who defined the relevant exposure and workplace characteristics with regard to the possible exposure to SARS-COV 2 infection. The C19-JEM contains four determinants of transmission risk (number of people, type of people, indirect contact and location), two mitigation measures (social distance and face covering), and two social factors (income insecurity and migrant workers). Finally, we developed and piloted a questionnaire on COVID-19 as occupational disease, which provide data on 1) COVID-19 as occupational disease or injury, 2) criteria for recognition and compensation regarding exposure, disease, role of use of PPE and of competing non-occupational exposure; and 3) what can be compensated. Results are available from 36 largely European countries.

CONCLUSIONS: Through the development and implementation of tools we not only provide instruments, but also insights on the occupational risks and diseases in relation to SAR-COV 2.

Keywords: COVID-19, questionnaires, JEM, occupational disease



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SYMPOSIUM 23

Coordination and Harmonisation of Occupational Cohorts, the international OMEGA-NET Network

Chairs: Ingrid Sivesind Mehlum, Norway & Michelle Turner, Spain

O-SY-119

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

What is needed for federated learning in occupational cohorts?

Roel Vermeulen

Institute for Risk Assessment Sciences, Utrecht University, The Netherlands

BACKGROUND AND AIM: Occupational studies have been instrumental in not only identifying occupational but also environmental risk factors for ill health. As exposures are generally higher, occur in more defined and confined settings they may be better suited to study and detect environmental risks. Examples are occupational studies on environmentally relevant pollutants such as benzene, trichloroethylene, formaldehyde, PFOA and pesticides. However, as occupational exposures have generally decreased, with notable exceptions, and as the more hazardous chemicals have been phased out detecting these less hazardous exposures at lower levels of exposures is challenging.

METHODS: One way to overcome this challenge is to seek and leverage collaboration of cohorts with extensive occupational histories as to increase sample size. Pooling such cohorts would facilitate maximum exploitation of these resources, and therefore advancing etiological research. However, pooling demands harmonisation of endpoint, covariate, and exposure data. Harmonisation of exposure data has turned out to be taxing as many methods and tools are used in cohort studies for occupational exposure assessment. Furthermore, pooling of cohort data is increasingly difficult due to national and international privacy regulations necessitating federated learning solutions.

RESULTS: In OMEGA-NET we inventoried the different methods in occupational exposure assessment to facilitate a concerted effort on harmonization of occupational exposure data to allow pooling and replication of findings. Furthermore, we explored the use of federated learning solutions such as datashield to facilitate virtual pooled analyses.

CONCLUSIONS: Federated learning within occupational cohorts could be instrumental in identifying new occupational and environmental risks. To fully harness the collective resource on occupational risks we need to facilitate further harmonization and pooling of these resources.

Keywords: occupational exposure, FAIR, federated learning, harmonisation, exposure assessment



ABSTRACT E-BOOK

August 26, 2021 / 11:30 - 13:00 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 23

Coordination and Harmonisation of Occupational Cohorts, the international OMEGA-NET Network

Chairs: Ingrid Sivesind Mehlum, Norway & Michelle Turner, Spain

O-SY-120

Cancer and Cancer-Precursors » Survival

Occupational Cohort Studies in North America: Opportunities for Collaboration with OMEGA-NET partners

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BACKGROUND AND AIM: While establishing and maintaining occupational cohorts is resource-intensive, findings from these studies often provide the basis for evidence-based policy decisions. The global harmonization of occupational cohort studies, as proposed by the OMEGA-NET project, will increase their value. This presentation provides an overview of selected U.S. and Canadian occupational cohorts, highlighting international collaborations. We will also discuss characteristics of successful international collaborations in progress, and some of the challenges.

METHODS: The National Institute for Occupational Safety and Health has over 70 industrial cohorts representing a range of exposures including metals, organic compounds, particles and physical agents. Inclusion criteria vary and cohort sizes range from a few hundred to over 100,000. Many cohorts have detailed exposure histories and job-exposure matrices. In the U.S., cause of death and cancer incidence are determined by linkage with the U.S. National Death Index and state-based cancer registries, respectively. In Canada, cohort studies focused on specific industries (e.g. mining or forestry) or very large multi-industry cohorts have been conducted using national mortality and tumor registry or provincial medical record linkages.

RESULTS: Several North American occupational cohorts currently participate in international pooled studies, including the International Nuclear Workers Study (INWORKS; n=308,000); the Pooled Uranium Miner Analysis (PUMA; n=120,000); and A Consortium of Agricultural Cohorts (AGRICOH; 22 cohorts). Potential cohorts that could involve global collaboration include workers exposed to engineered nanomaterials, firefighters, flight crew, and styrene. Challenges of pooling data include privacy concerns, and institutional restrictions on data sharing. Benefits of encouraging OMEGA-NET users to include North American occupational cohorts in pooled studies include the increased ability to investigate effect heterogeneity due to diversity of participants.

CONCLUSIONS: Occupational exposures are among the most important modifiable risk factors in public health. The OMEGA-NET activity promotes collaborative and harmonized research that will enable evidence-based decision-making to reduce occupational disease.

Keywords: Cancer, International Pooled Studies, Occupational



ABSTRACT E-BOOK

August 26, 2021 / 11:30 - 13:00 / Times Square Hall (Hall 3)

SYMPOSIUM 24

Towards 'Pesticidovigilance': Do We Have the Tools to Monitor Pesticide Exposures Related Health Outcomes in Vulnerable Populations?

Chairs: Roel Vermeulen, Netherlands & Beate Ritz, United States

O-SY-121

Omics Technologies » Metabolomics

Pesticide Exposure, Systems Biology, and Parkinson's disease

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BACKGROUND AND AIM: Since 1972, California law mandates the recording of all agricultural pesticide use to the pesticide use reports database, documenting nearly 50 years of applications of hundreds of pesticides.

METHODS: We developed an untargeted "Pesticide-wide Association Study" approach for handling this vast exposure data in a community-based study of rural Central California residents to assess chronic and long-term health effects.

