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#### Socioeconomic position and outdoor nitrogen dioxide (NO2) exposure in Western Europe: A multicity analysis

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## Socioeconomic position and air pollution exposure in Western Europe: A multi-city analysis

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#### **Methods:**

#### Selection of the macroeconomic data:

Correspondence between SESAP area and NUTS3 level (Nomenclature of Territorial Units for Statistics)

SESAP areas	Code NUTS3	Label NUTS3
Norwich	UKH13	Norfolk
Ipswich	UKH14	Suffolk
Paris	FR101	Paris
Lyon	FR716	Rhône
Grenoble	FR714	Isère
Marseille	FR824	Bouches-du-Rhône
Verona	ITH31	Verona
Pavia	ITC48	Pavia
Turin	ITC11	Torino
Oviedo	ES120	Asturias
Galdakao	ES213	Vizcaya
Barcelona	ES511	Barcelona
Albacete	ES421	Albacete
Huelva	ES615	Huelva

List of the 22 variables at NUTS3 level (Nomenclature of Territorial Units for Statistics) (Eurostat 2015). All variables were first standardized (i.e. centered and reduced). Then, several consecutive PCA were thus performed to conserve only the variables most strongly correlated with the first component and contributing most to its construction. In bold, list of the variables retained after the PCA that explained 84% of the variability.

#### - Demography:

#### - Population density, inhabitants per km<sup>2</sup>

- Population by age group:
  - Less than 15 years, %
  - From 15 to 64 years, %
  - 65 years or over, %
- Demographic balance (Crude rate of total population change)
- Education:
- Educational attainment, %
  - Pre-primary and primary education (levels 0 and 1)
  - Lower secondary or second stage of basic education (level 2)
  - Upper secondary education (level 3)
  - Post-secondary non-tertiary education (level 4)

#### - First and second stage of tertiary education (levels 5 and 6)

Job market:

- Percent of active population (between 15 and 64 years), %
- Employed persons aged 15 and over, %:
  - In agricultural sector, %
  - In industrial sector, %
  - In services sector, %
  - Extra-EU-15, %

Economy:

- Gross domestic product (GDP) at current market prices, euros per inhabitants
- Purchasing Power Standard, euros per inhabitant

- Housing:

- Private households by composition or size, %
  - Person living alone
  - Lone parent living with at least one child
  - Person in a married couple
  - Household composed of one-family nucleus
  - Household composed of one person
- Conventional dwellings occupied by the owner

### **Results: supplementary analysis**

We found an interaction between education level and age and between education level and sex only in Lugano (older participants with lower education level were more exposed to NO<sub>2</sub> than younger participants; men with lower education level were more exposed than women). We found an interaction between education and unemployment for only 4 cities (Norwich, Antwerp, Verona and Paris). In all, except Paris, participants with higher education level who lived in less favored neighborhoods tended to be more exposed. We found an interaction between occupational class and sex only in Pavia (women in lower occupational class were more exposed than men). Finally, we found an interaction between unemployment and age in Grenoble (younger participants living in neighborhoods with higher unemployment rate were more exposed to NO<sub>2</sub>) and in Huelva (only older participants living in neighborhoods with higher unemployment were exposed to NO<sub>2</sub>).



## Figure S1: Flow chart of the main population covering 20 cities (n=8277)

Dotted frame: missing data

ESCAPE: European Study of Cohorts for Air Pollution Effects.

ECRHS: European Community Respiratory Health Survey.

EGEA: Epidemiological study on Genetics and Environment of Asthma.

SAPALDIA: Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults

The neighborhood unemployment rate was not available for Umea, Erfurt, Basel and Lugano and was missing for 63 participants in the other cities for whom neighborhood could not be linked. The main analyses were performed including only cities with available data at both individual- and neighborhood SEP (16 cities, n=5692).

Brief description of the cohorts:

ECRHS is a population-based cohort study. More than 18,000 young adults aged 20-44 were recruited mainly across Europe in 1991-1993 (ECRHS I) and 10,364 participated to the first follow-up (ECRHS II) between 2000-2002.

EGEA is a French case-control and family-based study including 2047 participants aged 7-65 recruited between 1991-1995 (EGEA1). At the first follow-up (EGEA2), 1922 participants provided a self-completed questionnaire between 2003-2007.

