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### **Supplemental Material**

#### **Air Pollution and Performance-Based Physical Functioning in Dutch Older Adults**

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**Supplemental material, Table S1.** Land-use regression models with model performance (leave-one-out cross-validation  $R^2$ ,  $R^2_{\text{Loocv}}$ )

Exposure	Land-use regression model	$R^2_{\text{Loocv}}$
NO <sub>2</sub>	$-7.80 + 1.18 \times \text{REGIONALESTIMATE} + 2.30 \times 10^{-5} \times \text{POP\_5000} + 2.46 \times 10^{-6} \times \text{TRAFLOAD\_50} + 1.06 \times 10^{-4} \times \text{ROADLENGTH\_1000} + 9.84 \times 10^{-5} \times \text{HEAVYTRAFLOAD\_25} + 12.19 \times \text{DISTINVNEARC1} + 4.47 \times 10^{-7} \times \text{HEAVYTRAFLOAD\_25\_500}$	0.81
NO <sub>x</sub>	$3.25 + 0.74 \times \text{REGIONALESTIMATE} + 4.22 \times 10^{-6} \times \text{TRAFLOAD\_50} + 6.36 \times 10^{-4} \times \text{POP\_1000} + 2.39 \times 10^{-6} \times \text{HEAVYTRAFLOAD\_500} + 71.65 \times \text{DISTINVMAJOR1} + 0.21 \times \text{MAJORROADLENGTH\_25}$	0.82
PM <sub>2.5</sub> abs	$0.07 + 2.95 \times 10^{-9} \times \text{TRAFLOAD\_500} + 2.93 \times 10^{-3} \times \text{MAJORROADLENGTH\_50} + 0.85 \times \text{REGIONALESTIMATE} + 7.90 \times 10^{-9} \times \text{HLDRES\_5000} + 1.72 \times 10^{-6} \times \text{HEAVYTRAFLOAD\_50}$	0.89
PM <sub>10</sub>	$23.71 + 2.16 \times 10^{-8} \times \text{TRAFMAJORLOAD\_500} + 6.68 \times 10^{-6} \times \text{POP\_5000} + 0.02 \times \text{MAJORROADLENGTH\_50}$	0.60
PM <sub>2.5</sub>	$9.46 + 0.42 \times \text{REGIONALESTIMATE} + 0.01 \times \text{MAJORROADLENGTH\_50} + 2.28 \times 10^{-9} \times \text{TRAFMAJORLOAD\_1000}$	0.61
PM <sub>coarse</sub>	$7.59 + 5.02 \times 10^{-9} \times \text{TRAFLOAD\_1000} + 1.38 \times 10^{-7} \times \text{PORT\_5000} + 5.38 \times 10^{-5} \times \text{TRAFNEAR}$	0.38

DISTINVMAJOR1: inverse distance ( $\text{m}^{-1}$ ) to the nearest road of the local road network; DISTINVNEARC1: Inverse distance to the nearest road; HEAVYTRAFLOAD\_X: Total heavy-duty traffic load of all roads in X m buffer (sum of (heavy-duty traffic intensity \* length of all segments)); HLDRES\_X: Sum of high density and low density residential land in X m buffer; MAJORROADLENGTH\_X: Road length of major roads in X m buffer; POP\_X: Number of inhabitants in X m buffer; PORT: port in X m buffer; REGIONALESTIMATE: Regional estimate; ROADLENGTH\_X: Road length of major roads in X m buffer; TRAFLOAD\_X: Total traffic load of all roads in X m buffer (sum of (traffic intensity \* length of all segments)); TRAFMAJORLOAD\_X: Total traffic load of major roads in X m buffer (sum of (traffic intensity \* length of all segments)); TRAFNEAR: Traffic intensity on nearest road;

**Supplementary material, Table S2.** Distribution of baseline performance scores by participant characteristics (N=1,762 participants).