RESULTS: Using this agnostic approach analyzing exposure information for >300 pesticides in a study of Parkinson's disease (PD) n=1870, we have implicated 33 real-world pesticide profiles most strongly associated with PD (FDR<0.01). The strength of this agnostic analysis is that it highlights out of all pesticides used in California the most strongly associated and suggests novel associations. For instance, our top associated pesticide was sodium chlorate (OR=1.26 per log-transformed lbs/acre applied, 95% CI=1.16-1.36, p=1.1e-8), a defoliant sprayed primarily on cotton. Correlation analysis revealed trends of co-applications and exposure clusters, including a cluster of 8 pesticides almost exclusively applied on cotton (>97% reported usage). Based on overrepresentation analysis, the organophosphate, organoarsenic, and n-methyl-carbamate classes and the insecticide and solvent types were significantly overrepresented in the group of PD-associated pesticides. Linking the pesticides to tox21, we found these pesticides were linked to various mechanisms of interest in PD, including mitochondrial membrane permeability (enrichment p-value=1.8e-2), xenobiotic homeostasis (p=5.46e-5), and sex hormone homeostasis (p=3.03e-3). We were further able to implicate PD specific pathways through integrative omics analysis, relating the matrix of PD-associated pesticides to matrices of multiple omic layers (methylome, metabolome, and genome), using systems biology to describe pesticide-associated



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ABSTRACT E-BOOK

biologic pathways perturbed more among patients versus controls, and thus contributing to PD even under chronic low-level exposure scenarios.

CONCLUSIONS: We developed an exposure assessment approach based on novel tools in the era of big data and omics and implicate new pesticide exposures and biologic pathways in PD.

Keywords: Pesticides, systems biology, Parkinson's disease



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SYMPOSIUM 24

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Chairs: Roel Vermeulen, Netherlands & Beate Ritz, United States

O-SY-122

Exposure Assessment Methods » Exposure assessment-general

Environmental pesticide concentrations in air and pregnant women's urinary pesticide metabolites in the Infants' Environmental Health Study (ISA)

Andrew Giffin¹, Jane Hoppin², Leonel Córdoba Gamboa³, Karla Solano Díaz³, Clemens Ruepert³, Jorge Peñaloza Castañeda³, Christian Lindh⁴, Brian Reich¹, Berna Van Wendel De Joode³

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BACKGROUND AND AIM: We evaluated associations between environmental pesticide concentrations in air and specific urinary pesticide metabolites among pregnant women from the Infants' Environmental Health Study (ISA) in Matina County, Costa Rica.

METHODS: We used a Bayesian spatiotemporal model to extrapolate concentrations of the fungicide pyrimethanil and the insecticide chlorpyrifos measured with polyurethane foam passive air samplers (n=48, from 12 schools) across space and time. Using mixed models, we compared them with urinary specific-gravity corrected pesticide metabolite concentrations: 4-hydroxypyrimethanil (OHP, metabolite of pyrimethanil) and 3,5,6-trichloro-2-pyridinol (TCPy, metabolite of chlorpyrifos), repeatedly obtained among 451 pregnant women from the ISA Study (n=951). Pyrimethanil in air, OHP, and TCPy were log-transformed prior to statistical analysis to normalize residuals of models. We considered several covariables.

RESULTS: Median (p10-p90) concentrations were: pyrimethanil = 1.33 (0.27-17.0) ng/m³, chlorpyrifos = 15.62 (4.38 - 24.19) ng/m³, OHP = 0.39 (0.06- 2.75) µg/L, and TCPy = 1.63 (0.75-4.27) µg/L. A 10% increase in pyrimethanil in air was associated with a 5.7% (95% CI 4.6, 6.8) increase in urinary OHP (µg/L), women who lived near banana plantations had higher OHP, whilst frequent consumption of rice and beans was associated with lower OHP. In addition, each 1 ng/m³ increase in chlorpyrifos in air was associated with a 1.5% increase in TCPy (µg/L), and women who worked in agriculture tended to have higher TCPy.

CONCLUSIONS: Despite the limitations of having limited data on pesticide air concentrations in space and time, and biomonitoring of pesticides with short half-lives, the results of this study indicate environmental air concentrations of pyrimethanil and chlorpyrifos explained to some extent internal pesticide metabolite concentrations in pregnant women. Our results suggest that inhalation of these pesticides is one of the pathways of environmental exposure. Passive air sampling of current-use pesticides seems a promising method to monitor environmental pesticide exposure.

Keywords: passive air sampling, pesticides, environmental exposure, biomonitoring



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SYMPOSIUM 24

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Chairs: Roel Vermeulen, Netherlands & Beate Ritz, United States

O-SY-123

Exposure Assessment Methods » Exposure assessment-biomarkers of exposure

Pesticide monitoring of vulnerable populations in Uganda and South Africa

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BACKGROUND AND AIM: Weak governance of pesticides and poor knowledge, attitude and agricultural practices result in farmers and their families being exposed to multiple pesticides in Africa. What are the important routes of exposure and are there interconnections between family members? How can we quantify exposure to multiple pesticides in these most vulnerable populations?

METHODS: First, we provide results from our systematic literature review on pesticide environmental contamination, human exposure and health issues on the African continent. Second, we show pesticide exposure situations from two fundamentally different farming systems using longitudinal data from our PESTROP cohort study in Uganda with smallholder farmers and from our CapSA cohort study investigating children in areas with large-scale agriculture production in South Africa. Finally, pesticide exposure assessment tools to monitor multiple pesticides will be highlighted (e.g., passive air sampling, questionnaire-based exposure algorithms, urinary biomarkers and wristbands).

RESULTS: Only from few countries in Africa research studies are available on pesticide exposure. Also, most research studies focus on organochlorine pesticides, while research on currently used pesticide classes is lacking or only crude exposure assessments are done (e.g., sprayers vs non-sprayers). This is problematic as in our two cohorts, we showed that (high) exposure to multiple currently used pesticides over time is the reality for farmers and their children (also to pesticides that are already banned in the EU).

CONCLUSIONS: We developed low-cost and context-specific assessments to monitor exposure to multiple pesticides in remote areas in Africa. Such tools could be used in intervention studies to monitor their efficiency to reduce exposure and resulting health risks from multiple currently used pesticides. This is done, for example, within our new initiative "African Pesticide Intervention Study (APSENT)" where we use these assessment tools, bring stakeholders together and thereby reduce pesticide exposure and associated risks.

Keywords: Africa, Pesticide, Exposure, urine, wristband, air



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SYMPOSIUM 24

Towards 'Pesticidovigilance': Do We Have the Tools to Monitor Pesticide Exposures Related Health Outcomes in Vulnerable Populations?

