SUPPLEMENTARY MATERIAL

Air pollution exposure and lung function until age 16: The PIAMA birth cohort study.

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Table S1. Comparison of characteristics between baseline population and study populations [α]

Characteristic	Baseline population (N=3963)		Cross-sectional analyses population (N=721)			Longitudinal analyses population (N=915)		
	n/N	%	n/N	%	P-Value[β]	n/N	%	P-value[γ]
Parental atopy								
Atopic mother	1237/3963	31.2	232/720	32.1	0.607	434/915	47.4	0.000
Atopic father	1217/3957	30.7	242/720	33.6	0.128	306/914	33.5	0.041
Boys	2054/3963	51.8	338/721	46.8	0.014	434/915	47.4	0.002
Presence of pets at 3 months	1923/3947	48.7	312/718	43.4	0.009	409/911	44.9	0.008
Presence of moulds at 1 year	1047/3702	28.3	193/708	27.2	0.579	243/900	27.1	0.326
Breastfeeding > 12 weeks	1892/3896	48.5	434/721	60.2	<0.000	534/915	58.4	<0.000
Gas cooking at 3 months	3247/3923	82.7	613/718	85.3	0.085	771/910	84.7	0.074
Maternal smoking during pregnancy	700/3926	17.8	92/716	12.8	0.001	72/863	13.6	0.000
Indoor tobacco smoke exposure at 3 months	1129/3963	28.4	146/721	20.2	<0.000	124/910	20.9	<0.000
Parental education					<0.000			<0.000
Low	502/3812	13.1	53/721	7.3		7 5/914	8.2	
Intermediate	1402/3812	36.7	215/721	29.8		282/914	30.8	
High	1908/3812	50.1	453/721	62.8		557/914	60.9	
Dutch nationality	3485/3700	94.1	686/707	97.1	0.002	872/904	96.5	0.000
Asthma at age 16	66/767	8.6	59/691	8.5	0.649	55/607	9.1	0.085

α Continuous characteristics compared by t-tests and categorical characteristics compared using Chi-Square tests

β: Comparison of baseline population and the cross-sectional analyses data

γ: Comparison of baseline population and the longitudinal analyses data.

Table S2. Comparison of characteristics between non- movers and movers in cross-sectional analyses study population (N=721)$^{\alpha}$

Characteristic	Non-Movers (N=268)		Movers (N=453)		
	n/N	(%)	n/N	(%)	P-Value
Parental atopy					
Atopic mother	83/268	30.9	149/453	32.8	0.593
Atopic father	91/268	33.9	151/452	33.5	0.880
Boys	139/268	51.8	199/453	43.9	0.039
Presence of pets at 3 months	118/268	44.1	94/450	43.1	0.810
Presence of moulds at 1 year	72/258	27.3	121/445	27.2	0.957
Breastfeeding > 12 weeks	159/268	59.3	275/453	60.7	0.714
Gas cooking at 3 months	221/265	16.6	392//453	86.5	0.250
Maternal smoking during pregnancy	32/266	12.1	60/450	13.3	0.614
Indoor tobacco smoke exposure at 3 months	54/268	20.1	92/453	20.3	0.958
Parental education					0.000
Low	26/268	9.7	27/453	5.9	
Intermediate	99/268	36.9	116/453	25.7	
High	143/268	53.3	310/453	68.4	
Dutch nationality	254/261	97.3	432/446	96.7	0.729
Respiratory infections in the 3 weeks before the lung function measurement	109/268	40.6	194/453	42.8	0.571
N, Mean (SD)					
Age (years) $^{\beta}$	268, 16.3 (0.2)		453, 16.3 (0.2)		0.643
Weight (kg)$^{\beta}$	268, 64.9 (10.3)		453, 63.8 (10.1)		0.160
Height (cm)$^{\beta}$	268, 175.9 (8.2)		453, 175.7 (8.9)		0.246
FEV1 (L)$^{\beta}$	268, 4.1 (0.7)		453, 3.9 (0.7)		0.037
FVC (L)$^{\beta}$	268, 4.7 (0.8)		453, 4.6 (0.8)		0.111

α: Continuous characteristics compared by t-tests and categorical characteristics compared using Chi-Square tests.

β: at the time of the 16-year lung function measurements

Table S3. Distribution of annual average concentrations of air pollution for different time windows of exposure, and short-term exposures for longitudinal analyses population, N=915.