SAPALDIA is a cohort study in Switzerland. In 1991, 9651 participants aged 20-65 were recruited for a detailed interview and health examination (SAPALDIA1). The follow-up (SAPALDIA2) was conducted in 2001-2002 at which 8047 participants provided health information.

#### General information regarding the tables below:

- The neighborhood unemployment rate has been assigned individually to participants using their residential addresses. The variable was not available in Umea, Erfurt, Basel and Lugano and was missing for some participants in Pavia (n=2), Antwerp (n=55) and Turin (n=6).
- Occupation class (OC): OC-I: Manager and Professional, OC-II: Technician and associate professional, OC-III: other non-manual, OC-IV: skilled, semi-skilled or unskilled manual

## Table S1: Definition of neighborhood and distribution of the study population by neighborhood and city

City	Name of area	Average number of inhabitants by area	Number of neighborhoods (number of participants)	Participants by neighborhood mean (min-max)	Proportion neighborhoods with one participant (%)
Norwich		1200	117 (242)	2.3 (1 – 6)	18
Ipswich	LSUA	1200	117 (338)	3.0 (1 – 11)	11
Antwerp	Statistical sector	671	272 (500)	2.1 (1 – 9)	27
Paris		2000	427 (785)	1.9 (1 – 10)	37
Lyon	$\mathbf{DIS}^{b}$	2000	100 (210)	2.1 (1 – 10)	25
Grenoble	IKIS	2000	152 (690)	4.6 (1 – 16)	4
Marseille		2000	70 (119)	1.7 (1 – 6)	35
Geneva	Sous-secteur	2000	153 (612)	4.0 (1 – 18)	25
Verona		169	161 (179)	1.1 (1 – 3)	80
Pavia	Sezione di censimento	169	136 (188)	1.4 (1 – 7)	56
Turin		169	159 (170)	1.0(1-2)	89
Oviedo		1000	138 (315)	2.4 (1 – 8)	14
Galdakao		1000	164 (408)	2.6 (1 – 12)	14
Barcelona	Secciones censales	1000	251 (284)	1.1 (1 – 3)	77
Albacete		1000	99 (419)	4.3 (1 – 13)	2
Huelva		1000	90 (233)	2.7(1-8)	8

<sup>*a*</sup> Lower layer Super Output Area

<sup>b</sup> IRIS is a French acronym for 'aggregated units for statistical information'.

Cities	Ν	Occupational class				
		OC-I	OC-II	OC-III	OC-IV	Not in labor force
Umea	451	25.3	24.4	22.6	19.5	22.4
Norwich	242	20.0	18.0	16.6	16.0	16.0
Ipswich	338	18.7	18.6	16.2	15.9	16.1
Antwerp	539	21.8	20.9	19.6	17.5	16.5
Erfurt	238	22.7	20.2	20.7	18.6	19.6
Paris	785	23.0	20.9	19.1	18.2	20.8
Lyon	210	22.3	20.2	18.9	16.3	20.0
Grenoble	690	23.2	20.5	19.0	17.5	20.1
Marseille	119	22.5	19.6	18.8	16.7	19.7
Basel	847	23.2	22.1	19.2	19.1	20.6
Geneva	612	23.0	21.0	18.9	17.4	19.1
Lugano	1002	22.5	20.7	17.7	16.8	20.3
Verona	179	22.5	21.4	18.6	16.3	16.4
Pavia	190	21.8	20.6	18.4	15.2	17.4
Turin	176	23.4	21.9	18.6	17.1	14.8
Oviedo	315	21.5	21.5	19.8	16.5	16.2
Galdakao	408	22.0	20.0	18.6	16.6	15.1
Barcelona	284	21.8	19.7	17.9	16.1	16.2
Albacete	419	20.9	19.8	18.7	15.7	14.5
Huelva	233	22.0	19.0	18.6	16.1	15.4
Pooled cities	8277	22.5	20.9	18.9	17.1	18.4

Table S2: Mean age at completed education by occupational class (crude)

Occupation class (OC): OC-I: Manager and Professional, OC-II: Technician and associate professional, OC-III: other non-manual, OC-IV: skilled, semi-skilled and unskilled manual. All p-values for trend across the occupational classes were significant (p < 0.0001)

