

Long-term exposure to ambient fine particulate matter originating from traffic and residential wood combustion and the prevalence of depression

Supplementary material

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Supplementary materials and methods

Estimation of exposures to traffic noise, and green and blue space

We used façade noise levels as estimates of exposure to traffic noise. The road traffic noise exposure model considered the direction of windows in residential dwellings. A consulting company, Sito, calculated façade noise levels emitted by road traffic, in accordance with the EU Environmental Noise Directive 2002/49/EC¹. The company used input data for the year 2016. The Common Noise Assessment Methods in Europe (CNOSSOS-EU) method was used for major highways, main streets and collector streets within areas.² All façade noise calculation points within 20 m of residential address coordinates with L_{den} (Day-evening-night equivalent level) equal to or higher than 30 dB were selected for each home. Where all windows of the dwelling faced the street, the highest L_{den} was attributed as noise exposure to the building. Where all windows faced the yard, the lowest L_{den} was used. Where the windows faced both the street and the yard, an average of the highest and lowest noise levels was used.

The Urban Atlas 2012 was used to determine the percent coverages of green and blue spaces within buffer zones of 300 m and 1 km around each home.³ The ArcMap 10.5 was used to calculate the surface areas of green and blue spaces within the buffers. Arable lands, pastures, forests, green urban areas, herbaceous vegetation associations, and open spaces with little or no vegetation were classified as green spaces, while sea, lakes, rivers, and wetlands were classified as blue spaces. In the main analyses, we used *accessible* green space as a confounder, i.e. green space excluding arable lands and pastures.

References

- (1) European Parliament/Council of the European Union. Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the Assessment and Management of Environmental Noise – Declaration by the Commission in the Conciliation Committee on the Directive relating to the Assessment and Management of Environmental Noise. *Official Journal of the European Communities L* 2002;189:12–26.
- (2) Kephelopoulos S, Paviotti M, Anfosso-Lédée F. Common noise assessment methods in Europe (CNOSSOS-EU). Luxembourg: Publications Office of the European Union, 2012.
- (3) European Union, Copernicus Land Monitoring Service 2012, European Environment Agency (EEA). The Urban Atlas 2012. <https://land.copernicus.eu/local/urban-atlas/urban-atlas-2012/> (20 December 2017, date last accessed).

Supplementary tables and figures

Supplementary table S1. Covariate categories.

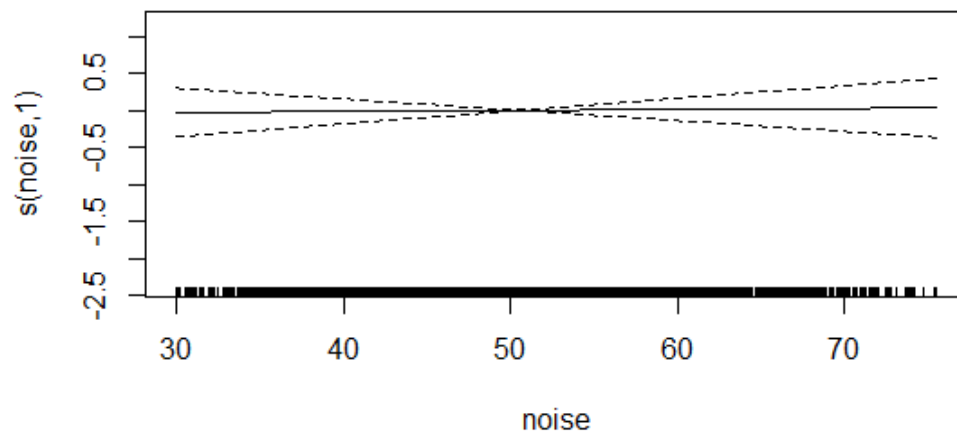
Covariate	Categories
Age	< 55 years old / 55-69 years old / > 69 years old
Sex	female / male
Marital status	single / married or cohabiting / divorced or widow
Employment status	full-time job / part-time job / retired / unemployed / other
Annual household income	≤ 30 000 € / > 30 000 – 50 000 € / > 50 000 – 90 000 € / > 90 000 €
Education	comprehensive school / vocational or high school / college level or polytechnic training / academic training
Alcohol intake in the last 7 days	none / moderate / high
Daily smoking	none / ≤ 2 units / > 2 units
Weekly physical exercise	< once / 1-2 times / ≥ 3 times
Use of summer cottage in summer	0-13 days / 14 days – 2 months / > 2 months
Own wood combustion	never or < once a month / 1-3 times a month / 1-2 times a week / ≥ 3 times a week
Comorbidities	none / 1 comorbidity / 2 comorbidities / > 2 comorbidities Note: The covariate included hypertension, heart failure, angina pectoris, diabetes, cancer, bronchial asthma, pulmonary emphysema or chronic bronchitis, mental disease other than depression, rheumatoid arthritis, and other chronic disease
Road traffic noise annoyance	no / little / some to extremely high Note: The covariate was defined by the survey question “are you usually disturbed by [road traffic noise] when you are at home indoors and the windows are closed?”.