Covariate	Performance-based			Self-reported		
	N	Mean (std)	p-value <sup>a</sup>	N	Mean (std)	p-value <sup>a</sup>
Age at performance measurement			<b>&lt;0.0001</b>			<b>&lt;0.0001</b>
≤ 65 years	606	12.8 (2.5)		630	33.9 (2.8)	
65 – 70 years	676	12.4 (2.8)		714	33.4 (3.6)	
70 – 75 years	905	11.9 (2.9)		946	33.1 (3.6)	
75 – 80 years	750	10.8 (3.3)		801	32.3 (4.2)	
80 – 85 years	559	9.3 (3.7)		598	30.5 (5.4)	
> 85 years	609	7.0 (3.6)		716	27.0 (7.0)	
Female sex			<b>&lt;0.0001</b>			<b>&lt;0.0001</b>
Male	1896	11.1 (3.3)		1985	32.8 (4.1)	
Female	2209	10.5 (3.9)		2420	30.9 (5.8)	
Educational level			<b>&lt;0.0001</b>			
Low	1892	10.1 (3.8)		2073	30.8 (5.8)	
Medium	1409	11.1 (3.6)		1494	32.2 (4.6)	
High	804	11.9 (3.2)		838	33.3 (3.7)	
Smoking			<b>0.0009</b>			<b>&lt;0.0001</b>
Never smoker	1264	10.4 (4.0)		1382	31.0 (5.8)	
Ex-smoker	2169	10.9 (3.6)		2298	32.1 (4.6)	
Current smoker	672	11.2 (3.3)		725	32.1 (5.2)	
Alcohol consumption			<b>&lt;0.0001</b>			<b>&lt;0.0001</b>
Non drinker	572	9.0 (4.1)		651	28.8 (6.8)	
Light drinker	2143	10.8 (3.7)		2287	31.8 (5.0)	
Moderate drinker	1147	11.7 (3.2)		1209	33.0 (3.9)	
Excessive drinker	243	11.7 (3.3)		258	32.9 (3.9)	

**Supplementary material, Table S2.** (continued)

Covariate	Performance-based			Self-reported		
	N	Mean (std)	p-value <sup>a</sup>	N	Mean (std)	p-value <sup>a</sup>
Physical activity past 2 weeks			<b>&lt;0.0001</b>			<b>&lt;0.0001</b>
< 78 min/day	905	9.9 (4.0)		1024	30.0 (6.7)	
78 – 199 min/day	2126	11.0 (3.6)		2257	32.1 (4.6)	
≥ 199 min/day	1074	11.1 (3.5)		1124	32.6 (4.1)	
Depression			<b>&lt;0.0001</b>			<b>&lt;0.0001</b>
No	3572	11.1 (3.5)		3793	32.3 (4.6)	
Yes	533	9.1 (4.1)		612	28.5 (6.8)	
Chronic diseases			<b>&lt;0.0001</b>			<b>&lt;0.0001</b>
0	979	12.4 (2.8)		1033	34.0 (2.9)	
1	1509	11.3 (3.3)		1613	32.6 (4.1)	
2 or more	1617	9.4 (3.9)		1759	29.6 (6.2)	

<sup>a</sup> F-test taking into account the correlation between repeated observations within the same participant.

**Supplementary material, Table S3.** Residential exposure to air pollution – Pearson correlations between pollutants.

	<b>NO<sub>2</sub></b>	<b>NO<sub>x</sub></b>	<b>PM<sub>2.5</sub> abs</b>	<b>PM<sub>2.5</sub></b>	<b>PM<sub>10</sub></b>	<b>PM<sub>coarse</sub></b>
<b>NO<sub>2</sub></b>	1.00	0.91	0.88	0.43	0.87	0.89
<b>NO<sub>x</sub></b>		1.00	0.86	0.43	0.88	0.87
<b>PM<sub>2.5</sub> abs</b>			1.00	0.69	0.92	0.82
<b>PM<sub>2.5</sub></b>				1.00	0.48	0.36
<b>PM<sub>10</sub></b>					1.00	0.90
<b>PM<sub>coarse</sub></b>						1.00

**Supplementary material, Table S4.** Distribution of daily average air pollution concentrations on the days of the physical performance test for all study participants.

<b>Pollutant</b>	<b>Mean (SD)</b>	<b>Min</b>	<b>Median</b>	<b>Max</b>	<b>IQR</b>
NO <sub>2</sub> (µg/m <sup>3</sup> )	18.6 (7.1)	7.4	17.1	47.8	11.1
PM <sub>10</sub> (µg/m <sup>3</sup> )	23.9 (10.1)	6.7	21.9	69.0	15.0

**Supplemental material, Table S5.** Adjusted <sup>a</sup> associations <sup>b</sup> between performance-based physical functioning and residential air pollution exposure from linear mixed model analyses with additional adjustment for air pollution concentrations during the week preceding the performance test <sup>c</sup>.