	Min	Median	Mean (SD)	IQR	75th Percentile	Max
Preschool						
NO_2 ($\mu g/m^3$)	10.3	22.6	22.4 (6.2)	8.2	26.3	52.4
$PM_{2.5}$ absorbance ($10^{-5}/m$)	0.8	1.2	1.2 (0.2)	0.3	1.3	2.6
$PM_{2.5}$ ($\mu g/m^3$)	15.2	16.4	16.3 (0.6)	1.5	16.7	19.4
PM_{10} ($\mu g/m^3$)	23.7	24.5	24.7 (0.9)	0.9	25.0	29.8
PM_{coarse} ($\mu g/m^3$)	7.6	8.1	8.3 (0.6)	0.7	8.5	12.3
Primary school						
NO_2 ($\mu g/m^3$)	10.3	22.0	21.8 (5.8)	8.4	25.8	47.7
$PM_{2.5}$ absorbance ($10^{-5}/m$)	0.8	1.2	1.1 (0.2)	0.3	1.3	2.0
$PM_{2.5}$ ($\mu g/m^3$)	14.9	16.4	16.2 (0.6)	1.1	16.7	19.4
PM_{10} ($\mu g/m^3$)	23.7	24.4	24.6 (0.8)	0.9	24.9	29.8
PM_{coarse} ($\mu g/m^3$)	7.6	8.0	8.2 (0.6)	0.6	8.43	11.4
Secondary school						
NO_2 ($\mu g/m^3$)	10.0	21.8	21.5 (5.8)	8.6	25.56	47.7
$PM_{2.5}$ absorbance ($10^{-5}/m$)	0.8	1.1	1.1 (0.2)	0.3	1.30	2.0
$PM_{2.5}$ ($\mu g/m^3$)	14.9	16.4	16.2 (0.6)	1.1	16.6	18.6
PM_{10} ($\mu g/m^3$)	23.7	24.4	24.5 (0.8)	0.8	24.8	29.8
PM_{coarse} ($\mu g/m^3$)	7.60	8.0	8.2 (0.6)	0.6	8.3	11.4
Short term exposure[α]						
NO_2 ($\mu g/m^3$)						
8 year med. exam	2.7	19.2	21.4 (10.3)	14.6	28.7	55.7
12 year med. exam	4.0	15.6	20.1 (9.9)	11.1	22.8	62.1
16 year med. exam	4.1	14.7	15.9 (6.9)	9.7	20.2	42.8
PM_{10} ($\mu g/m^3$)						
8 year med. exam	12.5	25.5	28.0 (9.5)	11.1	32.3	74.7
12 year med. exam	8.8	20.8	23.1 (9.6)	11.1	27.7	70.5
16 year med. exam	8.3	16.1	18.1 (6.8)	7.2	20.7	46.5

α: average concentrations of 7 days preceding the respective lung function measurements.

Table S4. Mean difference between preschool and secondary school exposure for movers (N=453)

	Mean (SD)	(Min, Max)
NO_2 ($\mu g/m^3$)	-1.65 (5.1)	-19.2, 17.5
$PM_{2.5}$ absorbance ($10^{-5}/m$)	-0.05 (0.1)	-1.2, 0.6
$PM_{2.5}$ ($\mu g/m^3$)	-0.08 (0.6)	-3.6, 2.7
PM_{10} ($\mu g/m^3$)	-0.26 (0.9)	-5.1, 3.3
PM_{coarse} ($\mu g/m^3$)	-0.14 (0.6)	-2.3, 1.8

Table S5. Correlation matrix of time window average concentrations of air pollution for the cross-sectional analyses population (N=721)[α]

	NO$_2$			PM$_{2.5}$ absorbance			PM$_{2.5}$			PM$_{10}$			PM$_{coarse}$		
	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16
NO$_2$															
Birth–4	1.00	**0.89**	**0.80**	**0.87**	0.78	0.71	0.71	0.65	0.61	0.70	0.58	0.52	0.73	0.63	0.56
5-12		1.00	**0.94**	0.79	**0.86**	**0.82**	0.67	0.71	0.69	0.60	0.67	0.63	0.63	0.72	0.69
13–16			1.00	0.71	**0.80**	**0.85**	0.61	0.67	0.69	0.51	0.62	0.67	0.54	0.67	0.72
PM$_{2.5}$ absorbance															
Birth–4				1.00	**0.89**	0.80	**0.91**	**0.82**	0.75	**0.86**	0.70	0.61	0.72	0.64	0.55
5-12					1.00	**0.93**	0.83	**0.91**	**0.86**	0.72	**0.85**	0.78	0.62	0.72	0.66
13–16						1.00	0.74	**0.86**	**0.89**	0.61	0.77	**0.84**	0.54	0.67	0.70
PM$_{2.5}$															
Birth–4							1.00	**0.90**	**0.82**	0.67	0.56	0.46	0.56	0.52	0.44
5-12								1.00	**0.96**	0.57	0.65	0.61	0.49	0.57	0.51
13–16									1.00	0.48	0.59	0.64	0.43	0.53	0.53
PM$_{10}$															
Birth–4										1.00	0.78	0.65	0.77	0.63	0.52
5-12											1.00	**0.91**	0.61	0.75	0.67
13–16												1.00	0.52	0.68	0.72
PM$_{coarse}$															
Birth–4													1.00	**0.82**	0.66
5-12														1.00	**0.90**
13–16															1.00

α: Birth–4=**Preschool**, 5-12=**Primary school**, 13–16=**secondary school**. High correlations (r≥0.80) are presented in bold font

Table S6. Correlation matrix of time window average concentrations of air pollution for the longitudinal analyses population (N=915)[α]