Supplementary figure S1.

Road traffic noise

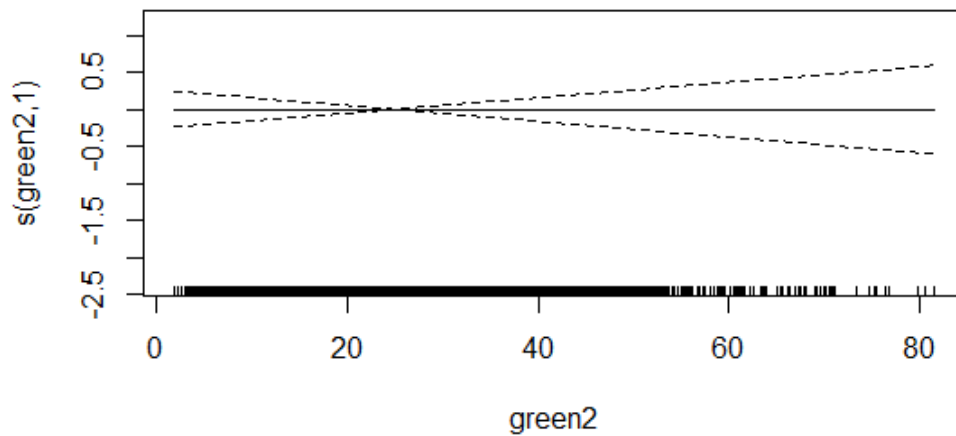
- 0.09	Green space within 300m						
- 0.09	0.52	Green space within 1km					
- 0.20	0.39	0.69	Nature space within 1km				
0.08	0.04	0.17	- 0.19	Residential wood combustion PM _{2.5}			
0.47	- 0.19	- 0.24	- 0.34	- 0.23	Road traffic PM _{2.5}		
- 0.02	- 0.03	- 0.06	0.18	- 0.03	- 0.10	Area-level income	
- 0.05	0	- 0.06	- 0.19	- 0.09	- 0.01	- 0.83	Area-level unemployment

Spearman correlation matrix for various physical and social environmental exposures. PM_{2.5}, particulate matter with an aerodynamic diameter $\leq 2.5 \mu\text{m}$.

Supplementary figure S2.