Pollutant	Increment	Mean		p-value
		difference	(95% CI)	
NO <sub>2</sub>	8.9 µg/m <sup>3</sup>	-0.22	(-0.42; -0.02)	0.028
NO <sub>x</sub>	13.5 µg/m <sup>3</sup>	-0.20	(-0.36; -0.03)	0.019
PM <sub>2.5abs</sub>	0.31 10 <sup>-5</sup> m <sup>-1</sup>	-0.12	(-0.29; 0.06)	0.182
PM <sub>2.5</sub>	1.4 µg/m <sup>3</sup>	0.18	(-0.05; 0.41)	0.130
PM <sub>10</sub>	1.5 µg/m <sup>3</sup>	-0.21	(-0.36; -0.07)	0.004
PM <sub>coarse</sub>	0.8 µg/m <sup>3</sup>	-0.18	(-0.31; -0.05)	0.008

<sup>a</sup> Adjusted for age, sex, education level, smoking, alcohol consumption, depression, physical activity, area-level socio economic status defined as the status score of the four-position postcode, air pollution concentrations on the day of the performance test, and cross-products of time since baseline with education, alcohol consumption, and depression.

<sup>b</sup> Associations are presented as mean difference in physical performance score with 95% confidence intervals (CI) for an interquartile range increase in air pollution exposure and were derived from models with exposure and exposure-time since baseline interaction.

<sup>c</sup> Associations with NO<sub>2</sub> and NO<sub>x</sub> were adjusted for NO<sub>2</sub> concentrations on the day of the test, all other associations were adjusted for PM<sub>10</sub> concentrations on the day of the test.

<sup>d</sup> N=1,676 participants, n = 4,005 observations for NO<sub>2</sub> and NO<sub>x</sub> and N=1,674 participants, n = 3,974 observations for all other associations due to some missings for air pollution concentrations on the test day.



**Supplemental material, Table S6** Adjusted <sup>a</sup> associations <sup>b</sup> between physical performance (performance-based and self-reported) and residential air pollution exposure from linear mixed model analyses, restricted to participants who completed all three cycles of data collection.

Pollutant	Increment	Performance-based <sup>c</sup>			Self-reported <sup>d</sup>		
		Mean difference	(95% CI)	p-value	Mean difference	(95% CI)	p-value
NO <sub>2</sub>	8.9 µg/m <sup>3</sup>	-0.26	(-0.49; -0.04)	0.022	0.12	(-0.18; 0.42)	0.441
NO <sub>x</sub>	13.5 µg/m <sup>3</sup>	-0.21	(-0.40; -0.03)	0.027	0.15	(-0.10; 0.40)	0.242
PM <sub>2.5abs</sub>	0.31 10 <sup>-5</sup> m <sup>-1</sup>	-0.17	(-0.37; 0.03)	0.092	0.07	(-0.20; 0.33)	0.610
PM <sub>2.5</sub>	1.4 µg/m <sup>3</sup>	0.16	(-0.11; 0.43)	0.251	-0.09	(-0.44; 0.27)	0.627
PM <sub>10</sub>	1.5 µg/m <sup>3</sup>	-0.24	(-0.41; -0.07)	0.005	0.11	(-0.11; 0.34)	0.319
PM <sub>coarse</sub>	0.8 µg/m <sup>3</sup>	-0.21	(-0.36; -0.05)	0.008	0.12	(-0.08; 0.33)	0.236

<sup>a</sup> Adjusted for age, sex, education level, smoking, alcohol consumption, depression physical activity, area-level socio economic status defined as the status score of the four-position postcode, and cross-products of time since baseline with education, alcohol consumption and depression.

<sup>b</sup> Associations are presented as mean difference in physical performance score with 95% confidence intervals (CI) for an interquartile range increase in air pollution exposure and were derived from models with exposure and exposure-time since baseline interaction.

<sup>c</sup> N=1,022 participants, n = 3,066 observations

<sup>d</sup> N=1,165 participants, n = 3,495 observations

**Supplemental material, Table S7.** Adjusted <sup>a</sup> associations <sup>b</sup> between physical performance (performance-based and self-reported) and residential air pollution exposure from linear mixed model analyses, restricted to participants who did not change address between three years prior to the 2005/2006 cycle and the last completed cycle.