	NO$_2$			PM$_{2.5}$ absorbance			PM$_{2.5}$			PM$_{10}$			PM$_{coarse}$		
	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16
NO$_2$															
Birth–4	1.00	**0.92**	**0.84**	0.74	0.67	0.62	0.76	0.67	0.57	**0.90**	**0.83**	0.76	0.75	0.67	0.59
5-12		1.00	**0.95**	0.70	0.72	0.69	0.68	0.73	0.67	**0.83**	**0.89**	**0.85**	0.68	0.74	0.69
13–16			1.00	0.64	0.69	0.70	0.60	0.68	0.70	0.76	**0.85**	**0.88**	0.62	0.71	0.73
PM$_{2.5}$ absorbance															
Birth–4				1.00	**0.90**	**0.81**	0.65	0.56	0.46	**0.89**	**0.82**	0.73	0.58	0.50	0.42
5-12					1.00	**0.95**	0.56	0.62	0.57	0.79	**0.88**	**0.84**	0.49	0.54	0.49
13–16						1.00	0.48	0.57	0.61	0.71	**0.83**	**0.87**	0.44	0.51	0.51
PM$_{2.5}$															
Birth–4							1.00	**0.86**	0.70	**0.87**	0.76	0.66	**0.80**	0.68	0.57
5-12								1.00	**0.91**	0.75	0.85	**0.80**	0.69	0.76	0.70
13–16									1.00	0.63	0.78	**0.85**	0.58	0.70	0.74
PM$_{10}$															
Birth–4										1.00	**0.91**	**0.81**	0.75	0.65	0.56
5-12											1.00	**0.95**	0.66	0.72	0.66
13–16												1.00	0.60	0.69	0.70
PM$_{coarse}$															
Birth–4													1.00	**0.85**	0.72
5-12														1.00	**0.93**
13–16															1.00

α: Birth–4=**Preschool**, 5-12=**Primary school**, 13–16=**secondary school.** High correlations (r≥0.80) are presented in bold font

Table S7. Correlation matrix of time window average concentrations of air pollution for participants who changed address since birth (N=453)$^{\alpha}$

	NO_2			$PM_{2.5}$ absorbance			$PM_{2.5}$			PM_{10}			PM_{coarse}		
	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16	Birth–4	5-12	13–16
NO_2															
Birth–4	1.00	**0.83**	0.67	**0.88**	0.67	0.62	0.70	0.59	0.57	0.67	0.56	0.41	0.69	0.62	0.47
5-12		1.00	**0.87**	0.76	**0.83**	0.78	0.67	0.69	0.68	0.59	0.69	0.59	0.63	0.74	0.66
13–16			1.00	0.62	**0.80**	**0.85**	0.56	0.67	0.69	0.43	0.56	0.68	0.47	0.62	0.75
$PM_{2.5}$ absorbance															
Birth–4				1.00	0.74	0.67	**0.88**	0.69	0.65	**0.81**	0.66	0.44	0.69	0.61	0.45
5-12					1.00	**0.91**	0.72	**0.90**	**0.84**	0.57	0.78	0.75	0.52	0.67	0.66
13–16						1.00	0.66	**0.84**	**0.88**	0.49	0.67	**0.84**	0.47	0.61	0.69
$PM_{2.5}$															
Birth–4							1.00	0.79	0.74	0.67	0.56	0.36	0.56	0.52	0.39
5-12								1.00	**0.95**	0.45	0.60	0.58	0.42	0.54	0.51
13–16									1.00	0.39	0.52	0.61	0.38	0.50	0.53
PM_{10}															
Birth–4										1.00	0.77	0.48	0.76	0.61	0.39
5-12											1.00	0.77	0.60	0.74	0.57
13–16												1.00	0.39	0.57	0.71
PM_{coarse}															
Birth–4													1.00	**0.83**	0.51
5-12														1.00	0.76
13–16															1.00

α: Birth–4=**Preschool**, 5-12=**Primary school**, 13–16=**secondary school**. ≥0.80=high correlation

Table S8. Associations of time window average air pollution exposure with FEV_1 and FVC at age 16.