		Educational class			
	n	High	Medium	Low	P-value for trend
Umea	NA	-	-	-	-
Norwich	242	10.0	10.6	13.9	0.004
Ipswich	338	8.1	10.8	12.1	< 0.0001
Antwerp	500	8.4	7.2	9.0	0.41
Erfurt	NA	-	-	-	-
Paris	785	10.3	10.3	11.1	0.05
Lyon	210	9.4	9.1	8.9	0.47
Grenoble	690	9.6	9.6	10.1	0.21
Marseille	119	12.8	11.3	12.3	0.74
Basel	NA	-	-	-	-
Geneva	612	4.1	4.3	4.6	< 0.0001
Lugano	NA	-	-	-	-
Verona	179	4.4	4.9	4.5	0.89
Pavia	188	3.3	3.6	3.3	0.99
Turin	170	6.1	8.0	8.4	0.001
Oviedo	315	13.5	14.2	14.6	0.01
Galdakao	408	10.5	10.6	10.9	0.27
Barcelona	284	10.3	10.8	11.9	0.001
Albacete	419	13.3	14.5	15.4	0.001
Huelva	233	18.9	22.1	24.1	< 0.0001
Pooled cities	5692	9.4	10.1	10.7	< 0.0001

Table S3: Mean unemployment rate (%) by education level (crude)

The neighborhood unemployment rate has been assigned individually to participants using their residential addresses. The variable was not available (NA) in Umea, Erfurt, Basel and Lugano and was missing for some participants in Pavia (n=2), Antwerp (n=55) and Turin (n=6).

Cities	Ν	Occupational class						
		OC-I	OC-II	OC-III	OC-IV	Not in labor force*	P-value for trend	
Umea	NA	-	-	-	-		-	
Norwich	242	8.9	9.2	13.4	12.6	10.6	0.0002	
Ipswich	338	9.1	8.9	10.7	11.1	13.9	0.02	
Antwerp	500	8.0	6.9	8.3	9.7	7.3	0.03	
Erfurt	NA	-	-	-	-		-	
Paris	785	10.6	10.5	10.9	11.1	9.0	0.36	
Lyon	210	9.5	9.2	9.5	7.7	9.8	0.06	
Grenoble	690	9.4	9.6	9.8	11.6	10.0	0.0003	
Marseille	119	12.2	10.9	12.8	13.2	11.6	0.66	
Basel	NA	-	-	-	-		-	
Geneva	612	4.1	4.3	4.4	4.8	4.5	0.0001	
Lugano	NA	-	-	-	-		-	
Verona	179	4.8	4.8	4.9	3.5	4.5	0.15	
Pavia	188	3.2	3.8	3.0	3.7	3.5	0.69	
Turin	170	6.8	6.6	7.5	8.1	8.2	0.12	
Oviedo	315	13.2	13.6	13.8	15.0	14.8	0.0002	
Galdakao	408	10.1	10.7	10.6	11.2	10.0	0.04	
Barcelona	284	10.2	10.3	10.4	11.6	11.3	0.004	
Albacete	419	13.4	13.7	13.8	16.0	14.7	0.0005	
Huelva	199	18.5	20.1	20.9	24.8	22.5	< 0.0001	
Pooled cities	5692	9.2	9.1	10.1	11.8	10.1	< 0.0001	

 Table S4: Mean unemployment rate (%) by occupational class (crude)

Occupation class (OC): OC-I: Manager and Professional, OC-II: Technician and associate professional, OC-III: other non-manual, OC-IV: skilled, semi-skilled and unskilled manual.

\*Category "not in the labor force" was excluded to calculate the p-value for trend.

The neighborhood unemployment rate has been assigned individually to participants using their residential addresses.

The variable was not available (NA) in Umea, Erfurt, Basel and Lugano and was missing for some participants in Pavia (n=2), Antwerp (n=55) and Turin (n=6).