Pollutant	Increment	Performance-based <sup>c</sup>			Self-reported <sup>d</sup>		
		Mean difference	(95% CI)	p-value	Mean difference	(95% CI)	p-value
NO <sub>2</sub>	8.9 µg/m <sup>3</sup>	-0.38	(-0.60; -0.15)	0.001	0.17	(-0.12; 0.46)	0.252
NO <sub>x</sub>	13.5 µg/m <sup>3</sup>	-0.27	(-0.46; -0.09)	0.004	0.28	(0.03; 0.52)	0.026
PM <sub>2.5</sub> abs	0.31 10 <sup>-5</sup> m <sup>-1</sup>	-0.25	(-0.44; -0.05)	0.014	0.06	(-0.20; 0.31)	0.662
PM <sub>2.5</sub>	1.4 µg/m <sup>3</sup>	0.03	(-0.23; 0.29)	0.823	-0.19	(-0.52; 0.15)	0.276
PM <sub>10</sub>	1.5 µg/m <sup>3</sup>	-0.29	(-0.46; -0.13)	0.001	0.14	(-0.07; 0.36)	0.188
PM <sub>coarse</sub>	0.8 µg/m <sup>3</sup>	-0.24	(-0.39; -0.09)	0.001	0.18	(-0.01; 0.38)	0.069

<sup>a</sup> Adjusted for age, sex, education level, smoking, alcohol consumption, depression, physical activity, area-level socio economic status defined as the status score of the four-position postcode, and cross-products of time since baseline with education, alcohol consumption and depression.

<sup>b</sup> Associations are presented as mean difference in physical performance score with 95% confidence intervals (CI) for an interquartile range increase in air pollution exposure and were derived from models with exposure and exposure-time since baseline interaction.

<sup>c</sup> N=1,247 participants, n = 3,042 observations

<sup>d</sup> N=1,287 participants, n = 3,218 observations

**Supplemental material, Table 8.** Post hoc sensitivity analyses of residual confounding of the association between air pollution and performance-based physical functioning due to an unmeasured binary confounder (U).

Outcome	Performance-based physical functioning	
Exposure contrast	4th vs 1st quartile of NO <sub>2</sub> exposure	
Effect estimate (exposure – outcome)	-0.46 points	
Difference in outcome per year	-0.30 points	
<b>Sensitivity analysis specifications and results</b>		
<i>Hypothetical relation of U to cognitive outcome (U - outcome)</i>		
Difference in cognitive outcome, U = 1 vs U = 0	-0.6 points	-1.5 points
Years apart in age associated with the same difference in outcome	2 years	5 years
<i>Resulting relation of U to exposure required to produce the reported effect estimate</i>		
Difference in the prevalence of U, high vs low exposure <sup>a</sup>	77%	31%
Equivalent minimum relative odds (OR) of high exposure, U = 1 vs U = 0 <sup>b</sup>	59.2	3.6

<sup>a</sup> For details on the method used please see Vanderweele TJ and Arah OA. 2011. Unmeasured confounding for general outcomes, treatments, and confounders: Bias formulas for sensitivity analyses. *Epidemiology* 22(1):42-52.

<sup>b</sup> Prevalence differences are absolute not relative differences. Given the difference in U prevalence shown, the minimum OR of high exposure is the smallest OR across all possible pairs of U prevalence.

**Supplemental material, Table S9.** Adjusted<sup>a</sup> associations<sup>b</sup> between physical performance (performance-based and self-reported) and residential air pollution exposure from linear mixed model analyses without exposure-time since baseline interaction terms.

Pollutant	Increment	Performance-based <sup>c</sup>			Self-reported <sup>d</sup>		
		Mean difference	(95% CI)	p-value	Mean difference	(95% CI)	p-value
NO <sub>2</sub>	8.9 µg/m <sup>3</sup>	-0.22	(-0.40; -0.04 )	0.014	0.21	(-0.06; 0.47 )	0.121
NO <sub>x</sub>	13.5 µg/m <sup>3</sup>	-0.17	(-0.32; -0.02 )	0.022	0.23	(0.01; 0.46 )	0.037
PM <sub>2.5</sub> abs	0.31 10 <sup>-5</sup> m <sup>-1</sup>	-0.12	(-0.27; 0.04 )	0.142	0.10	(-0.14; 0.33 )	0.413
PM <sub>2.5</sub>	1.4 µg/m <sup>3</sup>	0.08	(-0.13; 0.28 )	0.456	-0.16	(-0.46; 0.15 )	0.311
PM <sub>10</sub>	1.5 µg/m <sup>3</sup>	-0.19	(-0.32; -0.06 )	0.005	0.17	(-0.03; 0.36 )	0.096
PM <sub>coarse</sub>	0.8 µg/m <sup>3</sup>	-0.16	(-0.29; -0.04 )	0.008	0.20	(0.02; 0.38 )	0.031