Exposure	Difference in FEV_1: % (95% CI)		Difference in FVC: % (95% CI)	
	Minimally adjusted (N=719)$^{\alpha}$	Additionally adjusted (N=671)$^{\beta}$	Minimally adjusted (N=719)$^{\alpha}$	Additionally adjusted (N=671)$^{\beta}$
Preschool				
NO_2	-0.92 (-2.04 to 0.20)	-1.52 (-2.81 to -0.22)	0.02 (-0.94 to 1.00)	-0.50 (-1.61 to 0.63)
$PM_{2.5}$ absorbance	-1.37 (-2.51 to -0.21)	-1.71 (-2.91 to -0.49)	-0.00 (-1.00 to 1.00)	-0.23 (-1.28 to 0.83)
$PM_{2.5}$	-1.79 (-3.11 to -0.44)	-2.14 (-3.53 to -0.73)	0.07 (-1.10 to 1.25)	-0.15 (-1.37 to 1.08)
PM_{10}	-0.88 (-1.81 to 0.06)	-1.07 (-2.05 to -0.08)	-0.12 (-0.92 to 0.70)	-0.27 (-1.12 to 0.58)
PM_{coarse}	-0.56 (-1.49 to 0.37)	-0.76 (-1.77 to 0.27)	-0.16 (-0.96 to 0.64)	-0.32 (-1.19 to 0.56)
Primary school				
NO_2	-1.34 (-2.50 to -0.16)	-2.15 (-3.48 to -0.80)	-0.35 (-1.36 to 0.67)	-0.99 (-2.14 to 0.18)
$PM_{2.5}$ absorbance	-1.74 (-2.90 to -0.57)	-2.08 (-3.29 to -0.86)	-0.43 (-1.45 to 0.59)	-0.63 (-1.68 to 0.44)
$PM_{2.5}$	-1.94 (-3.27 to -0.60)	-2.27 (-3.66 to -0.87)	-0.20 (-1.36 to 0.98)	-0.36 (-1.57 to 0.87)
PM_{10}	-1.12 (-2.08 to -0.16)	-1.32 (-2.31 to -0.32)	-0.46 (-1.29 to 0.37)	-0.58 (-1.43 to 0.29)
PM_{coarse}	-0.82 (-1.81 to 0.17)	-1.02 (-2.05 to 0.03)	-0.25 (-1.10 to 0.60)	-0.43 (-1.32 to 0.47)
Secondary school				
NO_2	-1.53 (-2.66 to -0.38)	-2.30 (-3.59 to -0.99)	-0.42 (-1.41 to 0.58)	-1.01 (-2.14 to 0.13)
$PM_{2.5}$ absorbance	-1.75 (-2.92 to -0.57)	-2.07 (-3.29 to -0.83)	-0.38 (-1.40 to 0.66)	-0.56 (-1.63 to 0.52)
$PM_{2.5}$	-2.08 (-3.41 to -0.72)	-2.36 (-3.76 to -0.94)	-0.30 (-1.48 to 0.89)	-0.46 (-1.69 to 0.78)
PM_{10}	-1.10 (-2.09 to -0.11)	-1.29 (-2.31 to -0.26)	-0.41 (-1.26 to 0.44)	-0.55 (-1.43 to 0.34)
PM_{coarse}	-1.27 (-2.27 to -0.27)	-1.41 (-2.45 to -0.36)	-0.42 (-1.29 to 0.45)	-0.64 (-1.54 to 0.26)

α:Adjusted for sex, age, log-transformations of weight and height

β: Adjusted for sex, age, log-transformations of weight and height, parental education, maternal atopy, paternal atopy, breastfeeding, respiratory infections in the last 3 weeks, Dutch nationality, indoor tobacco smoke exposure in the home at 3 months, maternal smoking in pregnancy, furry pets at 3 months, mould in the home at 1 year, gas cooking at 3 months, and average air pollution concentrations for the 7 days preceding the lung function measurement.

Exposure increments: 7.8 µg/m³ for NO_2, 0.3 10^{-5}/m for $PM_{2.5}$ absorbance, 1.2 µg/m³ for $PM_{2.5}$, 0.9 µg/m³ for PM_{10} and 0.5 µg/m³ for PM_{coarse}.

Table S9. Association of preschool time window average air pollution exposure with FEV_1 and FVC growth stratified by asthma status and sex

Exposure	Non-asthmatic (N=607)	Asthmatic(N=55)	P-Value for interaction	Boys (N=333)	Girls (N=383)	P-Value for interaction
Difference in FEV_1: % (95% CI)						
NO_2	-0.22 (-0.43 to 0.00)	-0.33 (-1.04 to 0.39)	0.56	-0.52 (-0.77 to -0.27)	-0.07 (-0.26 to 0.11)	0.05
$PM_{2.5}$ absorbance	-0.20 (-0.42 to 0.03)	-0.40 (-1.15 to 0.36)	0.44	-0.60 (-0.88 to -0.32)	-0.06 (-0.25 to 0.14)	0.07
$PM_{2.5}$	-0.13 (-0.40 to 0.14)	-0.44 (-1.37 to 0.49)	0.31	-0.53 (-0.90 to -0.16)	-0.03 (-0.27 to 0.22)	0.15
PM_{10}	-0.18 (-0.37 to 0.01)	-0.26 (-0.89 to 0.37)	0.85	-0.42 (-0.61 to -0.22)	0.01 (-0.12 to 0.14)	0.07
PM_{coarse}	-0.14 (-0.30 to 0.02)	-0.13 (-0.66 to 0.40)	0.34	-0.37 (-0.54 to -0.20)	0.05 (-0.06 to 0.16)	0.70
Difference in FVC: % (95% CI)						
NO_2	0.02 (-0.18 to 0.22)	0.07 (-0.64 to 0.78)	0.69	-0.14 (-0.36 to 0.08)	0.18 (-0.01 to 0.37)	0.43
$PM_{2.5}$ absorbance	0.11 (-0.09 to 0.32)	0.04 (-0.70 to 0.79)	0.54	-0.17 (-0.41 to 0.07)	0.30 (0.10 to 0.50)	0.42
$PM_{2.5}$	0.26 (0.02 to 0.51)	0.18 (-0.73 to 1.09)	0.73	-0.03 (-0.43 to 0.36)	0.49 (0.24 to 0.74)	0.38
PM_{10}	-0.02 (-0.19 to 0.15)	-0.13 (-0.74 to 0.49)	0.26	-0.17 (-0.34 to -0.00)	0.15 (0.01 to 0.28)	0.51
PM_{coarse}	-0.01 (-0.15 to 0.13)	-0.06 (-0.57 to 0.46)	0.83	-0.14 (-0.29 to 0.01)	0.15 (0.03 to 0.26)	0.71

