

## Supplementary Material

### Air pollution, lung function and COPD: results from the population-based UK Biobank study

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**Table S1:** ESCAPE project Southeast England area (London/Oxford) LUR models\*

Pollutant	Predictor variables in final model †	Final LUR model	R <sup>2</sup> of model	R <sup>2</sup> cross validation
PM <sub>2.5</sub>	<ul style="list-style-type: none"> <li>Product of inverse distance to the nearest road and nearest major road and traffic intensity on this road (INTMAJORINVDIST)<sup>‡</sup></li> <li>Road length of all roads in a 500-meter buffer (ROADLENGTH_500)</li> </ul>	$7.19 + 1.38 \times 10^{-3} \times$ INTMAJORINVDIST + $2.65 \times 10^{-4} \times$ ROADLENGTH_500	82%	77%
PM <sub>10</sub>	<ul style="list-style-type: none"> <li>Inverse distance to the nearest road of the central road network (DISTINVMAJORC1)<sup>§</sup></li> <li>Heavy-duty traffic intensity on nearest major road (HEAVYTRAFMAJOR)</li> <li>Sum of high density and low-density residential land in a 300-meter buffer (HLDRES_300)</li> </ul>	$11.40 +$ $76.99 \times$ DISTINVMAJOR C1 + $1.35E-$ $3 \times$ HEAVYTRAFMAJOR + $1.30E-5 \times$ HLDRES_300	90%	88%
PM <sub>coarse</sub>	<ul style="list-style-type: none"> <li>Inverse distance and inverse squared distance to the nearest major road in local road network (DISTINVMAJOR1)<sup>‡</sup></li> <li>Heavy-duty traffic intensity on nearest major road (HEAVYTRAFMAJOR)<sup>‡</sup></li> </ul>	$5.36 +$ $33.08 \times$ DISTINVMAJOR1 + $7.98 \times 10^{-4} \times$ HEAVYTRAFMAJOR	68%	57%
NO <sub>2</sub>	<ul style="list-style-type: none"> <li>Total traffic load of major roads in a 50-meter buffer (sum of (traffic intensity * length of all segments)) (TRAFMAJORLOAD_50)<sup>‡</sup></li> <li>Road length of all roads in a 500-meter buffer (ROADLENGTH_500)</li> <li>Sum of high density and low-density residential land in a 5000-meter buffer (HLDRES_5000)</li> </ul>	$8.51 + 7.30E-$ $6 \times$ TRAFMAJORLOAD_5 $0 + 1.10E-$ $3 \times$ ROADLENGTH_500 + $2.00E-7 \times$ HLDRES_5000	89%	87%

*Definition of abbreviations:* PM<sub>2.5</sub> = fine particulate matter with diameter <2.5 µm, PM<sub>10</sub> = particulate matter with diameter <10 µm, PM<sub>coarse</sub> = coarse particulate matter with diameter between 2.5 µm and 10 µm, NO<sub>2</sub> = nitrogen dioxide

\* Information extracted from Eeftens *et al.* [1] and Beelen *et al.* [2]; validation data shown in this table is not specific to the study area included in the present analysis

† Units used: road length in meters, traffic load and intensity in veh. day<sup>-1</sup> m, number of inhabitants in numbers, surface area in m<sup>2</sup>

‡ Major roads for local road network are road with traffic intensity > 5,000 mvh/24h

§ Major roads for central road network are classes 0, 1, and 2 (+ classes 3 and 4 based on local knowledge and decision)

**Table S2:** List of 14 occupations showing a moderate increased risk of COPD (prevalence ratio ≥ 1.30) \*

SOC code, version 2000	Occupation
8217	Seafarers; barge, lighter and boat operatives
8122	Coal mine operatives
9132	Industrial cleaning process occupations
5313	Roofers, roof tilers and slaters
9134	Packers, bottlers, canners, fillers
5112	Horticultural trades
8111	Food, drink and tobacco process operatives
9233	Cleaners, domestics
5322	Floorers and wall tilers
8114	Chemical and related process operatives
9211	Postal workers, mail sorters, messengers, couriers
9121	Labourers in building and woodworking trades
9244	School mid-day assistants
9223	Kitchen and catering assistants

*Definition of abbreviations:* SOC = Standard Occupational Classification

\* Information extracted from: De Matteis *et al.* [3]