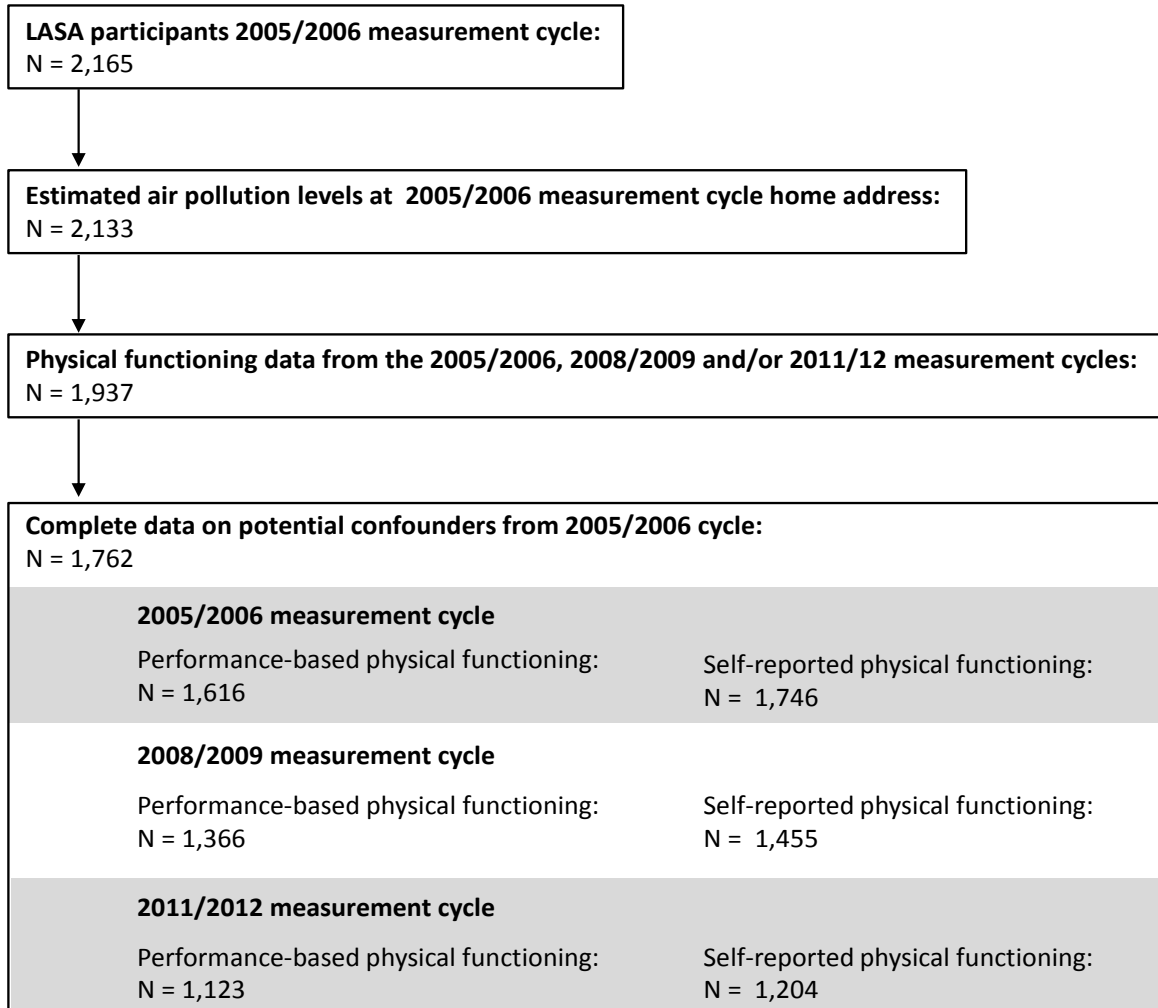
<sup>a</sup> Adjusted for age, sex, education level, smoking, alcohol consumption, depression, physical activity, area-level socio economic status defined as the status score of the four-position postcode, and cross-products of time since baseline with education, alcohol consumption and depression.