City	n	Educationa	l level (ref=high)	Neighborhood	
-			-		Unemployment t <sup>∞</sup>
		Medium	Low	P-value	
				for trend	
Norwich	242	0.45 (0.21; 1.00)	0.44 (0.17; 1.15)	0.05	1.59 (1.11; 2.62)
Ipswich	338	1.04 (0.49; 2.18)	0.57 (0.19; 1.67)	0.36	1.21 (0.78; 1.86)
Antwerp	500	0.72 (0.40; 1.31)	0.69 (0.36; 1.32)	0.23	3.68 (2.49; 5.44)
Paris	785	1.00 (0.64; 1.55)	0.47 (0.29; 0.75)	0.002	1.33 (1.04; 1.69)
Lyon	210	0.49 (0.20; 1.17)	0.37 (0.14; 0.95)	0.04	1.95 (1.07; 3.56)
Grenoble	690	0.83 (0.42; 1.63)	0.51 (0.30; 0.89)	0.64	1.63 (1.17; 2.26)
Marseille	119	0.57 (0.15; 2.14)	0.20 (0.04; 0.96)	0.05	2.19 (1.23; 3.88)
Geneva	612	0.80 (0.42; 1.51)	0.87 (0.48; 1.56)	0.62	1.60 (1.04; 2.45)
Verona	179	0.60 (0.23; 1.54)	0.23 (0.08; 0.68)	0.009	1.38 (0.96; 2.00)
Pavia	188	0.65 (0.29; 1.44)	0.35 (0.15; 0.81)	0.02	1.37 (0.89; 2.09)
Turin	170	0.68 (0.24; 1.91)	1.41 (0.51; 3.89)	0.55	1.03 (0.68; 1.56)
Oviedo	315	0.77 (0.45; 1.32)	0.36 (0.16; 0.83)	0.02	0.52 (0.27; 1.01)
Galdakao	408	0.75 (0.41; 1.38)	0.49 (0.24; 0.97)	0.04	2.80 (1.53; 5.11)
Barcelona	284	0.87 (0.45; 1.69)	0.77 (0.35; 1.68)	0.48	0.53 (0.29; 0.95)
Albacete	419	0.74 (0.39; 1.42)	0.63 (0.31; 1.28)	0.21	0.39 (0.22; 0.72)
Huelva	233	1.16 (0.49; 2.75)	0.65 (0.20; 2.09)	0.43	2.06 (1.16; 3.65)

Table S5a: Odd ratios (OR) for high exposure (95% CI) in association with education level adjusted for neighborhood unemployment rate (n=5692)

A multilevel logistic regression model (PROC GLIMMIX) was performed with neighborhood at level-2 (random intercept for neighborhood level); adjusted for study, age, sex. High exposure was defined as concentrations above the 75th percentile of the distribution by cities

City	n		Neighborhood			
		OC-II	OC-III	OC-IV	P-value for trend	
Norwich	242	1.02 (0.39; 2.68)	0.43 (0.16; 1.12)	0.42 (0.15; 1.20)	0.09	1.71 (1.17; 2.51)
Ipswich	338	1.91 (0.79; 4.62)	1.23 (0.54; 2.81)	0.81 (0.17; 1.50)	0.27	1.23 (0.81; 1.86)
Ântwerp	500	1.00 (0.49; 2.04)	1.23 (0.75; 2.03)	0.45 (0.18; 1.08)	0.34	3.96 (2.65; 5.90)
Paris	785	0.91 (0.58; 1.41)	0.88 (0.53; 1.46)	0.68 (0.30; 1.56)	0.24	1.33 (1.04; 1.69)
Lyon	210	0.41 (0.16; 1.08)	0.42 (0.16; 1.11)	0.45 (0.15; 1.36)	0.65	1.94 (1.05; 3.59)
Grenoble	690	1.19 (0.66; 2.15)	0.89 (0.44; 1.81)	1.07 (0.50; 2.27)	0.75	1.60 (1.15; 2.23)
Marseille	119	0.43 (0.10; 1.77)	0.06 (0.01; 0.48)	0.50 (0.10; 2.64)	0.08	2.40 (1.34; 4.31)
Geneva	612	0.93 (0.45; 1.92)	0.88 (0.45; 1.73)	0.55 (0.28; 1.12)	0.68	1.62 (1.06; 2.48)
Verona	179	1.31 (0.38; 4.49)	1.07 (0.38; 3.03)	0.14 (0.03; 0.83)	0.06	1.28 (0.87; 1.87
Pavia	188	1.58 (0.59; 4.21)	0.25 (0.10; 0.65)	0.22 (0.07; 0.69)	0.004	1.36 (0.88; 2.10)
Turin	170	0.34 (0.06; 1.93)	0.84 (0.29; 2.45)	0.83 (0.24; 2.86)	0.84	1.02 (0.70; 1.49)
Oviedo	315	0.30 (0.10; 0.93)	0.53 (0.29; 0.99)	0.52 (0.24 1.12)	0.20	0.49 (0.25; 0.96)
Galdakao	408	0.50 (0.20; 1.24)	0.64 (0.31; 1.33)	0.63 (0.31; 1.30)	0.35	2.71 (1.49; 4.91)
Barcelona	284	1.69 (0.69; 4.15)	0.96 (0.45; 2.04)	0.91 (0.40; 2.07)	0.74	0.52 (0.29;0.93)
Albacete	419	0.93 (0.37; 2.36)	0.38 (0.16; 0.90)	0.54 (0.27; 1.09)	0.19	0.38 (0.21; 0.69)
Huelva	233	1.13 (0.33; 3.87)	1.27 (0.47; 3.39)	1.64 (0.57; 4.78)	0.42	1.08 (1.04; 3.26)