Adjusted for sex, age, log-transformations of weight and height, parental education, maternal atopy, paternal atopy, breastfeeding, respiratory infections in the last 3 weeks, Dutch nationality, indoor tobacco smoke exposure in the home at 3 months, maternal smoking in pregnancy, furry pets at 3 months, mould in the home at 1 year, gas cooking at 3 months, and average air pollution concentrations for the 7 days preceding the lung function measurement.

Exposure increments: 7.8 µg/m³ for NO_2, 0.3 10^{-5}/m for $PM_{2.5}$ absorbance, 1.2 µg/m³ for $PM_{2.5}$, 0.9 µg/m³ for PM_{10} and 0.5 µg/m³ for PM_{coarse}.

Table S10. Association of time window average air pollution exposure with FEV_1 and FVC at age 16 stratified by sex

Exposure	Difference in FEV_1: % (95% CI)			Difference in FVC: % (95% CI)		
	Boys (N=338)	Girls (N=383)	P-Value for interaction	Boys (N=338)	Girls (N=383)	P-Value for interaction
Preschool						
NO_2	-2.85 (-4.81 to -0.85)	-0.18 (-1.94 to 1.61)	0.03	-1.52 (-3.20 to 0.19)	0.59 (-0.93 to 2.13)	0.01
$PM_{2.5}$ absorbance	-3.13 (-4.96 to -1.26)	-0.27 (-1.90 to 1.39)	0.02	-1.83 (-3.41 to -0.22)	1.17 (-0.27 to 2.62)	0.00
$PM_{2.5}$	-3.66 (-5.77 to -1.50)	-0.45 (-2.35 to 1.49)	0.02	-2.05 (-3.88 to -0.18)	1.65 (-0.02 to 3.36)	0.00
PM_{10}	-2.23 (-3.74 to -0.69)	0.12 (-1.19 to 1.44)	0.03	-1.32 (-2.61 to -0.00)	0.65 (-0.49 to 1.80)	0.03
PM_{coarse}	-1.74 (-3.32 to -0.12)	0.18 (-1.16 to 1.54)	0.19	-1.50 (-2.84 to -0.14)	0.79 (-0.38 to 1.97)	0.02
Primary school						
NO_2	-2.95 (-5.00 to -0.85)	-1.36 (-3.17 to 0.47)	0.17	-1.71 (-3.46 to 0.08)	-0.36 (-1.93 to 1.23)	0.06
$PM_{2.5}$ absorbance	-3.40 (-5.26 to -1.50)	-0.83 (-2.46 to 0.84)	0.03	-2.24 (-3.83 to -0.61)	0.74 (-0.70 to 2.20)	0.00
$PM_{2.5}$	-3.92 (-6.05 to -1.74)	-0.61 (-2.47 to 1.29)	0.01	-2.55 (-4.39 to -0.68)	1.59 (-0.05 to 3.26)	0.00
PM_{10}	-2.44 (-3.97 to -0.89)	-0.24 (-1.58 to 1.12)	0.03	-1.64 (-2.95 to -0.31)	0.40 (-0.77 to 1.58)	0.02
PM_{coarse}	-2.04 (-3.72 to -0.33)	-0.17 (-1.53 to 1.20)	0.13	-1.72 (-3.14 to -0.28)	0.63 (-0.55 to 1.83)	0.02
Secondary school						
NO_2	-3.12 (-5.13 to -1.06)	-1.62 (-3.35 to 0.15)	0.17	-1.67 (-3.40 to 0.09)	-0.43 (-1.94 to 1.10)	0.05
$PM_{2.5}$ absorbance	-3.27 (-5.15 to -1.36)	-0.90 (-2.54 to 0.77)	0.04	-2.15 (-3.76 to -0.51)	0.80 (-0.65 to 2.27)	0.00
$PM_{2.5}$	-4.00 (-6.15 to -1.81)	-0.63 (-2.52 to 1.30)	0.01	-2.81 (-4.66 to -0.93)	1.70 (0.03 to 3.40)	0.00
PM_{10}	-2.28 (-3.83 to -0.71)	-0.22 (-1.59 to 1.17)	0.03	-1.72 (-3.04 to -0.39)	0.54 (-0.66 to 1.75)	0.01
PM_{coarse}	-2.38 (-4.06 to -0.67)	-0.48 (-1.82 to 0.88)	0.08	-2.12 (-3.54 to -0.67)	0.49 (-0.68 to 1.68)	0.00

Adjusted for age, log-transformations of weight and height, parental education, maternal atopy, paternal atopy, breastfeeding, respiratory infections in the last 3 weeks, Dutch nationality, indoor tobacco smoke exposure in the home at 3 months, maternal smoking in pregnancy, furry pets at 3 months, mould in the home at 1 year, gas cooking at 3 months, and average air pollution concentrations for the 7 days preceding the lung function measurement.

