

Online Supplements

Ambient air pollution, traffic noise and adult prevalent asthma: a

BioSHaRE approach

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Supplement-1

Pan-European LUR model methods

NO₂ and PM₁₀ annual estimates for the year 2005-2007 were derived from a pan-European LUR model, which was applied on a 100m grid across Western Europe. Annual mean NO₂ and PM₁₀ data during 2005-2007 were obtained from over 1500 monitoring sites across Europe, regulated and reported by EuroAirnet. Only those monitoring sites which captured over 75% of the total hours for NO₂ and days for PM₁₀ were included. These monitored air pollution data were served as dependent variables while satellite-based ground-level concentration of NO₂ and PM_{2.5} (both on a 10km grid) and GIS-derived land-use and traffic variables were served as independent variables in the LUR modelling.

- NO₂

GIS-derived variables included in the final NO₂ models for 2005, 2006 and 2007 across countries were highly consistent. Table 1 shows the variables included in the final NO₂ model for the year 2007. For variables included in the final models for year 2005 and 2006 as well as the model equations, please refer to the reference paper (Vienneau, D, 2013).

Table 1.1 GIS-variables which were included in the final Satellite-enhanced LUR model for NO₂ (year 2007) for HUNT3, LifeLines and UK Biobank

GIS variable name	Sources	Description
NO₂ (year 2007)		
Constant		
Minor roads 1500m	Central Road Network: EuroStreets V3.1	Lengths (metre) of all minor roads within 1500 metre
Major roads 100m	Central Road Network: EuroStreets V3.1	Lengths (metre) of all major roads within 100 metre
Semi-natural land 600m	CORINE	Semi-natural land (% of area) within a 600 metre buffer
Minor roads 1500-10000m	Central Road Network: EuroStreets V3.1	Lengths (metre) of all minor roads within 1500-10,000 metre
Total built up land 300m	CORINE	Total built up, % of area (residential, industrial, port, airports, mines, dumps and construction sites)

Satellite-derived surface NO ₂ 2007	OMI (Ozone Monitoring Instrument) derived from the Aura Satellite	Surface NO ₂ concentration: OMI derived NO ₂ (ppb) ~10km grid resolution
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- **PM₁₀**

Table 2 shows the variables included in the final PM₁₀ model for the year 2007. For model equations, please refer to the reference paper (Vienneau, D, 2013).

Table 1.2 GIS-variables included in the final Satellite-enhanced LUR model for PM₁₀ (year 2007) for HUNT3, LifeLines and UK Biobank

GIS variable name	Sources	Description
PM₁₀ (year 2007)		
Constant		
Minor roads 200-2500m	Central Road Network: EuroStreets V3.1	Lengths (metre) of all minor roads from 200-2500 metre
Minor roads 200m	Central Road Network: EuroStreets V3.1	Lengths (metre) of all minor roads within 200 metre
Major roads*	Central Road Network: EuroStreets V3.1	Lengths (metre) of all major roads
Altitude	SRTM Digital Elevation Database V4.1	Altitude of the geocoded address
Tree canopy 100m	Coarser Global land cover	% of area of tree canopy within 100 metre
Y coordinate	GIS database-ArcGIS10	Y coordinates for 100m cell centroids
Satellite-derived surface PM _{2.5} 2001-2006	Terra Satellite	Surface PM _{2.5} concentration: Terra- derived and humidity-corrected PM _{2.5} aggregated from 2001-2006 ~10km grid resolution

*Buffer not stated in the reference paper

Reference: Vienneau D, de Hoogh K, Bechle MJ, Beelen R, van Donkelaar A, Martin RV, Millet DB, Hoek G, Marshall JD. Western European land use regression incorporating satellite- and ground-based measurements of NO₂ and PM₁₀. *Environ Sci Technol* 2013; 47: 13555-13564