**Table S3:** Associations of lung function and ambient air pollution exposure, per interquartile range (IQR)\*

Exposure	N	FEV <sub>1</sub> (mL)	FVC (mL)	FEV <sub>1</sub> /FVC
		Beta [95% CI]	Beta [95% CI]	Beta [95% CI]
PM <sub>2.5</sub> (per IQR = 1.27 µg/m <sup>3</sup> )	278 228	-21.11 [-23.50, -18.73]	-15.90 [-18.77, -13.03]	-2.46 [-2.75, -2.17]
PM <sub>10</sub> (per IQR = 1.77 µg/m <sup>3</sup> )	278 228	-16.71 [-18.51, -14.91]	-21.76 [-23.93, -19.59]	-0.06 [-0.28, 0.16]
PM <sub>coarse</sub> (per IQR = 0.77 µg/m <sup>3</sup> )	278 228	-10.57 [-12.22, -8.91]	-14.89 [-16.89, -12.89]	0.21 [0.01, 0.40]
NO <sub>2</sub> (per IQR = 9.70 µg/m <sup>3</sup> )	299 537	-32.83 [-35.25, -30.41]	-32.46 [-35.38, -29.55]	-2.20 [-2.49, -1.91]

*Definition of abbreviations:* FEV<sub>1</sub> = forced expiratory volume in 1 second, FVC = forced vital capacity, CI = confidence interval, PM<sub>2.5</sub> = fine particulate matter with diameter <2.5 µm, PM<sub>10</sub> = particulate matter with diameter <10 µm, PM<sub>coarse</sub> = coarse particulate matter with diameter between 2.5 µm and 10 µm, NO<sub>2</sub> = nitrogen dioxide

\* Adjusted for age (continuous), age-squared, sex, height, BMI (Kg/m<sup>2</sup>), household income (less than £ 31,000 / £ 31,000 and above), education level (lower vocational or less / higher vocational or more), smoking status (never / former / current), and passive smoking exposure at home (none / any)

**Table S4:** Associations of COPD and ambient air pollution exposure, per interquartile range (IQR)\*

Exposure	No. cases / non-cases*	OR [95% CI]
PM <sub>2.5</sub> (per IQR = 1.27 µg/m <sup>3</sup> )	20 478 / 257 089	1.11 [1.09, 1.13]
PM <sub>10</sub> (per IQR = 1.77 µg/m <sup>3</sup> )	20 478 / 257 089	1.01 [1.00, 1.03]
PM <sub>coarse</sub> (per IQR = 0.77 µg/m <sup>3</sup> )	20 478 / 257 089	1.00 [0.99, 1.01]
NO <sub>2</sub> (per IQR = 9.70 µg/m <sup>3</sup> )	21 900 / 276 948	1.11 [1.09, 1.13]

*Definition of abbreviations:* OR = odds ratio, CI = confidence interval, PM<sub>2.5</sub> = fine particulate matter with diameter <2.5 µm, PM<sub>10</sub> = particulate matter with diameter <10 µm, PM<sub>coarse</sub> = coarse particulate matter with diameter between 2.5 µm and 10 µm, NO<sub>2</sub> = nitrogen dioxide

\* Adjusted for age (continuous), sex, BMI (Kg/m<sup>2</sup>), household income (less than £ 31,000 / £ 31,000 and above), education level (lower vocational or less / higher vocational or more), smoking status (never / former / current), passive smoking exposure at home (none / any)

**Table S5:** Associations of COPD and lung function with PM<sub>2.5</sub>, NO<sub>2</sub>, smoking status and passive smoking exposure\*

Exposure	FEV <sub>1</sub> (mL)	FVC (mL)	FEV <sub>1</sub> /FVC	COPD
	Beta [95% CI]	Beta [95% CI]	Beta [95% CI]	OR [95% CI]
PM <sub>2.5</sub> (per 5 µg/m <sup>3</sup> )	-83.13 [-92.50, -73.75]	-62.62 [-73.91, -51.32]	-9.68 [-10.81, -8.56]	1.52 [1.42, 1.62]
NO <sub>2</sub> (per 10 µg/m <sup>3</sup> )	-33.85 [-36.34, -31.36]	-33.47 [-36.47, -30.46]	-2.27 [-2.57, -1.96]	1.12 [1.10, 1.14]
Former smoker	-127.13 [-147.54, -106.73]	38.05 [13.46, 62.64]	-47.17 [-49.62, -44.72]	4.40 [3.79, 5.11]
Current smoker	-283.98 [-343.04, -224.93]	-63.84 [-135.01, 7.33]	-70.15 [-77.24, -63.06]	9.95 [6.80, 14.47]
Passive smoking exposure at home	-294.95 [-338.68, -251.23]	-270.68 [-323.37, -217.99]	-24.97 [-30.22, -19.72]	2.81 [2.09, 1.62]