Exposure increments: 7.8 µg/m^3 for NO_2, 0.3 10^{-5}/m for $PM_{2.5}$ absorbance, 1.2 µg/m^3 for $PM_{2.5}$, 0.9 µg/m^3 for PM_{10} and 0.5 µg/m^3 for PM_{coarse}.

Table S11. Association of time window average air pollution exposure with FEV_1 and FVC at age 16 stratified by asthma status

Exposure	Difference in FEV_1: % (95% CI)			Difference in FVC: % (95% CI)		
	Non-asthmatic (N=632)	Asthmatic (N=55)	P-Value for interaction	Non-asthmatic (N=632)	Asthmatic (N=55)	P-Value for interaction
Preschool						
NO_2	-1.80 (-3.16 to -0.42)	2.96 (-3.18 to 9.49)	0.36	3.46 (-0.58 to 7.66)	-0.51 (-1.73 to 0.73)	0.93
$PM_{2.5}$ absorbance	-1.95 (-3.24 to -0.64)	2.24 (-3.98 to 8.87)	0.48	-1.03 (-4.65 to 2.72)	-0.03 (-1.20 to 1.16)	0.53
$PM_{2.5}$	-2.39 (-3.86 to -0.90)	2.30 (-4.10 to 9.12)	0.49	-1.48 (-5.57 to 2.78)	-0.06 (-1.40 to 1.30)	0.45
PM_{10}	-1.14 (-2.24 to -0.04)	1.49 (-5.77 to 9.30)	0.87	-1.07 (-3.79 to 1.73)	0.06 (-0.92 to 1.05)	0.37
PM_{coarse}	-0.87 (-1.99 to 0.27)	1.70 (-5.25 to 9.16)	0.58	0.38 (-2.88 to 3.76)	-0.06 (-1.07 to 0.95)	0.70
Primary school						
NO_2	-2.53 (-3.94 to -1.10)	1.76 (-5.03 to 9.03)	0.57	1.70 (-2.34 to 5.91)	-1.20 (-2.47 to 0.08)	0.97
$PM_{2.5}$ absorbance	-2.49 (-3.77 to -1.19)	1.32 (-5.38 to 8.50)	0.34	-1.67 (-5.31 to 2.12)	-0.56 (-1.72 to 0.62)	0.67
$PM_{2.5}$	-2.69 (-4.13 to -1.23)	0.33 (-3.70 to 4.53)	0.24	-1.36 (-5.39 to 2.85)	-0.41 (-1.72 to 0.93)	0.82
PM_{10}	-1.59 (-2.68 to -0.50)	1.33 (-3.20 to 7.08)	0.61	-1.88 (-4.64 to 0.97)	-0.40 (-1.38 to 0.59)	0.48
PM_{coarse}	-1.23 (-2.38 to -0.07)	0.69 (-4.00 to 5.61)	0.45	-0.80 (-4.28 to 2.81)	-0.27 (-1.30 to 0.77)	0.75
Secondary school						
NO_2	-2.83 (-4.19 to -1.45)	0.72 (-4.03 to 5.70)	0.27	2.63 (-1.18 to 7.59)	-1.22 (-2.45 to 0.03)	0.77
$PM_{2.5}$ absorbance	-2.53 (-3.81 to -1.23)	1.82 (-3.02 to 7.91)	0.27	-0.97 (-4.78 to 2.99)	-0.49 (-1.66 to 0.69)	0.77
$PM_{2.5}$	-2.80 (-4.26 to -1.33)	4.12 (-1.19 to 9.71)	0.20	-0.57 (-4.61 to 3.65)	-0.54 (-1.87 to 0.81)	0.48
PM_{10}	-1.61 (-2.72 to -0.48)	4.01 (-1.68 to 10.03)	0.47	-1.11 (-3.98 to 1.84)	-0.37 (-1.37 to 0.65)	0.62
PM_{coarse}	-1.67 (-2.82 to -0.50)	2.30 (-2.68 to 7.53)	0.43	-0.13 (-3.18 to 3.03)	-0.57 (-1.60 to 0.48)	0.95

Adjusted for sex, age, log-transformations of weight and height, parental education, maternal atopy, paternal atopy, breastfeeding, respiratory infections in the last 3 weeks, Dutch nationality, indoor tobacco smoke exposure in the home at 3 months, maternal smoking in pregnancy, furry pets at 3 months, mould in the home at 1 year, gas cooking at 3 months, and average air pollution concentrations for the 7 days preceding the lung function measurement.