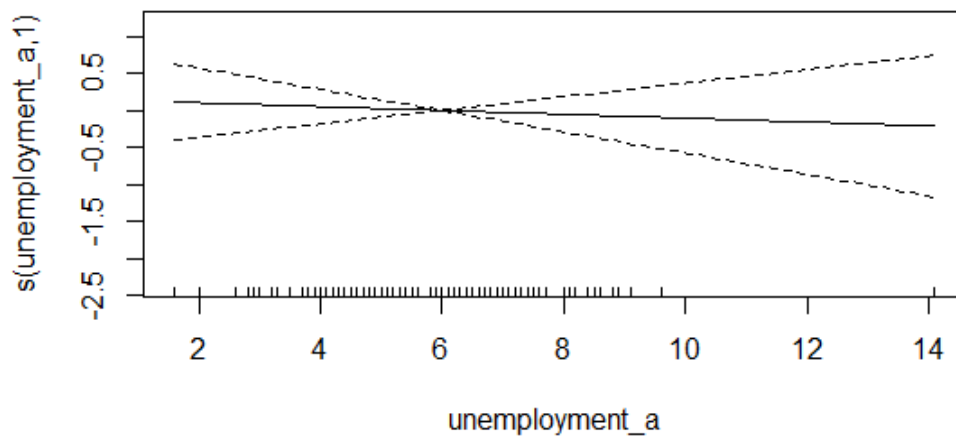
Shape of the association between the confounder road traffic noise (noise) and depression in the main model. $s(\cdot)$, spline function. The continuous line is the graphical representation of the smooth function for road traffic noise and the dashed line its 95% confidence interval.

Supplementary figure S3.



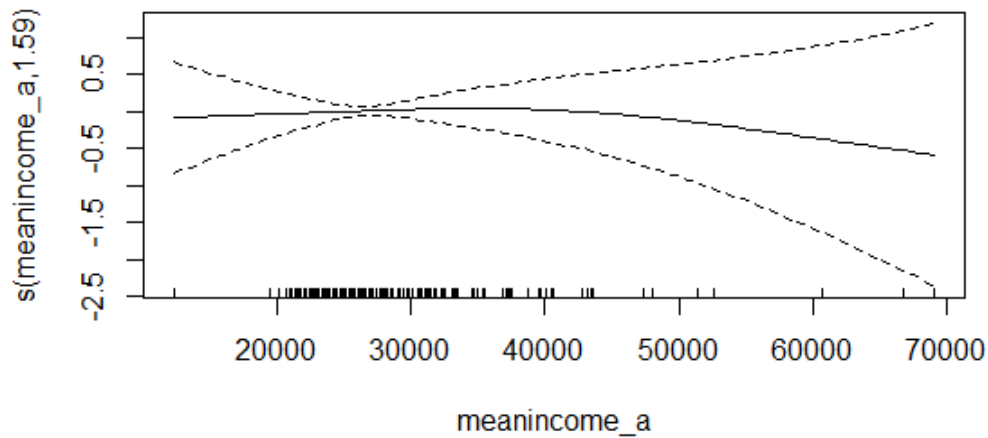
Shape of the association between the confounder green spaces within 1 km (green2) and depression in the main model. $s()$, spline function. The continuous line is the graphical representation of the smooth function for green spaces within 1 km and the dashed line its 95% confidence interval.

Supplementary figure S4.



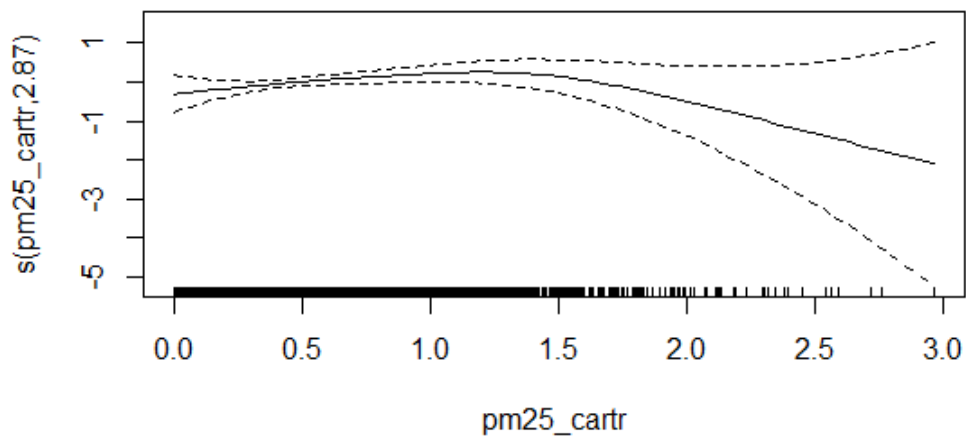
Shape of the association between the confounder area-level unemployment (unemployment_a) and depression in the main model. $s()$, spline function. The continuous line is the graphical representation of the smooth function for area-level unemployment and the dashed line its 95% confidence interval.