Chairs: Roel Vermeulen, Netherlands & Beate Ritz, United States

O-SY-124

Chemical exposures » Pesticides

From modeling, measuring, to exposomics - a Roadmap to pesticidovigilance

Roel Vermeulen

Institute for Risk Assessment Sciences, Utrecht University, The Netherlands

BACKGROUND AND AIM: Pesticides are often linked to ill health. However, to determine the role of specific pesticides in the causation of diseases detailed high-quality exposure assessment is required. Recently, several advancements have been made in exposure assessment of pesticides varying from improved models to predict residents exposures to the use of large pesticide screens in biological fluids.

METHODS: The pesticide assessment toolbox consists currently of worker, bystander and residents exposure models, a diversity of measurement techniques to quantify pesticides in different environmental domains (air, water, dust), and personal measurements through biomonitoring, omics-technologies and wearables. But which techniques can be successfully implemented in which circumstances, and what is the minimal input data needed?

RESULTS: In this interactive session we will explore the roadmap towards pesticidovigilance in different populations including vulnerable populations. We will identify and discuss where the methodological and input data gaps are and how these could be overcome.

CONCLUSIONS: Given the sustained public concerns around pesticide exposures it is important to facilitate better studies on pesticide and health using diverse study designs and exposure assessment methods. The outcome of this workshop should result in the formulation of the top research priorities in pesticidovigilance.

Keywords: Pesticides, Exposure Assessment, Wearables, OMICs, biomonitoring, Modelling



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SYMPOSIUM 24

Towards 'Pesticidovigilance': Do We Have the Tools to Monitor Pesticide Exposures Related Health Outcomes in Vulnerable Populations?

Chairs: Roel Vermeulen, Netherlands & Beate Ritz, United States

O-SY-125

Birth and Pregnancy Outcomes » Birth outcomes

Linking Pesticide Use Records and Birth Certificates in Arizona

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¹University of Arizona

²University of California at Los Angeles

BACKGROUND AND AIM: Pesticide use registries (PURs) can be used to estimate geospatially-based pesticide exposures during pregnancy. These measures can provide a complementary approach to biomarker measures, by inexpensively estimating exposures across entire trimesters and/or pregnancy, in large populations. Here we present a study linking data from a pesticide use registry in Arizona with five years of birth records in the agricultural county of Yuma. We estimate trimester-specific associations and modification by race/ethnicity.

METHODS: We calculated the log of pounds of organophosphate (OP) and pyrethroid pesticides applied within 500 meters of addresses at birth for the years 2010-2014, by trimester. We describe exposure distributions and then use linear and logistic regression to examine associations of pesticide exposures with preterm birth (<37 weeks), birth weight, and birth length. We evaluated modification by maternal race/ethnicity (white/non-white), and controlled for maternal marital status, education, age, and child sex. All health and demographic variables were derived from the birth certificates.

RESULTS: 6,731 mothers were included. 54% of women lived within 500m of at least one pyrethroid application during pregnancy, and 33% near OP applications. For any given trimester, however, these numbers ranged from 18-23% for pyrethroids and 8-11% for OPs. In interaction models, first-trimester log pyrethroid poundage was negatively associated with birth weight ($\beta=-5.64$, 95%CI -9.92, -1.42), gestational age ($\beta=-0.03$, 95%CI -0.047, -0.011), birth length ($\beta=-.01$, 95%CI -0.02, -0.00), and positively associated with preterm birth (OR=1.03 95%CI 1.01, 1.06), among white mothers only (interaction p-values all<0.05, associations all null among non-white mothers). There were no associations in main-effects models, or for OPs.

CONCLUSIONS: We observed associations of living near pyrethroid pesticide applications during the first trimester of pregnancy with several adverse birth outcome measures among white women living in a highly agricultural county along the US-Mexico border. PURs may provide valuable, inexpensive trimester-specific exposure information.

Keywords: pesticides, pyrethroids, preterm birth, birth outcomes



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 25

The European Human Exposome Network

Chairs: Roel Vermeulen, Netherlands & Joakim Dillner, Sweden

O-SY-126

Exposome » General

Decoding our environment: The European Human Exposome Network

Roel Vermeulen¹, Joakim Dillner²

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²Department of Laboratory Medicine, Karolinska Institutet, Stockholm, Sweden

BACKGROUND AND AIM: European citizens are increasingly concerned about the effects of climate change, urbanization, and environmental deterioration on health. This concern is well reflected in the European Green Deal and the cross-cutting zero-pollution strategy that has the ambition to: “protect citizens' health from environmental degradation and pollution, address air and water quality, hazardous chemicals, industrial emissions, pesticides and endocrine disruptors”. The sum of the environmental exposures to people-kind is called the exposome and can nowadays be systematically measured. Exposome research is recognized by the European Commission as an important innovative research area that could significantly contribute to these ambitions and future policies.

METHODS: The European Human Exposome Network (EHEN) was initiated in 2020 and consists of 9 large-scale projects in which a total of 126 partners from 24 countries participate. EHEN is tasked to develop a FAIR (Findable Accessible Interoperable Reusable) Toolbox for exposome research including but not limited to the development of new assessment methods for the external (e.g. sensors, geospatial models) and internal exposome (e.g. biomonitoring, OMICs-technologies); linkage of these measures to health records in bespoke and administrative datasets; developing methods for causal and biological interpretation of results; and to translate knowledge into impact through novel intervention strategies.

RESULTS: In the first year of EHEN significant steps have been made in cross-cutting working groups to address common challenges and opportunities. An example is the FAIRification of exposome research in Europe and on ethical considerations in exposome research.

CONCLUSIONS: The EHEN is a significant boost to exposome research in Europe and beyond. Besides scientific challenges, there are also legal and political challenges not in the least how we link exposome findings into policy such as the European Green Deal and the cross-cutting zero-pollution strategy.

Keywords: Exposome, Green deal, FAIR, external exposome, internal exposome, causal inference



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 25

The European Human Exposome Network

Chairs: Roel Vermeulen, Netherlands & Joakim Dillner, Sweden

O-SY-127

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

FAIRification of data: Great but how?

Morris Swertz¹, Zdenka Dudová², Aleš Křenek³, Eleanor Hyde¹, Members Ehen Metadata Working Group⁴

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⁴Members of the 9 projects of the European Human Exposome Network: Athlete, Ephor, Equal-life, Eximious, Expanse, HEAP, Hedimed, LongITools, Remedia (funded by H2020)

BACKGROUND AND AIM: The European Human Exposome Network (EHEN) unites 9 research projects studying the impact of environmental exposure on health, such as air quality, noise, chemicals, and urbanization. We report for the Metadata WG with 1-2 delegates from each project to promote findability, accessibility, interoperability and reusability (FAIRness) of all EHEN data and to jointly develop a sustainable exposome data infrastructure.