Exposure increments: 7.8 µg/m^3 for NO_2, 0.3 10^{-5}/m for $PM_{2.5}$ absorbance, 1.2 µg/m^3 for $PM_{2.5}$, 0.9 µg/m^3 for PM_{10} and 0.5 µg/m^3 for PM_{coarse}.

Table S12. Associations of time window average air pollution exposure during preschool and the secondary school time window with FEV$_1$ and FVC at age 16 in movers with and without mutual adjustment[a]

Exposure	Difference in FEV$_1$: % (95% CI)		Difference in FVC: % (95% CI)	
	Single time-window in model	Preschool and secondary school time-windows in model	Single time-window in model	Preschool and secondary school time-windows in model
Preschool				
NO$_2$	-0.85 (-2.43 to 0.76)	0.92 (-1.17 to 3.05)	0.07 (-1.35 to 1.51)	0.41 (-1.17 to 2.02)
PM$_{2.5}$ absorbance	-0.89 (-2.35 to 0.60)	0.41 (-1.59 to 2.46)	0.65 (-0.68 to 2.00)	0.15 (-1.31 to 1.64)
PM$_{2.5}$	-1.18 (-2.87 to 0.54)	0.04 (-2.34 to 2.47)	0.91 (-0.64 to 2.48)	0.48 (-1.23 to 2.22)
PM$_{10}$	-0.39 (-1.54 to 0.78)	0.67 (-13.0 to 16.49)	0.40 (-0.64 to 1.45)	-0.21 (-1.19 to 0.78)
PM$_{coarse}$	-0.37 (-1.58 to 0.85)	0.52 (-0.88 to 1.93)	0.07 (-1.01 to 1.17)	-0.29 (-1.42 to 0.86)
Secondary school				
NO$_2$	-1.96 (-3.55 to -0.34)	-2.60 (-4.66 to -0.50)	-0.67 (-2.12 to 0.79)	-0.93 (-2.62 to 0.78)
PM$_{2.5}$ absorbance	-1.43 (-2.93 to 0.09)	-1.75 (-3.76 to 0.30)	0.18 (-1.19 to 1.57)	0.05 (-1.59 to 1.71)
PM$_{2.5}$	-1.49 (-3.20 to 0.26)	-1.55 (-3.90 to 0.87)	0.44 (-1.13 to 2.04)	0.10 (-1.81 to 2.05)
PM$_{10}$	-0.62 (-1.85 to 0.62)	-0.65 (-2.02 to 0.73)	0.08 (-1.02 to 1.20)	0.16 (-1.02 to 1.34)
PM$_{coarse}$	-1.39 (-2.63 to -0.13)	-1.57 (-2.99 t -0.13)	-0.41 (-1.54 to 0.73)	-0.33 (-1.51 to 0.88)

Adjusted for sex, age, log-transformations of weight and height, parental education, maternal atopy, paternal atopy, breastfeeding, respiratory infections in the last 3 weeks, Dutch nationality, indoor tobacco smoke exposure in the home at 3 months, maternal smoking in pregnancy, furry pets at 3 months, mould in the home at 1 year, gas cooking at 3 months, and average air pollution concentrations for the 7 days preceding the lung function measurement.

Exposure increments: 7.8 µg/m^3 for NO$_2$, 0.3 10^{-5}/m for PM$_{2.5}$ absorbance, 1.2 µg/m^3 for PM$_{2.5}$, 0.9 µg/m^3 for PM$_{10}$ and 0.5 µg/m^3 for PM$_{coarse}$.

Table S13. Summary of relevant studies assessing associations between air pollution exposure and lung function (growth)

Study	Age group	Exposure assessed	Pollutant levels (Range)	Results	Effect modification by sex	Effect modification by Asthma
Lung function growth in adolescence						
Gauderman et al 2000, CHS (USA) [1]	9-10	Annual average PM_{10}, $PM_{2.5}$, PM_{10}–$PM_{2.5}$, $NO2$, O_3, inorganic acid vapor assessed at study entry	PM_{10}: 18-70 µg/m^3 $PM_{2.5}$: 7- 36 µg/m^3 NO_2: 5- 43 ppb	PM_{10}, $PM_{2.5}$, PM_{10}–$PM_{2.5}$, NO_2, and inorganic acid vapor associated with reduced FEV_1 and FVC growth,	No effect modification	No effect modification
Gauderman et al 2002, CHS (USA) [2]	9-10	Annual average NO_2, PM_{10}, $PM_{2.5}$, O_3, acid vapor, elemental carbon assessed at study entry	PM_{10}: 10-73 µg/m^3 $PM_{2.5}$: 7-30 µg/m^3 NO_2: 3-40 ppb	Acid vapor associated with reduced FEV_1 but not FVC growth	No effect modification	No effect modification
Gauderman et al 2004, CHS (USA) [3]	10-18	Annual average NO_2, PM_{10}, $PM_{2.5}$, O_3, acid vapor, elemental carbon assessed at study entry	PM_{10}: 10-63 µg/m^3 $PM_{2.5}$: 7- 28 µg/m^3 NO_2: 3- 40 ppb	NO_2, $PM_{2.5}$, O_3, acid vapor, elemental carbon associated with reduced FEV_1 growth	Stronger associations in boys, but no statistically significant differences with girls	Significant associations in subgroups of children with no history of asthma
Gauderman et al 2007, CHS (USA) [4]	10-18	Traffic proximity at study entry	-	Associated with FEV_1 but not FVC growth	Stronger associations in boys than in girls, non-significant differences	Significant effects in subgroups of children who never had asthma
Schultz et al 2016, BAMSE (Sweden)* [5]	16	Time weighted annual averages of NO_X and PM_{10} since birth	PM_{10}: 0.2-22 µg /m3 Median: 4.5 µg/m^3	Exposure to NO_X and PM_{10} not associated with FEV_1 growth from 8-16 years	Significant associations in boys	Associations in non-asthmatics
Lung function level						
Rice et al, 2016, (USA) [6]	7	Lifetime exposure to $PM_{2.5}$ and black carbon since birth	$PM_{2.5}$: 18-28 µg/m^3 Median: 10.7 µg/m^3	$PM_{2.5}$ and black carbon associated with FVC but not FEV_1 and	No effect modification	No effect modification