Supplementary figure S5.



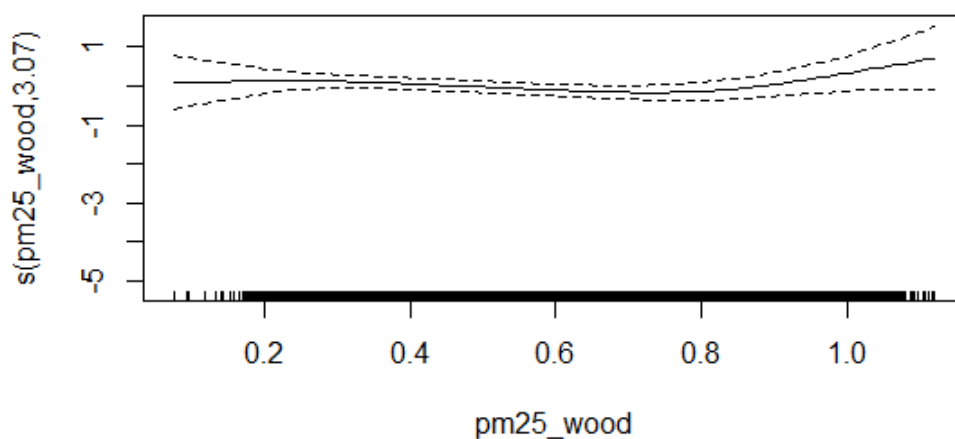
Shape of the association between the confounder area-level mean income (meanincome_a) and depression in the main model. $s()$, spline function. The continuous line is the graphical representation of the smooth function for area-level mean income and the dashed line its 95% confidence interval.

Supplementary figure S6.



Shape of the association between road traffic PM_{2.5} (pm25_cattr) and depression in the main model. $s()$, spline function. The continuous line is the graphical representation of the smooth function for road traffic PM_{2.5} and the dashed line its 95% confidence interval.

Supplementary figure S7.



Shape of the association between residential wood smoke $PM_{2.5}$ ($pm25_wood$) and depression in the main model. $s()$, spline function. The continuous line is the graphical representation of the smooth function for residential wood smoke $PM_{2.5}$ and the dashed line its 95% confidence interval.

Supplementary table S2. Sensitivity analyses for the associations of long-term exposure to $PM_{2.5}$ from residential wood combustion and road traffic with the prevalence of depression

Model	<i>n</i> (total)	<i>n</i> outcome event	Exposure	OR (95% CI)
Basic model ^d	5895	377	Residential wood smoke $PM_{2.5}$	0.81 (0.46, 1.44) <i>P</i> = 0.49
			Road traffic $PM_{2.5}$	1.24 (0.88, 1.75) <i>P</i> = 0.21
Main model ^b adjusted for green space within 300 m but not for green space within 1 km	5895	377	Residential wood smoke $PM_{2.5}$	0.78 (0.43, 1.41) <i>P</i> = 0.41
			Road traffic $PM_{2.5}$	1.22 (0.86, 1.72) <i>P</i> = 0.26
Main model adjusted for nature space within 1 km (and not green space) and use of summer cottage during summertime	5848	370	Residential wood smoke $PM_{2.5}$	0.85 (0.43, 1.67) <i>P</i> = 0.63
			Road traffic $PM_{2.5}$	1.27 (0.87, 1.83) <i>P</i> = 0.21
Main model adjusted for BMI	5804	369	Residential wood smoke $PM_{2.5}$	0.70 (0.38, 1.28) <i>P</i> = 0.25
			Road traffic $PM_{2.5}$	1.24 (0.87, 1.75)