METHODS: We compared the data management plans from the network and selected open areas in need of harmonisation. We are establishing short-term sub working groups to develop standards and tools therefore and analyse requirements for a network data catalogue. And we reached out beyond EHEN to relevant semantic and non-semantic standard and tool development initiatives for collaboration (e.g. BBMRI, IHECC, ELIXIR, GA4GH, Maelstrom, EUCAN-connect, LifeCycle, EOSC-life, CINECA, FAIR genomes).

RESULTS: We established an inventory of data modalities in the network, for example, chemical exposures, physical exposures, proteomics (25 main categories, 66 subcategories). We have chose three priorities for the sub working groups: standards for external exposome, omics and catalogue metadata. There is a draft catalogue for cross consortia dataset identification. It consist of 232 candidate metadata items organised in 6 areas: institutions (that provide access to data), data resources (databanks, datasets, cohorts, registries), networks (such as each project in EHEN), common data elements/standards (e.g. agreed upon harmonized data variables in a network), studies (uses of the data) and data harmonisations (sourceVariables, harmonizedVariables, and mappings between them).

CONCLUSIONS: With first templates in place for both metadata and data we want to reach out to the world to join on our mission: develop FAIR data infrastructure that enables frictionless identification, selection and harmonized access of/to datasets for exposome studies in EHEN and beyond.

Keywords: FAIR, metadata, exposome, catalogue, semantics



ABSTRACT E-BOOK

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SYMPOSIUM 25

The European Human Exposome Network

Chairs: Roel Vermeulen, Netherlands & Joakim Dillner, Sweden

O-SY-128

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

Ethics by Design in Exposome Research

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BACKGROUND AND AIM: Ethics plays an important role in research on the exposome and environmental epidemiology. However, this topic is often equated to discussions on data protection regulations. Without a doubt, these regulations are of utmost importance. However, because ethical considerations cover a wider area than the law, there is a broader question that concerns the ethical aspects of exposome research as such. Until now, the ethical discourse on the exposome has been limited, even though the subject borders on research areas with much more developed ethical debates (Big Data, Artificial Intelligence, Genomics, Personalized Medicine).

METHODS: In this presentation, we will share our insights on the ethical aspects of exposome research from an 'Ethics by Design' perspective. With this perspective, we aim to provide ethical guidance for exposome research during its development. Instead of providing end-of-the-pipeline advice, we analyze and evaluate ethical considerations surrounding exposome research proactively.

RESULTS: During the first half of this presentation, we will show the preliminary results of a literature review that intends to provide an overview of the ethical aspects of exposome research. During the second half, we will present the various considerations that are relevant from the perspective of political and legal philosophy

CONCLUSIONS: As the field of exposome research slowly starts to mature, it is important to identify and address its ethical aspects in a way that helps the field to develop. We contribute to this goal by discussing the major ethical themes that we have identified together with their relationship to related research areas.

Keywords: exposome, ethics, policy, omics technologies, environmental epidemiology



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Statue of Liberty Hall (Hall 1)

SYMPOSIUM 25

The European Human Exposome Network

Chairs: Roel Vermeulen, Netherlands & Joakim Dillner, Sweden

O-SY-129

Exposome » General

Big data does not equal big knowledge. A need for causal insights

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BACKGROUND AND AIM: There is hope that the bigger the data, the bigger the knowledge will become. Very large data are or will be made available and shall bring robust and replicable effect estimates in exposome research. While larger data and complementary sources of data will, with little doubt, bring robust effect sizes to estimate how environmental, toxic, social, and biological exposures are associated with health outcomes. We may also expect that larger (and precise) data will allow us to go beyond common effects (as an analogy to common genetic variants) and detect rare or small effects. Moving on into the paradigm of big data, it may be wise to remind each other that correlation is not proof of causality.

METHODS: Although bigger (observational) data will bring confidence on the strength of some association, relationships in large data are similarly affected by important selection and structural biases, confounding effects, and measurement errors. One strength of the European Human Exposome Network is to bring multiple study designs and dynamic longitudinal analytical strategies to help to triangulate the evidence.

RESULTS: We shall, for example, use negative control, quasi-experimental designs, interventions, and instrumental variables (e.g. Mendelian randomization or instrument based on exogenous factors, i.e. environmental policies) to infer causation and identify causative pathways.

CONCLUSIONS: These causal designs and approaches however are not always applicable or available. One should also seek for additional ways to gain confidence on the plausibility of causal insights through replication, triangulation, and integration of prior knowledge which is made available in the European Human Exposome Network.

Keywords: European Human Exposome Network, Big data, big knowledge, causal insights



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 26

Diet as Complementary Opportunity to Mitigate Effects of Environmental Pollutants on Health Outcomes

Chairs: Nasser Laouali, United States & Youssef Oulhote, United States

O-SY-130

Chemical exposures » Pesticides

Maternal diet as a modifier of environmental risk factors for child neurodevelopmental outcomes: Existing evidence and future directions

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BACKGROUND AND AIM: Emerging work suggests diet may modify the effects of environmental risk factors for neurodevelopmental outcomes like autism spectrum disorder (ASD). The goal of this symposium presentation is to summarize evidence for such interactions, highlight opportunities for future work, and discuss preliminary findings for dietary factors and pesticides in association with ASD-related outcomes.

METHODS: Participants (n=154) for analyses of joint effects of pesticides and diet on ASD were drawn from the Early Autism Risk Longitudinal Investigation (EARLI), a high-familial risk prospective cohort. Autism diagnosis and ASD-related traits, measured according to the Social Responsiveness Scale (SRS), were captured at 36 months. Levels of organochlorine pesticides, including hexachlorobenzene, transnonachlor, and p,p'-DDE, were measured in maternal mid-pregnancy serum samples. Associations between pesticides and SRS scores and ASD diagnosis were examined using linear and logistic regression respectively, adjusted for maternal characteristics, demographic confounders, and dietary factors like folate and vitamin D, and also stratified by key dietary factors and sources of pesticides.

RESULTS: No significant associations were observed with SRS scores, though patterns differed when stratified by vegetable intake, folate, and vitamin D, with increases in SRS scores among those with higher pesticide exposure and lower intake of these factors. Increased odds of ASD was also observed for those with higher levels of transnonachlor, and this association became stronger when stratified by vegetable intake (low intake AOR for interquartile range increase =3.12, 95% CI 1.01, 9.66; high intake AOR=1.03, 95% CI 0.19, 5.55).