*Definition of abbreviations:* FEV<sub>1</sub> = forced expiratory volume in 1 second, FVC = forced vital capacity, CI = confidence interval, PM<sub>2.5</sub> = fine particulate matter with diameter <2.5 µm, PM<sub>10</sub> = particulate matter with diameter <10 µm, PM<sub>coarse</sub> = coarse particulate matter with diameter between 2.5 µm and 10 µm, NO<sub>2</sub> = nitrogen dioxide

\* For FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC ratio: Adjusted for age (continuous), age-squared, sex, height, BMI (Kg/m<sup>2</sup>), household income (less than £ 31,000 / £ 31,000 and above), education level (lower vocational or less / higher vocational or more), smoking status (never / former / current), and passive smoking exposure at home (none / any). Former smoker, current smoker and passive smoking exposure associations are adjusted for PM<sub>2.5</sub> exposure.

For COPD: Adjusted for age (continuous), sex, BMI (Kg/m<sup>2</sup>), household income (less than £ 31,000 / £ 31,000 and above), education level (lower vocational or less / higher vocational or more), smoking status (never / former / current), and passive smoking

exposure at home (none / any). Former smoker, current smoker and passive smoking exposure associations are adjusted for PM<sub>2.5</sub> exposure.

**Table S6:** Lung function sensitivity analyses restricted to individuals having lived at the same address for 10 years or more\*

Exposure	N	FEV <sub>1</sub> (mL)	FVC (mL)	FEV1/FVC
		Beta [95% CI]	Beta [95% CI]	Beta [95% CI]
PM <sub>2.5</sub> (per 5 µg/m <sup>3</sup> )	188 257	<b>-75.20</b> [-86.76, -63.64]	<b>-49.15</b> [-63.09, -35.21]	<b>-10.86</b> [-12.27, -9.44]
PM <sub>10</sub> (per 10 µg/m <sup>3</sup> )	188 257	<b>-88.69</b> [-101.15, -76.23]	<b>-112.60</b> [-127.62, -97.58]	-1.24 [-2.76, 0.28]
PM <sub>coarse</sub> (per 5 µg/m <sup>3</sup> )	188 257	<b>-63.13</b> [-76.15, -50.11]	<b>-84.88</b> [-100.58, -69.19]	0.27 [-1.32, 1.86]
NO <sub>2</sub> (per 10 µg/m <sup>3</sup> )	203 041	<b>-31.75</b> [-34.83, -28.67]	<b>-29.89</b> [-33.60, -26.17]	<b>-2.58</b> [-2.96, -2.21]

*Definition of abbreviations:* FEV<sub>1</sub> = forced expiratory volume in 1 second, FVC = forced vital capacity, CI = confidence interval, PM<sub>2.5</sub> = fine particulate matter with diameter <2.5 µm, PM<sub>10</sub> = particulate matter with diameter <10 µm, PM<sub>coarse</sub> = coarse particulate matter with diameter between 2.5 µm and 10 µm, NO<sub>2</sub> = nitrogen dioxide

\*Adjusted for age (continuous), age-squared, sex, height, BMI (Kg/m<sup>2</sup>), household income (less than £ 31,000 / £ 31,000 and above), education level (lower vocational or less / higher vocational or more), smoking status (never, former, or current), passive smoking exposure at home (none / any)

**Table S7:** COPD sensitivity analyses restricted to individuals having lived at the same address for 10 years or more\*

Exposure	No. cases / non-cases	OR [95% CI]
PM <sub>2.5</sub> (per 5 µg/m <sup>3</sup> )	13 564 / 174 236	<b>1.56 [1.43, 1.70]</b>
PM <sub>10</sub> (per 10 µg/m <sup>3</sup> )	13 564 / 174 236	<b>1.13 [1.03, 1.24]</b>
PM <sub>coarse</sub> (per 5 µg/m <sup>3</sup> )	13 564 / 174 236	1.04 [0.94, 1.15]
NO <sub>2</sub> (per 10 µg/m <sup>3</sup> )	14 535 / 188 026	<b>1.13 [1.10, 1.15]</b>