Supplement-2

Table 2.1 Harmonised variables used as covariates in the analysis

Harmonised name	Harmonised definition	Unit/Categories
AGE_YRS	Age of the participant in years (continuous) at recruitment	Years
GENDER	Sex of the participant	0: Male; 1:Female
ADM_YRINT	Calendar Year of the interview	calendar year
PM_HEIGHT	Measured height	cm
PM_WEIGHT	Measured weight	kg
PM_BMI_CONTINUOUS	Body Mass Index: calculated using measured or self-reported weight and height (kg/m^2)	kg/m^2
PM_BMI_CATEGORICAL	Body Mass Index calculated using measured or self-reported weight and height ($\text{Mass in Kg} / (\text{Height in metre})^2$) and stratified in 3 categories.	1: less 25 kg/m^2 ; 2: 25 to 30 kg/m^2 ; 3: over 30 kg/m^2
SMK_STATUS	Indicator of the participant's current and past smoking status, which includes use of cigarettes, cigars, pipes and other tobacco products.	0: Never-smoker; 1: Ex-smoker; 2: Current-smoker
WORK_STATUS_CURRENT	Indicator of whether the participant is currently in paid employment or is self-employed.	0: No paid employment or not self-employed; 1: Paid employment or self-employed
EDU_HIGHEST_1	Highest level of education completed by the participant. Categories are adapted from the UNESCO Revision of the	0: No education or primary education 1: Secondary education; 2: Vocational/college/university

	International Standard Classification of Education, 2011	
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Supplement-3

Table 3.1 Distributions of exposures by cohort and in the pooled data

NO₂, µg/m³	N	5%	10%	25%	50%	75%	90%	95%	Mean(SD)	IQR
HUNT3	50,628	8.2	8.8	10.1	11.9	15.4	18.6	19.5	13.0 (3.9)	5.3
LifeLines	62,212	13.6	14.1	16.6	20.6	25.4	28.9	31.1	21.2 (5.7)	8.8
UK Biobank	495,262	16.7	19.2	23.6	28.9	35	45.1	52.1	30.7 (10.7)	11.4
Pooled	608,102	17	19.2	23.5	28.7	34.9	44.2	50.5	28.3 (9.9)	11.4
PM₁₀, µg/m³	N	5%	10%	25%	50%	75%	90%	95%	Mean(SD)	IQR
HUNT3	50,567	9.7	10	10.4	11.2	12	12.6	12.9	11.3 (1.1)	1.6
LifeLines	61,927	21	21.4	22.3	23.6	24.7	25.7	26.5	23.6 (1.7)	2.4
UK Biobank	494,163	17.7	18.7	20.2	21.8	23.6	26	27.5	22.1 (2.9)	3.4
Pooled	606,657	19.3	20.2	21.6	23.3	25	27.2	28.6	21.3 (2.7)	3.4
LDAY, dB(A)	N	5%	10%	25%	50%	75%	90%	95%	Mean(SD)	IQR
HUNT3	45,644	39.1	39.5	43.6	47.4	50.3	52.9	54.6	47.0 (4.9)	6.7
LifeLines	74,744	51.3	51.7	52.4	53.9	56.6	60.4	63.9	55.2 (4.0)	4.2
UK Biobank	495,262	51.1	51.4	52.9	54.3	56.4	60.6	66	55.4 (4.3)	3.5
Pooled	615,650	54.7	55.1	56.9	58.8	61.2	65.6	70.8	54.8 (4.3)	4.3
LNIGHT, dB(A)	N	5%	10%	25%	50%	75%	90%	95%	Mean(SD)	IQR
HUNT3	45,644	35.1	35.2	37.5	40.2	42.5	44.8	46.4	40.3 (3.7)	5
LifeLines	74,744	42.5	42.8	43.6	45.1	47.8	51.6	55.1	46.4 (4.0)	4.2
UK Biobank	495,262	42.3	42.6	44	45.5	47.5	51.8	57.2	46.6 (4.3)	3.5
Pooled	615,650	45.6	46	47.5	49.3	51.7	56.1	61.2	46.1 (4.2)	4.2

NO₂ AND PM₁₀ were estimated based on the pan-European satellite-enhanced LUR model for year 2007 while noise estimates (LDAY and LNIGHT) were for year 2009