				$P = 0.23$
Main model adjusted for own wood combustion	5723	363	Residential wood smoke PM _{2.5}	0.88 (0.48, 1.63)
				$P = 0.69$
			Road traffic PM _{2.5}	1.17 (0.81, 1.68)
				$P = 0.40$
Single pollutant model ^c for road traffic PM _{2.5} adjusted for own wood combustion	5723	363	Road traffic PM _{2.5}	1.20 (0.85, 1.68)
				$P = 0.29$
Main model adjusted for road traffic annoyance but not for road traffic noise	5895	377	Residential wood smoke PM _{2.5}	0.74 (0.41, 1.32)
				$P = 0.31$
			Road traffic PM _{2.5}	1.14 (0.84, 1.55)
				$P = 0.39$
Main model adjusted for comorbidities	5774	354	Residential wood smoke PM _{2.5}	0.78 (0.42, 1.45)
				$P = 0.44$
			Road traffic PM _{2.5}	1.19 (0.82, 1.71)
				$P = 0.36$

Supplementary table S2 (cont.). Sensitivity analyses for the associations of long-term exposure to PM_{2.5} from residential wood combustion and road traffic with the prevalence of depression

Model	<i>n</i> (total)	<i>n</i> outcome event	Exposure	OR (95% CI)
Main model where smokers are excluded	4716	325	Residential wood smoke PM _{2.5}	0.92 (0.48, 1.75)
				$P = 0.79$
			Road traffic PM _{2.5}	1.38 (0.94, 2.01)
				$P = 0.09$
Main model where participants who changed address in the past year are excluded	5448	340	Residential wood smoke PM _{2.5}	0.75 (0.40, 1.41)
				$P = 0.37$
			Road traffic PM _{2.5}	1.24 (0.84, 1.80)
				$P = 0.27$
Main model where participants who changed address in the past three years are excluded	4236	244	Residential wood smoke PM _{2.5}	1.12 (0.53, 2.33)
				$P = 0.77$
			Road traffic PM _{2.5}	1.01 (0.63, 1.59)
				$P = 0.96$
Main model where participants living in the fifth floor or higher are excluded	5139	314	Residential wood smoke PM _{2.5}	1.03 (0.54, 1.96)
				$P = 0.93$
			Road traffic PM _{2.5}	1.18 (0.77, 1.77)
				$P = 0.44$

Main model where participants with the highest residential wood smoke PM _{2.5} levels are excluded	5883	377	Residential wood smoke PM _{2.5}	0.78 (0.43, 1.42)
				<i>P</i> = 0.42
			Road traffic PM _{2.5}	1.23 (0.86, 1.74)
				<i>P</i> = 0.25
Main model where participants with the highest road traffic PM _{2.5} levels are excluded	5882	377	Residential wood smoke PM _{2.5}	0.77 (0.42, 1.39)
				<i>P</i> = 0.38
			Road traffic PM _{2.5}	1.20 (0.84, 1.70)
				<i>P</i> = 0.31
Main model where depression medication use is the response variable	5835	385	Residential wood smoke PM _{2.5}	0.96(0.53, 1.71)
				<i>P</i> = 0.88
			Road traffic PM _{2.5}	1.11 (0.77, 1.58)
				<i>P</i> = 0.56

BMI, body mass index; CI, confidence interval; OR odds ratios; PM_{2.5}, particulate matter with an aerodynamic diameter ≤ 2.5 μm.

^dBasic model adjusted for road traffic noise, green space within 1 km, age, sex, marital status, employment status, annual household income, education, daily smoking, and weekly physical exercise.

^{b, c}Main model and single pollutant model additionally adjusted for road traffic noise, green space within 1 km, age, sex, marital status, employment status, annual household income, education, daily smoking, weekly physical exercise, area-level unemployment, and area-level income.