<sup>b</sup> Associations are presented as mean difference in physical performance score with 95% confidence intervals (CI) for an interquartile range increase in air pollution exposure.

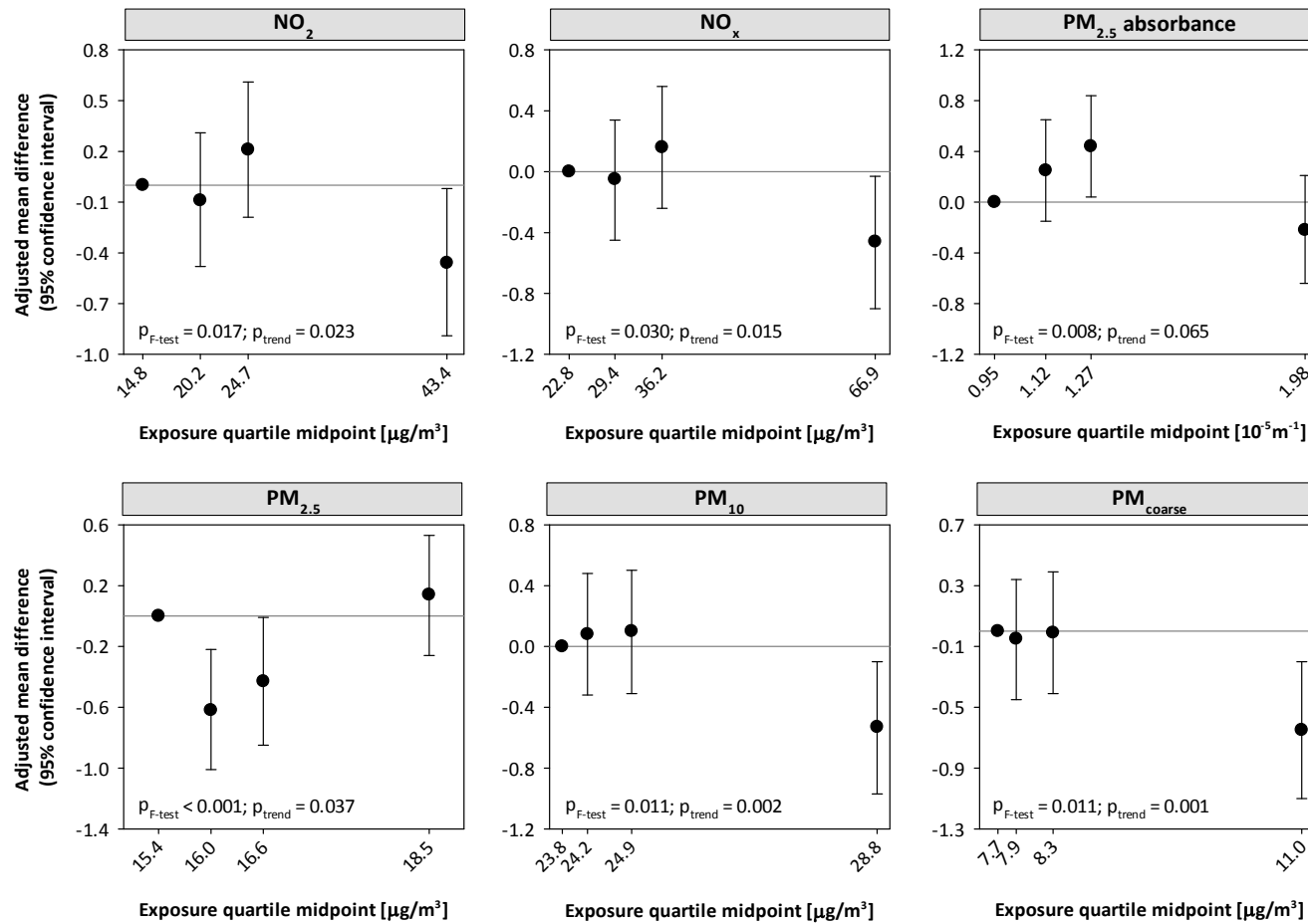
<sup>c</sup> N=1,695 participants, n = 4,105 observations

<sup>d</sup> N=1,758 participants, n = 4,405 observations

Supplemental material, Figure S1. Flow-chart of the study sample.