Supplement-4

Table 4.1 Spearman correlations between air pollutants and day-time noise (Lday) by cohort

HUNT3 (N=45581)	NO ₂	PM ₁₀	Lday		
NO ₂	-				
PM ₁₀	0.80	-			
Lday	-0.05	0.04	-		
LifeLines (N=62653)	NO ₂	PM ₁₀	NO ₂ _ESCAPE	PM ₁₀ _ESCAPE	Lday
NO ₂	-				
PM ₁₀	0.78	-			
NO ₂ _ESCAPE	0.86	0.78	-		
PM ₁₀ _ESCAPE	0.67	0.54	0.73	-	
Lday	0.43	0.38	0.56	0.57	-
UK Biobank (N=460,240)	NO ₂	PM ₁₀	NO ₂ _ESCAPE	PM ₁₀ _ESCAPE	Lday
NO ₂	-				
PM ₁₀	0.77	-			
NO ₂ _ESCAPE	0.86	0.66	-		
PM ₁₀ _ESCAPE	0.5	0.42	0.54	-	
Lday	0.11	0.11	0.23	0.22	-

Correlation between Lday and Lnight (r=0.99) in each cohort.

NO₂: pan-European LUR modelled NO₂ for year 2007

PM₁₀: pan-European LUR modelled PM₁₀ for year 2007

NO₂_ESCAPE: ESCAPE LUR modelled NO₂ for year 2010

PM₁₀_ESCAPE: ESCAPE LUR modelled PM₁₀ for year 2010

Supplement-5

Table 5.1 Associations (Odds ratio, 95%CI) between traffic noise and asthma prevalence: pooled individual-level analyses from three cohorts

	Day-time noise per 5 dB(A)		Night-time noise per 5 dB(A)	
	Ever-had asthma (n=613,362)	Current asthma (n=606,137)	Ever-had asthma (n=613,362)	Current asthma (n=606,137)
Model 1	1.005 (0.996 to 1.014)	1.000 (0.986 to 1.015)	1.005 (0.996 to 1.015)	1.001 (0.986 to 1.016)
Model 2	1.002 (0.993 to 1.011)	0.999 (0.985 to 1.014)	1.002 (0.993 to 1.012)	1.000 (0.985 to 1.015)
Model 3	0.998 (0.988 to 1.008)	0.994 (0.979 to 1.009)	0.999 (0.989 to 1.009)	0.995 (0.979 to 1.010)
Model 3+NO₂	0.996 (0.987 to 1.006)	0.997 (0.982 to 1.013)	0.997 (0.987 to 1.007)	0.998 (0.983 to 1.014)
Model 3+PM₁₀	0.994 (0.984 to 1.004)	0.992 (0.977 to 1.008)	0.995 (0.985 to 1.005)	0.993 (0.977 to 1.009)

Model1: adjusted for study; Model 2: adjusted for study, sex, age; Model 3: further adjusted for education, employment status, smoking status and body mass index.

Supplement-6

Table 6.1 Subgroup analyses on Model 3: Associations between pan-European LUR NO₂, PM₁₀ and ever-asthma prevalence

	NO₂, per 10 µg/m³		PM₁₀, per 10 µg/m³	
	N	Ever-had asthma	N	Ever-had asthma
Sex				
men	256,230	1.020 (1.007 to 1.033)	255,655	1.131 (1.079 to 1.185)
women	311,255	1.017 (1.006 to 1.029)	310,520	1.120 (1.076 to 1.166)
P (interaction)		0.05		0.18
Age				
<50 years	161,982	0.995 (0.980 to 1.010)	161,636	1.057 (1.000 to 1.119)
≥50 years	405,503	1.028 (1.018 to 1.038)	404,539	1.151 (1.110 to 1.193)
P (interaction)		0.13		0.01
Smoking				
never-smoker	301,380	1.003 (0.991 to 1.014)	300,698	1.073 (1.029 to 1.118)
ex-smoker	195,190	1.032 (1.018 to 1.047)	194,724	1.166 (1.108 to 1.227)
current-smoker	70,915	1.053 (1.028 to 1.078)	70,753	1.290 (1.178 to 1.413)
P (interaction)		0.52		0.00
BMI, kg/m²				
<25	194,806	1.015 (1.001 to 1.029)	194,412	1.129 (1.071 to 1.190)
25-30	240,402	1.016 (1.002 to 1.029)	239,827	1.122 (1.069 to 1.177)
≥30	132,277	1.021 (1.005 to 1.038)	131,936	1.103 (1.040 to 1.170)
P (interaction)		0.61		0.23
Education				
primary school or less	93,026	1.047 (1.024 to 1.070)	92,814	1.195 (1.106 to 1.294)