Table S5b: Odd ratios (OR) for high exposure (95% CI) in association with occupation class adjusted for neighborhood unemployment rate (n=5692)

A multilevel logistic regression model (PROC GLIMMIX) was performed with neighborhood at level-2 (random intercept for neighborhood level); adjusted for study, age, sex. High exposure was defined as concentrations above the 75th percentile of the distribution by cities

Occupation class (OC): OC-I: Manager and Professional, OC-II: Technician and associate professional, OC-III: other non-manual, OC-IV: skilled manual, semi-skilled or unskilled manual

Figure S2: Results for the city-specific standard linear regression of the association between NO<sub>2</sub> (µg\*m-3) and education level (n=8277)



Percent increase/decrease in NO<sub>2</sub> ( $\mu$ g\*m-3) concentration adjusted for age, sex and EGEA family structure. Negative value means a decrease in NO<sub>2</sub> (in percent) compared to the reference class. Reference category = high education level. In order, first estimate (lines)=medium, second estimate (triangles)=low; p-value for trend were calculated by introducing the categorical variables in continuous. Cities are sorted from north to south.

#### Figure S3: Results for the city-specific linear regression of the association between NO<sub>2</sub> (µg\*m-3) and occupational class (n=8277)



Percent increase/decrease in NO<sub>2</sub> ( $\mu$ g\*m-3) concentration adjusted for age, sex and EGEA family structure. Negative value means a decrease in NO<sub>2</sub> (in percent) compared to the reference class. Reference category = Manager and Professional (I). In order, diamonds=Technician and associate professional, lines=other non-manual, triangles=skilled manual, semi-skilled or unskilled manual. P-value corresponds to the p-value for trend across the occupational groups. Cities are sorted from north to south.

# Figure S4: Results for the city-specific multilevel linear regression of the association between NO<sub>2</sub> ( $\mu$ g\*m-3) and neighborhood unemployment rate (n=5692)



Percent increase/decrease in NO<sub>2</sub> ( $\mu$ g\*m-3) concentration adjusted for age, sex and EGEA family structure. The unemployment variable has been transformed in z-score. Negative value means a decrease in NO<sub>2</sub> (in percent) associated with an increase of 1 standard deviation in the unemployment. A multilevel model with random effect has been performed to take into account the non-independence of the variables unemployment at neighborhood level. Adjusted for age, sex and EGEA family structure. Cities are sorted from north to south.





In X axis, the Gross Domestic Product expressed in euros. In Y axis, the beta coefficient of the association between unemployment rate and NO2.

## Annex 1: Paris-Region: a case study

## **Methods:**

We described the departments regarding their geographical characteristics (population density, green areas) and socioeconomic indicators (unemployment, poverty, Gini index).

We ran a standard multilevel linear regression model with random effects that takes into account the hierarchical structure of the data by disentangling the residual variability at the individual, neighborhood level. We presented the results for the model including simultaneously the individual- and area-SEP markers and accounting for the neighborhood clustering. As NO<sub>2</sub> concentrations were positively skewed, we transformed the variables using natural log transformation. For ease of interpretation, we converted the regression coefficients ( $\beta$ s) into percent increase (95% CI) per unit change in the explanatory factor using the formula [exp( $\beta$ )-1]\*100. For the categorical variable, we calculated the percent increase (95% CI) for each SEP indicator's subgroup (i.e. low, medium and high for educational level) and tested the statistical differences of the coefficients against the highest SEP group (reference group). We considered three sub-regions rather than the departments as they present particular sociodemographic and geographic situations and also to have enough participants in each categories.