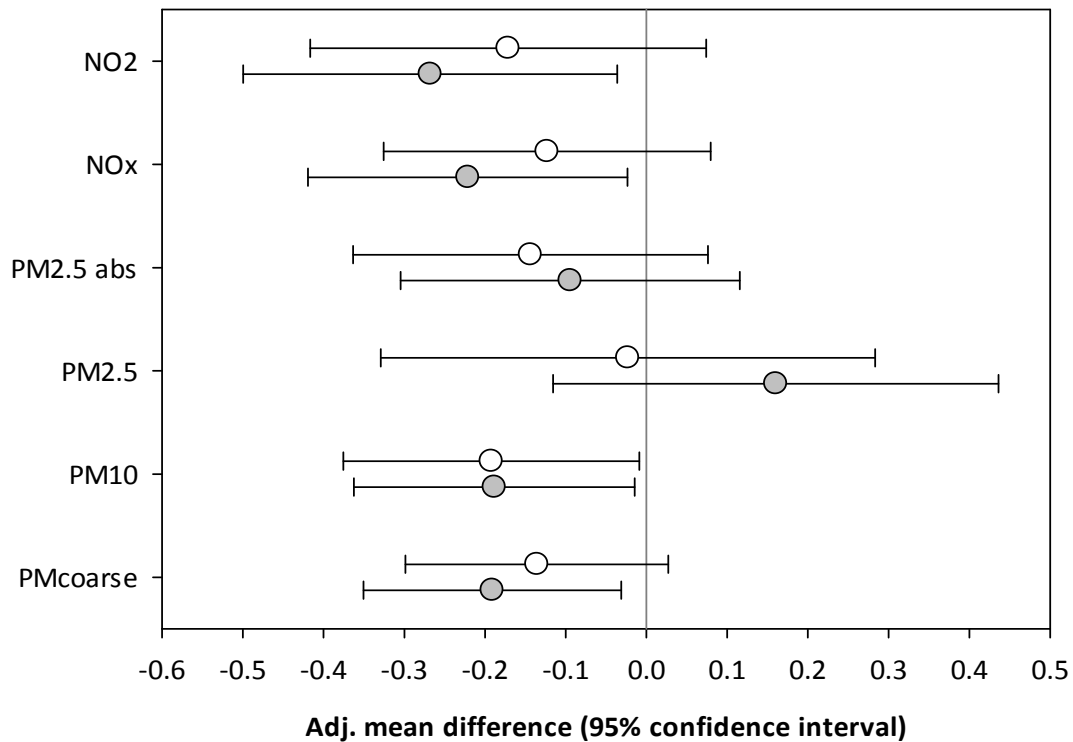


**Supplemental material, Figure S2.** Adjusted<sup>a</sup> associations<sup>b</sup> between self-reported physical functioning and quartiles of residential air pollution exposure from linear mixed model analyses with p-values of F-tests for equality of means and trend tests using quartile midpoints (N=1,758 participants, n=4,405 observations).



- <sup>a</sup> Adjusted for age, sex, education level, smoking, alcohol consumption, depression, physical activity, area-level socio economic status defined as the status score of the four-position postcode, and cross-products of time since baseline with education, alcohol consumption and depression..
- <sup>b</sup> Associations are presented as mean difference in physical performance score in the different quartiles as compared to the 1<sup>st</sup> quartile with 95% confidence intervals and were derived from models with exposure and exposure-time since baseline interaction.

**Supplemental material, Figure S3.** Adjusted <sup>a</sup> sex-specific associations <sup>b</sup> between performance-based physical functioning and residential air pollution exposure from linear mixed model analyses with exposure-sex interaction terms (N=1,735 participants, n=4,039 observations). Grey dots represent females, white dots represent males.



<sup>a</sup> Adjusted for age, education level, smoking, alcohol consumption, depression, physical activity, area-level socio economic status defined as the status score of the four-position postcode, and cross-products of time since baseline with education, alcohol consumption and depression..

<sup>b</sup> Associations are presented as mean difference in physical performance score with 95% confidence intervals (CI) for an interquartile range increase in air pollution exposure and were derived from models with exposure and exposure-time since baseline interaction.