secondary school	160,498	1.035 (1.017 to 1.054)	160,085	1.227 (1.147 to 1.311)
post-secondary school or above	313,961	1.009 (0.999 to 1.019)	313,276	1.085 (1.044 to 1.126)
P (interaction)		0.53		0.00

Table 6.2 Subgroup analyses on Model 3: Associations between pan-European LUR NO₂, PM₁₀ and current-asthma prevalence

	NO₂, per 10 µg/m³		PM₁₀, per 10 µg/m³	
	N	Ever-had asthma	N	Ever-had asthma
Sex				
men	252,503	0.992 (0.970 to 1.013)	251,933	1.087 (1.004 to 1.177)
women	308,040	0.984 (0.967 to 1.002)	307,312	1.044 (0.979 to 1.114)
P (interaction)		0.53		0.27
Age				
<50 years	159,102	0.961 (0.937 to 0.986)	158,758	1.016 (0.927 to 1.114)
≥50 years	401,441	0.996 (0.980 to 1.013)	400,487	1.071 (1.009 to 1.137)
P (interaction)		0.50		0.00
Smoking				
never-smoker	297,210	0.956 (0.937 to 0.973)	296,537	0.962 (0.898 to 1.031)
ex-smoker	193,028	1.023 (1.000 to 1.046)	192,575	1.175 (1.080 to 1.278)
current-smoker	70,295	1.022 (0.983 to 1.062)	70,133	1.231 (1.064 to 1.424)
P (interaction)		0.34		0.00
BMI, kg/m ²				
<25	192,194	0.981 (0.958 to 1.005)	191,806	1.036 (0.948 to 1.131)
25-30	237,402	0.972 (0.951 to 0.994)	236,830	1.045 (0.964 to 1.133)

>=30	130,947	1.010 (0.985 to 1.036)	130,609	1.096 (0.998 to 1.203)
P (interaction)		0.33		0.24
Education				
primary school or less	92,476	1.018 (0.983 to 1.055)	92,265	1.118 (0.988 to 1.267)
secondary school	159,132	1.028 (0.998 to 1.058)	158,722	1.205 (1.083 to 1.341)
post-secondary school or above	308,935	0.968 (0.951 to 0.985)	308258	1.004 (0.943 to 1.071)
P (interaction)		0.30		0.00