CONCLUSIONS: Certain dietary factors like vegetable intake, or nutrients within it, may mitigate adverse effects of pesticides on ASD-related outcomes. Future work should further consider these and other joint effects, targeting nutrients and chemicals that act in key pathways like inflammation and oxidative stress, to present opportunities for mitigation and intervention.

Keywords: autism, pesticides, diet, interactions



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 26

Diet as Complementary Opportunity to Mitigate Effects of Environmental Pollutants on Health Outcomes

Chairs: Nasser Laouali, United States & Youssef Oulhote, United States

O-SY-131

Chemical exposures » Heavy metals

Associations between blood lead and urinary cadmium levels and mortality, and effect modification by dietary inflammatory index

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BACKGROUND AND AIM: Previous studies in the US reported a high mortality risk associated with higher blood lead (BPb) and urinary cadmium (UCd) concentrations. Although the mechanisms of these metals toxicity are not completely understood, increasing oxidative stress and inflammation are suspected major pathways. In parallel, diet with a high anti-inflammatory potential may prevent from chronic inflammation.

We extended the follow-up of the previous analyses and evaluated the potential modifying effect of the dietary inflammatory index (DII) in the association between BPb and UCd concentrations and all-cause and specific causes of mortality.

METHODS: We used data on 15,598 adults aged ≥ 20 years enrolled in the NHANES-III between 1988 and 1994 and followed up through Dec 31, 2015. The DII was computed from baseline dietary intake assessed using 24-hour dietary recalls. Mortality was determined from the National Death Index records. Associations between metals concentrations and mortality were assessed using Cox regression models while controlling for confounding. Interaction terms between metals concentrations and DII were included in the models and stratified analyses across the DII groups were presented.

RESULTS: Over the follow-up, 1398 participants died (1398 from heart diseases, 399 from cerebrovascular diseases, 1247 from malignant neoplasms). Each increase in blood Pb level was associated with increased mortality from all-cause (HR: 1.50, 95%CI: 1.46-1.55), heart diseases (HR: 1.64, 95%CI: 1.55-1.74), cerebrovascular diseases (HR: 1.44, 95%CI: 1.30-1.60), and from malignant (1.46, 95%CI: 1.38-1.56). There was an interaction between BPb concentration and DII for all-cause and specific causes of mortality ($p < 0.033$ for all). Participants with lower DII scores, corresponding to a higher anti-inflammatory potential of the diet, have lower risk of mortality compared to those with higher DII. The same patterns of associations were observed for UCd.



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ABSTRACT E-BOOK

CONCLUSIONS: Our findings suggest that a higher anti-inflammatory diet may help prevent BPb and UCd adverse effects in adult.

Keywords: Diet, Inflammation, Mortality, CVD, Cancer, Nhanes



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 26

Diet as Complementary Opportunity to Mitigate Effects of Environmental Pollutants on Health Outcomes

Chairs: Nasser Laouali, United States & Youssef Oulhote, United States

O-SY-132

Birth and Pregnancy Outcomes » Birth outcomes

Antioxidant Intake and the Relationship between Air Pollution and Birth Defects: A comparison of approaches for effect modification

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BACKGROUND AND AIM: Previous research suggests that intake of antioxidants during pregnancy may reduce the harmful effects of air pollution exposure. However, examining effect modification in the context of multiple air pollutants and antioxidants can present a number of challenges. Prior to conducting an epidemiologic study to understand the relationship between air pollution, antioxidants and birth defects, we aim to compare methods for identifying effect measure modification within higher-dimensional exposure and dietary data.

METHODS: We first perform a simulation, based on a real-world case-control study of birth defects, to generate realistic data on exposure to criteria air pollutants in the first trimester of pregnancy, maternal dietary intake of antioxidants and birth outcomes. We construct multiple realistic scenarios, varying levels of correlation between features, the magnitude of association between air pollutants, antioxidants and congenital heart defects and the amount of effect measure modification by antioxidants. Using these data, we compare two data-driven methods, the Deletion-Substitution-Addition (DSA) algorithm and boosted regression trees, to the traditional use of multiple logistic regression models for evaluating effect measure modification.

RESULTS: This talk will describe the performance of each method across the various exposure-outcome scenarios.

CONCLUSIONS: Results from this simulation study will subsequently be applied to data from the National Birth Defects Prevention Study to investigate whether evidence exists for antioxidant intake during pregnancy to modify the relationship between early-pregnancy air pollution exposure and congenital heart defects in offspring.

Keywords: pregnancy, methods, environment-diet interactions



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 26

Diet as Complementary Opportunity to Mitigate Effects of Environmental Pollutants on Health Outcomes

Chairs: Nasser Laouali, United States & Youssef Oulhote, United States

O-SY-133

Chemical exposures » Heavy metals

Micronutrient intake is associated with reductions in chemical exposure effects on blood pressure of electronic waste recyclers at Agbogbloshie, Ghana

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BACKGROUND AND AIM: Increasing evidence suggests that chemical exposures may influence micronutrient status and further induce certain disease outcomes like hypertension- even at lower levels of exposure. This study, therefore, investigated whether micronutrient-rich diet intake may reduce the adverse effects of heavy metals and rare earth elements released during informal recycling of e-waste on blood pressure (BP) of e-waste recyclers in Ghana.

METHODS: Blood and urine samples were collected from 100 e-waste recyclers and 51 controls in March 2017 and analyzed for chemicals (cadmium, lead (Pb), arsenic (As), Terbium, Thallium (Tl), and Cerium) and micronutrients (calcium, magnesium, iron, selenium, zinc, and copper) using the ICP-MS. Dietary micronutrient intake was assessed using a 2-day-24-hour-dietary-recall. Cardiovascular indices (systolic BP (SBP), diastolic BP (DBP), and arterial pressure (AP)) were measured using a sphygmomanometer. Joint associations between chemicals, micronutrients and BP indices were modelled using simple linear regressions.

RESULTS: Urinary As and Pb as well as blood levels of Tl were significantly associated with increases in SBP, AP and pulse pressure in both groups and still similar when analyses were limited to only recyclers. Nonetheless, dietary intake of calcium and iron-rich diets were associated with significant reductions in SBP, DBP and AP in both groups. Further in the joint model, consumption of Fe-rich diets were associated with significant reductions in SBP ($\beta = -0.070$; 95% CI: -0.131, -0.009; $p = 0.026$), DBP ($\beta = -0.085$; 95% CI: -0.167, -0.004; $p = 0.040$), and AP ($\beta = -0.080$; 95% CI: -0.143, -0.016; $p = 0.014$), despite the particularly high exposure of e-waste recyclers to Pb.