## **Results:**



Paris Region is organized in three principal geographic areas: City of Paris (75), the inner suburbs (composed of three administrative "departments": Hauts-de-Seine (92), Seine-St-Denis (93) and Val de Marne (94)) and the outer suburbs (composed of four departments: Seine-et-Marne (77), Yvelines (78), Essonne (91) and Val d'Oise (95).

				D	epartment-level			Neighborhood- level		Individual-level data		
	Depart ment	N	Population density	% of green areas	% of unemployment	% Poverty rate	Gini index	Neighborhood Unemployment	NO <sub>2</sub> mean ±sd	% of participants with high Education	% of participants with high Occupation	
City of Paris	75	389	21347	21	8	16	0.45	11.9	42.7 ±8.9	58.9	50.1	
Inner suburbs	92	76	11315	18	6.2	12.0	0.40	9.2	35.9 ±14.2	47.4	47.4	
	93	35	7892	12	10.2	27.0	0.33	15.4	41.8 ±20.1	37.1	37.1	
	94	32	9833	9	6.7	15.0	0.35	9.4	33.7 ±12.0	46.9	59.4	
Total inner suburbs		143	10146 ±1416	14.5	7.3	16.3	0.37	10.8	37.2 ±15.8	44.8	47.6	
Outer suburbs	77	28	1761	59	5.1	11	0.32	9.7	19.8 ±5.6	14.3	28.6	
	78	63	2400	54	4.9	9	0.36	7.1	21.7 ±7.4	39.7	34.9	
	91	48	1856	48	4.8	12.0	0.33	7.5	24.4 ±7.6	35.4	43.8	
	95	35	3511	35	6.7	16.0	0.32	9.3	27.5 ±12.1	34.3	37.1	
Total outer suburbs		174	2371 ±630	49.3	5.3	11.6	0.34	8.1	23.7 ±9.0	33.3	36.8	
Paris Region		706	14401 ±8156	26.7	7.2	15.0	0.41	10.7	36.4 ±13.4	42.1	46.3	

Table A. Characteristics of the departments in Paris-Region

Table A: The sub-regions of Paris-Region are characterized by specific sociodemographic and socioeconomic situations. The outer suburbs are characterized globally by a low population density and high superficies of green areas. The unemployment (at department level and neighborhood level) and poverty rate are also less marked in this area compared to Paris or the inner suburbs. Regarding the participants, those living in the outer suburbs have lower education level and held less skilled occupations compared to Paris or the inner suburbs. As expected, the more the participants lived far from Paris, the less they were exposed to NO<sub>2</sub>. They were twice less exposed than those residing within Paris city (23.7 vs. 42.7). That is to say, even if Paris and its inner suburbs are more polluted areas they concentrate the most educated participants with the higher skills. This could explain the reverse association between education/occupation and NO<sub>2</sub> exposure.

Neighborhood unemployment is higher than unemployment measured at department level, however its distribution is the same (higher in Paris and inner suburbs than in the outer suburbs).

At department level,  $NO_2$  mean increases as expected with higher density and decreases with higher green areas. Regarding, the socioeconomics characteristics, the  $NO_2$  increases with higher unemployment and higher poverty rate.

Table B: Pearson	correlation b	between ind	lividual, r	neighborhood	and "de	partment"	characteristics

			Individual-lev	el	Neighborhood-level		D	Department-level		
		NO <sub>2</sub>	Individual	Individual	Unemployment	Population	Green	Unemployment	Poverty	Gini
			Education	Occupation	rate	density	areas	rate	rate	index
			level	class						
Individual-level	NO <sub>2</sub>	0								
	Education level	0.03 ns	0							
	Occupation class	0.05 ns	0.46*	0						
Neighborhood-level	Unemployment	0.39*	-0.08°	-0.03 ns	0					
	Population density	0.66*	$0.08^{\circ}$	0.12"	0.35*	0				
Donostmont loval	Green areas	-0.62*	-0.11"	-0.12"	-0.35*	-0.69*	0			
Department-level	Unemployment rate	0.62*	0.07 ns	0.06 ns	0.49*	0.73*	0.79*	0		
	Poverty rate	0.45*	0.04 ns	0.02 ns	0.45*	0.39*	-0.65*	0.90*	0	

P-value: NS non-significant, ° [0.05-0.01[; " [0.01-0.001[ ; \*p<10-5

Table B: As expected, mean  $NO_2$  concentrations exposure estimated at residential address increased with higher population density and less greens areas at department level in the Paris-Region.