Supplement-7

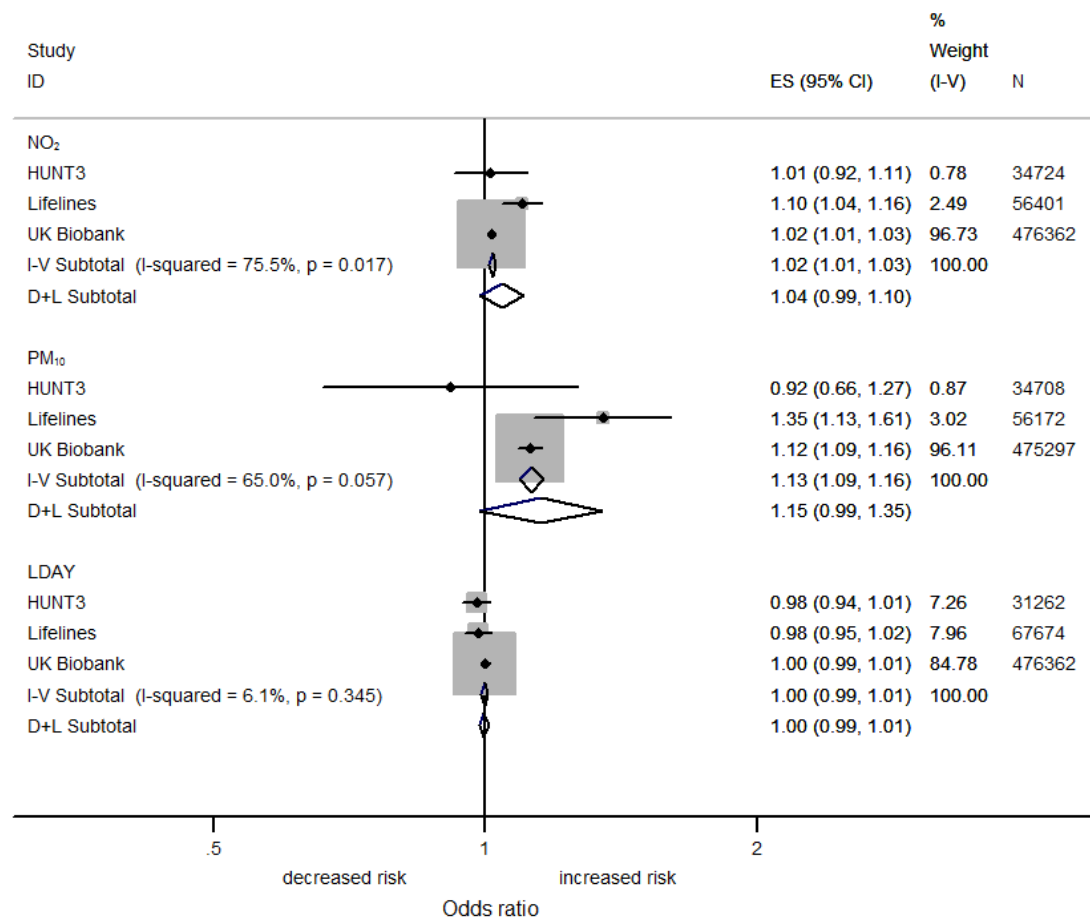
Table 7.1 Sensitivity analyses: restricting analyses to those living at the same address for more than 10 years, adjusting for study, age, sex, BMI, smoking, education, employment status.

NO₂, per 10 µg/m³				PM₁₀, per 10 µg/m³			
N	Ever-had asthma	N	Current asthma	N	Ever-had asthma	N	Current asthma
376,191	1.026 (1.015 to 1.037)	371,969	0.988 (0.971 to 1.005)	375,387	1.163 (1.120 to 1.208)	371,174	1.074 (1.009 to 1.143)
Day-time noise, per 5 dB(A)				Night-time noise, per 5 dB(A)			
N	Ever-had asthma	N	Current asthma	N	Ever-had asthma	N	Current asthma
379,794	1.005 (0.993 to 1.018)	375,572	1.007 (0.988 to 1.026)	379,794	1.006 (0.993 to 1.019)	375,572	1.009 (0.988 to 1.028)

Table 7.2 Sensitivity analyses: Using ESCAPE-LUR modelled NO₂ and PM₁₀ for LifeLines and UK Biobank and pan-European LUR modelled NO₂ and PM₁₀ for HUNT3 in the pooled analyses, adjusting for study, age, sex, BMI, smoking, education, employment status.

NO₂, per 10 µg/m³				PM₁₀, per 10 µg/m³			
N	Ever-had asthma	N	Current asthma	N	Ever-had asthma	N	Current asthma
567,485	1.023 (1.011 to 1.035)	560,543	1.019 (1.000 to 1.038)	534,347	1.071 (1.021 to 1.123)	527,733	1.114 (1.030 to 1.204)

Supplementary Figure S1



Supplementary Figure S1 Associations between pan-European LUR NO₂ (per 10 µg/m³), PM₁₀ (per 10 µg/m³), daytime noise (LDAY, per 5 dB(A)) and **ever-had asthma prevalence**: study-specific meta-analyses based on model 3 (adjusted for, age, sex, BMI, smoking status, education level and employment status).