CONCLUSIONS: Although the body burden of Pb, As and Tl seem to be associated with and serve as predictors of hypertension, the consumption of Fe-rich foods were associated with significant reductions in SBP, DBP and AP of e-waste recyclers even at high exposures of these chemicals.

Keywords: Chemical exposures, cardiovascular diseases, food/ nutrition



ABSTRACT E-BOOK

August 26, 2021 / 15:30 - 17:00 / Times Square Hall (Hall 3)

SYMPOSIUM 26

Diet as Complementary Opportunity to Mitigate Effects of Environmental Pollutants on Health Outcomes

Chairs: Nasser Laouali, United States & Youssef Oulhote, United States

O-SY-134

Respiratory and Allergic Outcomes » Asthma

Ambient air pollution, psychological stress, and early childhood respiratory outcomes: Modifying effects of prenatal maternal diet, sex, and race/ethnicity

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BACKGROUND AND AIM: Many lower income, racially/ethnically mixed communities experience co-occurring environmental hazards (i.e., pollutants, social inequities and related stress, poorer access to healthy foods) contributing to respiratory disease. Starting *in utero*, fine particulate matter (PM_{2.5}) and stress disrupt similar but not completely overlapping processes, including oxidative stress, influencing respiratory health. Antioxidant intake can have protective effects. We examined associations among prenatal PM_{2.5}, maternal stress, and antioxidant intake in relation to early childhood wheeze in a longitudinal pregnancy cohort in the Northeastern United States (N=539).

METHODS: Daily prenatal PM_{2.5} exposure was estimated using a satellite-based spatiotemporally resolved model. Women completed the Lifetime Stressor Checklist-Revised (LSC-R). A prenatal antioxidant index (AI) was based on average percentile intake of beta-carotene, vitamins (A,C,E), zinc, magnesium, and selenium. Mothers reported child wheeze with follow-up to 4.1±2.8 years. Logistic regression was used to examine effects of prenatal AI and LSC-R on repeated wheeze (≥2 episodes); effect modification was explored in stratified models. Bayesian distributed lag interaction models (BDLIMs) were used to examine associations between prenatal PM_{2.5} exposure on wheeze, and effect modification by AI, race/ethnicity, and child sex. Covariates included maternal age, education, asthma, and temperature.

RESULTS: Women were 39.3% black and 33% Hispanic with 35.6% reporting ≤high school education; 20.3% of children had repeated wheeze. The association between higher AI and decreased wheeze was significant only in blacks (Odds Ratio, OR=0.37, 95% confidence interval, CI: 0.19-0.73 per interquartile range increase). Higher stress was associated with repeated wheeze when AI was below the median, especially among blacks/Hispanics [OR=1.04 (1.01-1.06)]. BDLIMs found that cumulative effect on repeated wheeze per µg/m³ increase in PM_{2.5} across pregnancy was only significant in boys born to black mothers with low antioxidant intake [OR=1.2 (1.01-1.59)].

CONCLUSIONS: Relationships among prenatal PM_{2.5}, stress, antioxidant intake, and child wheeze are complex and are modified by race/ethnicity and child sex.

Keywords: particulate matter, prenatal stress, nutrition, antioxidants, pediatric respiratory outcomes



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 27

Environmental Health, Research and Civil Society - Discussing health promotion and environmental equity in the countryside and in cities in Latin America

Chairs: Rogerio Araujo Christensen, Telma De Cassia Dos Santos Nery, Brazil

O-SY-135

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

The agrotoxic theme in institutional documents of movement for the fight for agrarian reform

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BACKGROUND AND AIM: The study addresses the pesticide theme in documents from the Landless Rural Workers Movement (MST). Organized in 24 states, in the five Brazilian regions, there are 350 thousand families that conquered the land in Brazil through its organicity. The analysis sought to access and analyze the movement's official position in relation to the theme.

METHODS: Adopts Thompson's (2001) historical-cultural and Hermeneutic Depth Hermeneutics perspective. With the organization and analysis of the corpus formed with institutional documents, we sought to analyze the formal (structural) aspects, of content, and ending with the interpretation-of-interpretation.

RESULTS: The pesticide theme in the analyzed documents highlights a critical position about their impacts on socio-environmental health in the context of the challenges for promoting equity and environmental sustainability.

CONCLUSIONS: The continuity of this study will consist of the evaluation of practices for the use and contamination by pesticides in settlements linked to the movement and human values.

Keywords: Social Movements, Agrarian reform, Pesticides, Depth Hermeneutics



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 27

Environmental Health, Research and Civil Society - Discussing health promotion and environmental equity in the countryside and in cities in Latin America

Chairs: Rogerio Araujo Christensen, Telma De Cassia Dos Santos Nery, Brazil

O-SY-136

Chemical exposures » Pesticides

Science allied with Society and Public Policies

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BACKGROUND AND AIM: Brazil is a global agricultural commodity producer and the largest consumer of pesticides. They can persist in soil or water, accumulate in organisms/workers and the general population through air, water or food.

METHODS: Therefore, scientific studies that aim to investigate the potential risks of pesticides to produce data on impacts on human health, are of extreme importance. In this context, we analyzed 10 important pesticides used in Brazil: using the experimental zebrafish model.

RESULTS: The results demonstrated teratogenic and lethal effects of pesticides, highlighting that science has the potential to guide political changes, either in tracking the effects of pesticides or in more cautious use.

CONCLUSIONS: The results demonstrated teratogenic and lethal effects of pesticides, highlighting that science has the potential to guide political changes, either in tracking the effects of pesticides or in more cautious use.

Keywords: pesticides, human health, the experimental zebrafish model



ABSTRACT E-BOOK

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SYMPOSIUM 27

Environmental Health, Research and Civil Society - Discussing health promotion and environmental equity in the countryside and in cities in Latin America

Chairs: Rogerio Araujo Christensen, Telma De Cassia Dos Santos Nery, Brazil

O-SY-137

Chemical exposures » Pesticides

Overview of the Impacts of Pesticides on Human Health in Municipalities with high use and consumption in SPst - Brazil

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BACKGROUND AND AIM: The research and activities developed by the São Paulo Forum to Combat Impacts on Pesticides and Transgenics, involve municipalities with higher levels of aerial spraying and where the mortality rate is different. The Forum is composed of members of civil society and public institutions. **OBJECTIVE** in this symposium: To analyze intoxications, congenital malformation and the profile of cancer mortality in municipalities where high levels of pesticides were found in water for human consumption.