At department level, participants with higher education level or higher occupation class appeared to live in higher density areas with less green spaces. At this level, there was no correlation between NO<sub>2</sub> and education level or occupation class. Unemployment rate at neighborhood level was positively correlated with unemployment (<0.0001) and poverty rate (<0.0001) at department level. Green areas was positively associated to unemployment at department (not at neighborhood level). Unlike in the US, wealthier people generally live in more urban areas.

Individual-SEP markers were relatively well correlated to each other (r=0.46, p<0.0001), but they were weakly or not correlated to area-SEP (i.e. unemployment (both at neighborhood and department level) and poverty rate. This discrepancy could suggest a selection bias where only the high-SEP person living in disadvantaged neighborhood participated to the study. However, low correlation between individual- and area-SEP has been also found in other European studies, suggesting that, unlike in the US, the urban segregation that could explain environmental health inequalities at individual-level was not verified in Europe.

Table C: Percent increase in NO2 ( $\mu$ g\*m-3) concentration (95%CI) in relation to educational level with adjustment for neighborhood unemployment rate in Paris-Region (n=706)

	n	n Educational level (ref=high)			Neighborhood Unemployment t∞
		Medium	Low	P-value	
				for trend	
Paris-Region	785	0.1 (-2.6; 2.9)	-0.3 (-3.1; 2.6)	0.84	13.7 (9.7; 17.8)
City of Paris	420	1.5 (-2.0; 5.2)	1.0 (-2.5; 4.6)	0.53	4.8 (1.5; 8.2)
Inner Suburbs	156	0.3 (-1.7; 2.4)	0.3 (-1.7; 2.4)	0.67	7.3 (1.1; 13.9)
Outer suburbs	209	-1.2 (-5.9; 3.8)	-2.0 (-7.5; 3.8)	0.48	5.4 (-1.7; 13.0)

A multilevel linear regression model (PROC MIXED) was performed with neighborhood at level-2 (random intercept for neighborhood level); adjusted for study, age, sex

Reference= High education level, p-value for trend were calculated by introducing the categorical variables in continuous.

 $^{\infty}$  Unemployment has been transformed in z-score, the increase/decrease in NO<sub>2</sub> is showed for 1 standard deviation in the unemployment rate

We found the similar results by pooling participants in Paris-Region compared to pooling them by sub-regions that were not artefacts and with characteristics that could influence the association. The unemployment rate however became no longer significant in the outer suburbs.

City	n		Neighborhood Unemployment t∞			
		OC-II	OC-III	OC-IV	P-value for trend	
Paris-Region	785	-2.3 (-5.0; 0.6)	-3.3 (-6.4; -0.01)	-4.8 (-9.5; 0.1)	0.03	13.7 (9.7; 17.8)
City of Paris	420	-1.5 (-5.0; 2.1)	-3.4 (-7.3; 0.7)	-3.1 (-9.2; 3.5)	0.16	5.0 (1.7; 8.4)
Inner Suburbs	156	-0.3 (-1.8; 1.3)	1.5 (-0.4; 3.5)	-0.9 (-3.5; 1.8)	0.35	7.2 (1.0; 13.8)
Outer suburbs	209	-3.2 (-8.4; 2.3)	-4.4 (-10.6; 2.2)	-2.8 (-11.4; 6.6)	0.34	5.4 (-1.7; 13.0)

Table D: Percent increase in NO2 ( $\mu$ g\*m-3) concentration (95%CI) in relation to occupational class with adjustment for neighborhood unemployment rate in Paris-Region (n=706)

A multilevel linear regression model (PROC MIXED) was performed with neighborhood at level-2 (random intercept for neighborhood level); adjusted for study, age, sex

Occupation class (OC): OC-I: Manager and Professional, OC-II: Technician and associate professional, OC-III: other non-manual, OC-IV: skilled manual, semi-skilled or unskilled manual

<sup>∞</sup> Unemployment has been transformed in z-score, the increase/decrease in NO<sub>2</sub> is showed for 1 standard deviation in the unemployment rate

We found the similar results by pooling participants in Paris-Region compared to pooling them by sub-regions that were not artefacts and with characteristics that could influence the association. However, the associations were no longer significant.