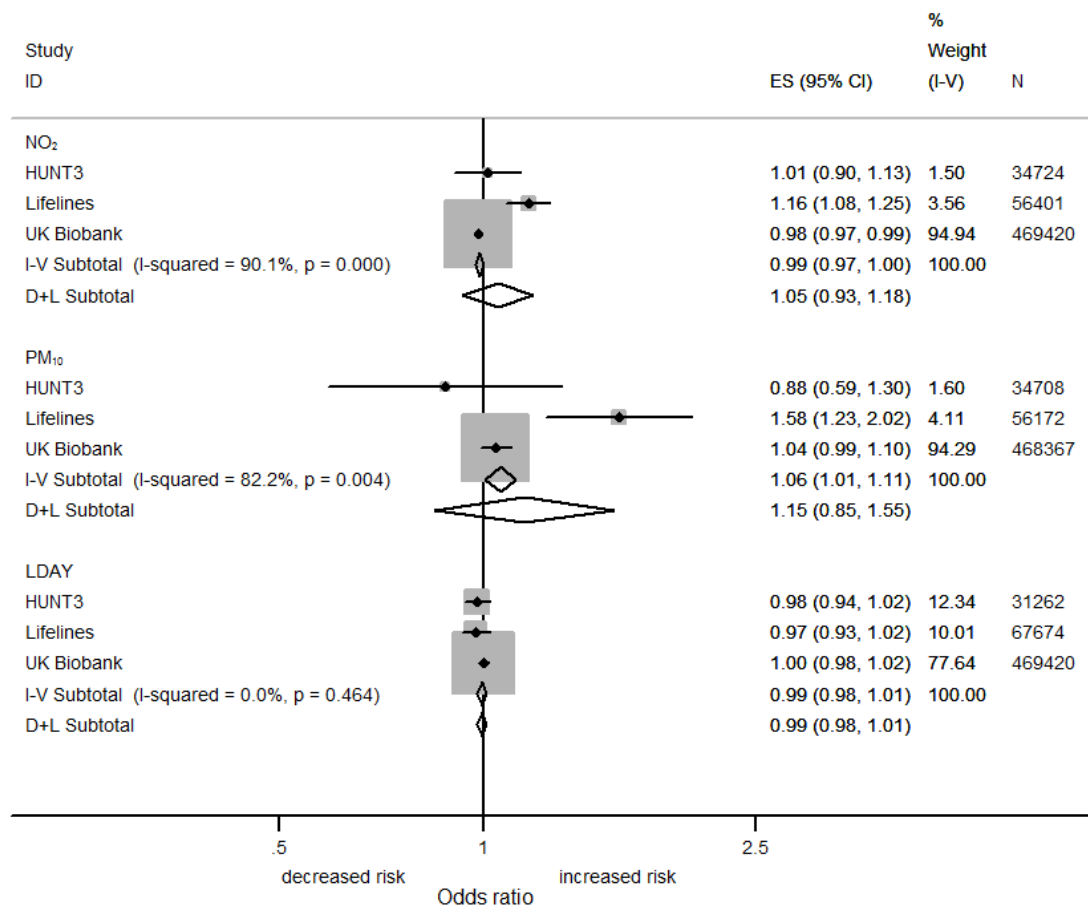
ES: Effect estimate

I-squared: variation in estimated effect attributable to heterogeneity

I-V: inverse-variance weighted (fixed effect model)

D+L: DerSimonian and Laird (random effect model)

Supplementary Figure S2



Supplementary Figure S2 Associations between pan-European LUR NO₂ (per 10 µg/m³), PM₁₀ (per 10 µg/m³), day-time noise (LDAY, per 5 dB(A)) and **current-asthma prevalence**: study-specific meta-analyses based on model 3 (adjusted for age, sex, BMI, smoking status, education level and employment status).

ES: Effect estimate

I-squared: variation in estimated effect attributable to heterogeneity

I-V: inverse-variance weighted (fixed effect model)

D+L: DerSimonian and Laird (random effect model)