*Definition of abbreviations:* OR = odds ratio, CI = confidence interval, PM<sub>2.5</sub> = fine particulate matter with diameter <2.5 µm, PM<sub>10</sub> = particulate matter with diameter <10 µm, PM<sub>coarse</sub> = coarse particulate matter with diameter between 2.5 µm and 10 µm, NO<sub>2</sub> = nitrogen dioxide

\* Adjusted for age (continuous), sex, BMI (Kg/m<sup>2</sup>), household income (less than £ 31,000 / £ 31,000 and above), education level (lower vocational or less / higher vocational or more), smoking status (never / former / or current), passive smoking exposure at home (none / any)

**Table S8:** Exposure estimate descriptive statistics for the five studies included in Adam *et al.* (2015) [4] meta-analysis

Study	Exposure	Mean ug/m3	Minimum ug/m3	Maximum ug/m3
European Community Respiratory Health Survey (ECRHS)	PM <sub>2.5</sub>	15.9	8.2	34.4
	PM <sub>10</sub>	25.8	11.9	55.2
	PM <sub>coarse</sub>	10.3	3.9	25.4
	NO <sub>2</sub>	28.9	0	115.5
French Epidemiological study on Genetics and Environment of Asthma (EGEA)	PM <sub>2.5</sub>	15.3	10	22.3
	PM <sub>10</sub>	25.1	18.6	36.2
	PM <sub>coarse</sub>	9.4	3.9	17.1
	NO <sub>2</sub>	27.4	9.3	98.5
National Survey of Health and Development (NSHD)	PM <sub>2.5</sub>	9.5	8.2	13.5
	PM <sub>10</sub>	15.7	11.8	26.2
	PM <sub>coarse</sub>	6.4	5.6	9.7
	NO <sub>2</sub>	22.4	12.9	62
Study on the influence of Air pollution on Lung function, Inflammation and Aging (SALIA)	PM <sub>2.5</sub>	17.8	15.9	21.9
	PM <sub>10</sub>	26.7	23.9	33.5
	PM <sub>coarse</sub>	9.4	2.8	14.8
	NO <sub>2</sub>	27.6	19.7	70.3
Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults (SAPALDIA)	PM <sub>2.5</sub>	16.8	12.4	23.5
	PM <sub>10</sub>	23.2	17.6	31.7
	PM <sub>coarse</sub>	6.5	4.3	10.4
	NO <sub>2</sub>	27	6.9	56.3

**Table S9:** Exposure estimate descriptive statistics for four studies in Schikowski *et al.* (2015) [5] meta-analysis

Study	Exposure	Mean ug/m3	Minimum ug/m3	Maximum ug/m3
European Community Respiratory Health Survey (ECRHS)	PM <sub>2.5</sub>	16.13	8.17	34.37
	PM <sub>10</sub>	25.88	11.91	55.17
	PM <sub>coarse</sub>	10.2	3.89	25.37
	NO <sub>2</sub>	28.95	0	115.52
National Survey of Health and Development (NSHD)	PM <sub>2.5</sub>	9.52	8.17	13.49
	PM <sub>10</sub>	15.73	11.79	26.2
	PM <sub>coarse</sub>	6.37	5.57	9.71
	NO <sub>2</sub>	22.39	12.93	61.99
Study on the influence of Air pollution on Lung function, Inflammation and Aging (SALIA)	PM <sub>2.5</sub>	17.76	15.9	21.9
	PM <sub>10</sub>	26.72	23.88	33.47
	PM <sub>coarse</sub>	9.37	2.85	14.79
	NO <sub>2</sub>	27.62	19.66	70.34
Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults (SAPALDIA)	PM <sub>2.5</sub>	16.78	12.36	23.48
	PM <sub>10</sub>	23.16	17.6	31.69
	PM <sub>coarse</sub>	6.49	4.27	10.39
	NO <sub>2</sub>	26.17	6.87	56.3

**Table S10:** Exposure estimate descriptive statistics in de Jong *et al.* (2016) [6]

<b>Study</b>	<b>Exposure</b>	<b>Median ug/m3</b>	<b>Minimum ug/m3</b>	<b>Maximum ug/m3</b>
LifeLines Cohort	PM <sub>2.5</sub>	15.4	14.8	20.2
	PM <sub>10</sub>	24	23.7	31.7
	NO <sub>2</sub>	15.7	8.4	50.8

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