METHODS: Descriptive cross-sectional study based on data from the Ministry of Health/DATASUS on deaths and poisoning by pesticides, domestic use, use in public health and rodenticides in municipalities in the State of São Paulo.

RESULTS: Between 2010 and 2019, 113,245 intoxications were reported in Brazil, 60,025 of which were attempted suicides and 39,255 of accidental and habitual use. Of the intoxications in Brazil, 78% were unrelated to work and 3,513 evolved to deaths. In SP state congenital malformations are the third leading cause of child and adolescent deaths (2.41 deaths/1000 inhab) and neoplasms, the fifth leading cause (1.92 deaths/1,000 inhabitants). In 11 municipalities where there is aerial spraying, the rate of neoplasms is 3.49 /100 thousand inhabitants and the second cause of congenital malformation in 5 of these municipalities. The 113,245 cases of poisoning in Brazil, 74.6% of the victims lived in urban areas. In relation to the São Paulo st, 86% lived in urban. Regarding color/race, in Brazil 43.1% were black. Most are between 20 and 39 yo and 26.8% were children under 1 year and 19 yo.

CONCLUSIONS: When analyzing the data on the commercialization of pesticides in Brazil, comparing with the incidences of notification of poisoning by pesticides (for agricultural, domestic, public health and rodenticide), a proportional growth is observed, as each product is consumed. We conclude that information is fundamental for society to seek public policies.

Keywords: Pesticides, Occupational exposures, Mortality, Toxicology, Water quality



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 27

Environmental Health, Research and Civil Society - Discussing health promotion and environmental equity in the countryside and in cities in Latin America

Chairs: Rogerio Araujo Christensen, Telma De Cassia Dos Santos Nery, Brazil

O-SY-138

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

Fighting for human rights to water in times of sanitary crisis: social pricing for affordable water in Brazil

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BACKGROUND AND AIM: ONDAS (Observatório Nacional dos Direitos à Água e ao Saneamento – National Observatory of Water and Sanitation Rights – homepage: <https://ondasbrasil.org/>) which acronym means WAVES in English, is an entity congregating professionals, academics, students and activist from urban, rural, water and forest grassroots movements. Emerged from 2018 Alternative World Water Forum, the observatory is dedicated to production and dissemination of critical knowledge and presents itself as a platform of technical and political action fighting for human rights to water and sanitation.

METHODS: Amidst the ongoing encroachment of ultraliberal efforts to privatise sanitation services in Brazil, ONDAS has been campaigning resistance strategies in favour of public systems of sanitation, accessible to all and held accountable through wide social participation. The observatory also joined solidarity efforts to provide aid for low-income urban population, who have been suffering the most from the many disruptions brought by COVID-19, worsened by Bolsonaro's genocidal politics.

RESULTS: One of ONDAS' output from its strategy of producing critical knowledge is the newly published e-book "Water as a Right: Social Pricing as Strategy for Affordability". Discussing the human right to water and sanitation service, this publication focuses on the analysis of social pricing as instrument to make such services affordable based on a research conducted in seven Brazilian capitals and the Federal District. The benefits of social pricing are examined in cities with different arrangements for sanitation provision, and the analysis highlights possibilities of promoting the instrument to assure better supply of services to people in most need.

CONCLUSIONS: Social pricing is understood as one of the strategies towards affordability, since even low cost solutions may still be unaffordable for people living in poverty. It is understood that the minimum amount of potable water to allow drinking, cooking, house cleaning, and personal hygiene must be provided for everyone, in every condition.

Keywords: Water quality, Socio-economic factors, Policy and practice, COVID-19



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Brooklyn Bridge Hall (Hall 2)

SYMPOSIUM 27

Environmental Health, Research and Civil Society - Discussing health promotion and environmental equity in the countryside and in cities in Latin America

Chairs: Rogerio Araujo Christensen, Telma De Cassia Dos Santos Nery, Brazil

O-SY-139

Chemical exposures » General

Epidemiological Research in Environmental Health in Latin America - How to consider inequalities?

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BACKGROUND AND AIM: In a context with high social inequity and poor distribution of wealth, several Latin American countries (LAC) based their economy on the excessive use of their natural resources. Chañaral (900 km north of Santiago, Chile) is an example of an extractivist model of mining, generating an artificial beach containing mine tailing around the city.

Our goal was to review the scientific evidence of the Chañaral Case, and to discuss options for analyzing other socio-environmental cases with impacts in public health in other LAC.

METHODS: Several studies were made from 2006, combining different dimensions of the exposure and health in adults and children. Together, environmental and historical reports were reviewed.

RESULTS: A dramatic decrease in the richness and diversity of species in the intertidal zones around the impacted area, and wind-driven transport of metal-rich particles towards the city of Chañaral were observed. In 2006, a higher risk of having levels of urinary nickel above the 4.1 µg/L reference value (OR = 2.5, 95%CI = 1.1- 5.8) was detected. Also, increased PM2.5 levels from mine tailings were associated with a reduction in Forced Vital Capacity (β -2.42 ml, 95%CI -4.7, -0.1) in schoolchildren living in the city.

CONCLUSIONS: The metal-enriched dust transported from the tailings is a source of exposure to metals, they are excreted in the urine of persons and affect lung function. The lack of soil quality standards, permissive air standards, and the non-existence of urban planning for many years led to the settlement of large mine tailings close to population settlements. Civil organizations have had to educate themselves on metal exposures, generating lawsuits to generate mitigation plans. Today, when Chile is going through constitutional changes, it is essential to strengthening the discussion on environmental health management based the human rights perspective to guarantee the right to live in an equitable healthy environment.

Keywords: Chile, Chañaral Case, mine tailings, environmental injustice, metals, air pollution



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

SYMPOSIUM 28

Protecting Workers in the Face of Climate Change

Chairs: Jaime Butler Dawson, United States & Katherine James, United States

O-SY-143

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

Improving Kidney Health Among Workers in Guatemala

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BACKGROUND AND AIM: With rising global temperatures, agricultural laborers are increasingly exposed to heat and high humidity for extended periods. Agricultural jobs can be extremely physically demanding, such as in manual sugarcane cutting. The high intensity of labor coupled with extreme climate put agricultural workers at increased risk of heat related illnesses and injuries. There is growing evidence that extreme heat stress and repeated dehydration is likely one of the contributors to the epidemic of Chronic Kidney Disease of Unknown Origin (CKDu).

METHODS: Our Total Worker Health (TWH) [®] approach to addressing kidney health in Guatemala has included the implementation of enhanced prevention measures and interventions to protect workers by addressing known risk factors.

RESULTS: We describe several research findings and intervention strategies to accomplish the goal of reducing the burden of both acute kidney injury and CKDu.

CONCLUSIONS: Future research needs are discussed, as well as current recommendations for occupational and community prevention strategies.

Keywords: climate, occupational exposures



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

SYMPOSIUM 28

Protecting Workers in the Face of Climate Change

Chairs: Jaime Butler Dawson, United States & Katherine James, United States

O-SY-140

Climate » Health co-benefits

Worker protection at the intersection of the COVID-19 pandemic and climate change: lessons learned through industry partnership

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BACKGROUND AND AIM: The Center for Health, Work & Environment began a collaborative project to address Total Worker Health® (TWH) with a Latin American sugarcane agribusiness. TWH is an approach which integrates hazard protection with promotion of injury and illness prevention. TWH strategies are especially relevant when addressing a complex mix of occupational, environmental, social, and personal risk factors that impact health, such as those related to climate change. Climate change has increased the risk to workers' health and safety. Workers are at increased risk of heat-related disorders, occupational injuries and illnesses, and reduced work capacity. **METHODS:** The CHWE conducted a TWH needs assessment across all levels of the organization, in Guatemala, Nicaragua and Mexico. The assessment was conducted through in person and online Employee Health and Safety Culture surveys, Employee Health Risk Assessments, a Leadership Self-Assessment, as well as through semi-structured interviews and focus groups with top leaders and managers at the company.

RESULTS: We will present preliminary results of the needs assessment. The priority areas identified were 1) chronic disease prevention & management, 2) sleep hygiene, and 3) stress management and mental health. This collaboration aimed to address climate-related hazards such as heat stress and dehydration, while also evaluating and addressing other risks including chronic disease, fatigue, stress and mental health that have been further exacerbated by the COVID-19 pandemic.

CONCLUSIONS: This project represents one of the first examples of international TWH in practice within the agricultural industry. Workers face both new and existing risks that require an integrated approach to protect health, safety and well-being to address the dual crisis of climate change and a global pandemic. TWH programs, policies and practices can be utilized and adapted by employers to meet the health, safety and well-being needs of workers.

Keywords: Climate, Occupational exposures, International collaboration, Health co-benefits, Mental health outcomes



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

SYMPOSIUM 28

Protecting Workers in the Face of Climate Change

Chairs: Jaime Butler Dawson, United States & Katherine James, United States

O-SY-141

Climate » Temperature

Cooling Interventions Among Agricultural Workers: A Pilot Study

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BACKGROUND AND AIM: Agricultural workers perform intense labor outside in direct sunlight and in humid environmental conditions, exposing workers to a high risk of heat-related illness (HRI). The aim of this study was to use biomonitoring equipment to examine the effectiveness of selected cooling devices at preventing agricultural workers from exceeding the core body temperature threshold of 38.0°C (Tc38) and attenuating heat-related illness symptoms.

METHODS: A sample of 84 agricultural workers in Florida were randomized to 1 of 4 groups: 1) no intervention, clothing as usual; 2) cooling bandana; 3) cooling vest; and 4) both the cooling bandana and cooling vest. Biomonitoring equipment worn by the participants included core body temperature and heart rate monitor belts, and an accelerometer to capture physical activity.

RESULTS: A total of 78 agricultural workers completed one intervention workday. Logistic regression analysis revealed the bandana group had lower odds of exceeding a core body temperature of 38.0°C (OR 0.7, CI90 [0.2, 3.2]) and the vest group had higher odds of exceeding 38.0°C (OR 1.8, CI90 [0.4, 7.9]). The use of both the cooling vest and bandana (combination group) showed the effect was little different from the control group (OR 1.3, CI90 [0.3, 5.6]).

CONCLUSIONS: This is the first field-based study to examine cooling intervention among agricultural workers in the United States using biomonitoring equipment. This study found that agricultural workers that used a bandana while working in a hot environment has the potential to be protective against exceeding a core body temperature of 38.0°C.

Keywords: Temperature, Occupational exposures



ABSTRACT E-BOOK

August 26, 2021 / 19:00 - 20:30 / Grand Central Hall (Hall 5)

SYMPOSIUM 28

Protecting Workers in the Face of Climate Change

Chairs: Jaime Butler Dawson, United States & Katherine James, United States

O-SY-142

Air pollution » Wildfires

Wildfire-related PM_{2.5} and Intensive Care Unit Admissions and Bed Utilization in the United States, 2006-2015

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BACKGROUND AND AIM: Wildfire smoke is a growing public health concern in the United States. Numerous studies have documented associations between ambient smoke exposure and severe patient outcomes for single fire seasons or limited geographic regions. However, there are few national-scale health studies of wildfire smoke in the U.S., few studies investigating Intensive Care Unit (ICU) admissions as an outcome, and few specifically framed around hospital operations. This study retrospectively examined the associations between ambient wildfire-related PM_{2.5} at a hospital ZIP code with total hospital ICU admissions using a national-scale hospitalization data set during the years 2006-2015.

METHODS: Wildfire smoke was characterized using a combination of kriged PM_{2.5} monitor observations and satellite-derived plume polygons from NOAA's Hazard Mapping System. ICU admissions data were acquired from Premier, Inc. and encompass 15-20% of all U.S. ICU admissions during the study period. Associations were estimated using a distributed-lag conditional Poisson model under a time-stratified case-crossover design. The impact on ICU admissions and bed utilization of a severe 7-day 120 µg/m³ smoke wave was simulated.

RESULTS: We found that a 10 µg/m³ increase in daily wildfire PM_{2.5} was associated with a 2.7% (95% CI: 1.3, 4.1; p=0.00018) increase in ICU admissions five days later. Following the simulated smoke wave, our results predict ICU bed utilization peaking at 131% (95% CI: 43, 239; p<0.00001) over baseline.

CONCLUSIONS: Our work suggests that hospitals may need to pre-position vital critical care resources when severe smoke events are forecast.

Keywords: Intensive Care Unit, Wildfire, Smoke, Particulate Matter, Critical Care



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