Table S13. (continued)

Study	Age group	Exposure assessed	Range and means/medians of pollutant levels	Results	Effect modification by sex	Effect modification by Asthma
Schultz et al 2012, BAMSE (Sweden)* [7]	8	PM_{10}, NOx assessed from birth	PM_{10}: 6-30.9 μg/m^3 Mean: 15.7 μg/m^3	First year of life PM_{10} exposure associated with lower FEV_1	Stronger associations in boys	Stronger effects in those with asthma
Gehring et al 2013, PIAMA (Netherlands) [8]*	8	Annual average NO_2, NOx, $PM_{2.5}$, PM_{10}, and PMcoarse, $PM_{2.5}$ absorbance since birth	PM_{10}: 23.7-29.8 μg/m^3 Mean: 24.8 μg/m^3 $PM_{2.5}$: 14.9- 19.3 μg/m^3 Mean: 16.3 μg/m^3 NO_2: 9.4–52.1 μg/m^3 Mean: 22.2 μg/m^3 $PM_{2.5}$ abs: 0.8- 2.1 10^{-5}/m Mean: 1.2 μg/m^3 PM_{coarse}: 7.6-11.2 μg/m^3 Mean: 8.3 μg/m^3	NO_2, NOx, $PM_{2.5}$ absorbance, and $PM_{2.5}$ at current address associated with FEV_1	No effect modification	No effect modification
Oftedal et al,2008,Oslo (Norway) [9]	9-10	Lifetime exposures to NO_2, $PM_{2.5}$, PM_{10}	PM_{10}: 10-17 μg/m^3 Mean: 14.5 μg/m^3 $PM_{2.5}$: 5- 19 μg/m^3 Mean: 12.3 μg/m^3 NO_2: 3- 65 μg/m^3 Mean: 29.0 μg/m^3	Early life and lifetime exposure to NO_2, $PM_{2.5}$, PM_{10} associated with FVC, PEF, FEF	Stronger associations in girls	Not assessed
Peters et al 1999,CHS (USA) [10]	9-16	24 h/-week averages of PM_{10}, $PM_{2.5}$, O_3 and NO_2 , acid vapor assessed at study entry	PM_{10}: 13-70.7 μg/m^3 Mean: 34.9 μg/m^3 $PM_{2.5}$: 6.7- 31.5 μg/m^3 Mean: 15.1 μg/m^3 NO_2: 2.7- 42.6 ppb Mean: 21.5 ppb	PM_{10}, $PM_{2.5}$, and NO_2 significantly associated with lower FVC, FEV_1	Stronger associations in girls	Significant associations between O_3 and FEV_1 in asthmatic girls
Fuertes et al (2015) GINI/LISA (Germany)* [11]	15	Annual averages of NO_2, PM_{10}, $PM_{2.5}$ and $PM_{2.5}$ absorbance since birth	NO_2: 11.4-59.7 μg/m^3 Median: 21.9 μg/m^3 PM_{10}: 14.8 -32.7 g/m^3 Median: 22.3 5μg/m^3 $PM_{2.5}$: 10.6-21.3 μg/m^3 Median: 14.2 μg/m^3 $PM_{2.5}$abs: 0.9-3.1 10^{-5}/m Median: 1.4 10^{-5}/m^{-1}	No associations observed for either FEV_1 or FVC for all pollutants	No consistent trends in the associations between sexes in stratified analyses	Negative associations of NO_2, PM_{10}, $PM_{2.5}$ with FEV_1 among asthmatics
Schultz et al 2016,	16	Time weighted	PM_{10}: 0.2-22 μg /m3	Early life exposure	Significant	Associations in non-

BAMSE (Sweden)[5]		annual averages of NO_X and PM_{10} since birth	Median: 4.5 μg/m³ NO_X: 0.5-50 μg/m³ Median: 6 μg/m³	to NO_X but not PM_{10} associated with FEV_1 at age 16 but not FVC	associations in boys	asthmatics

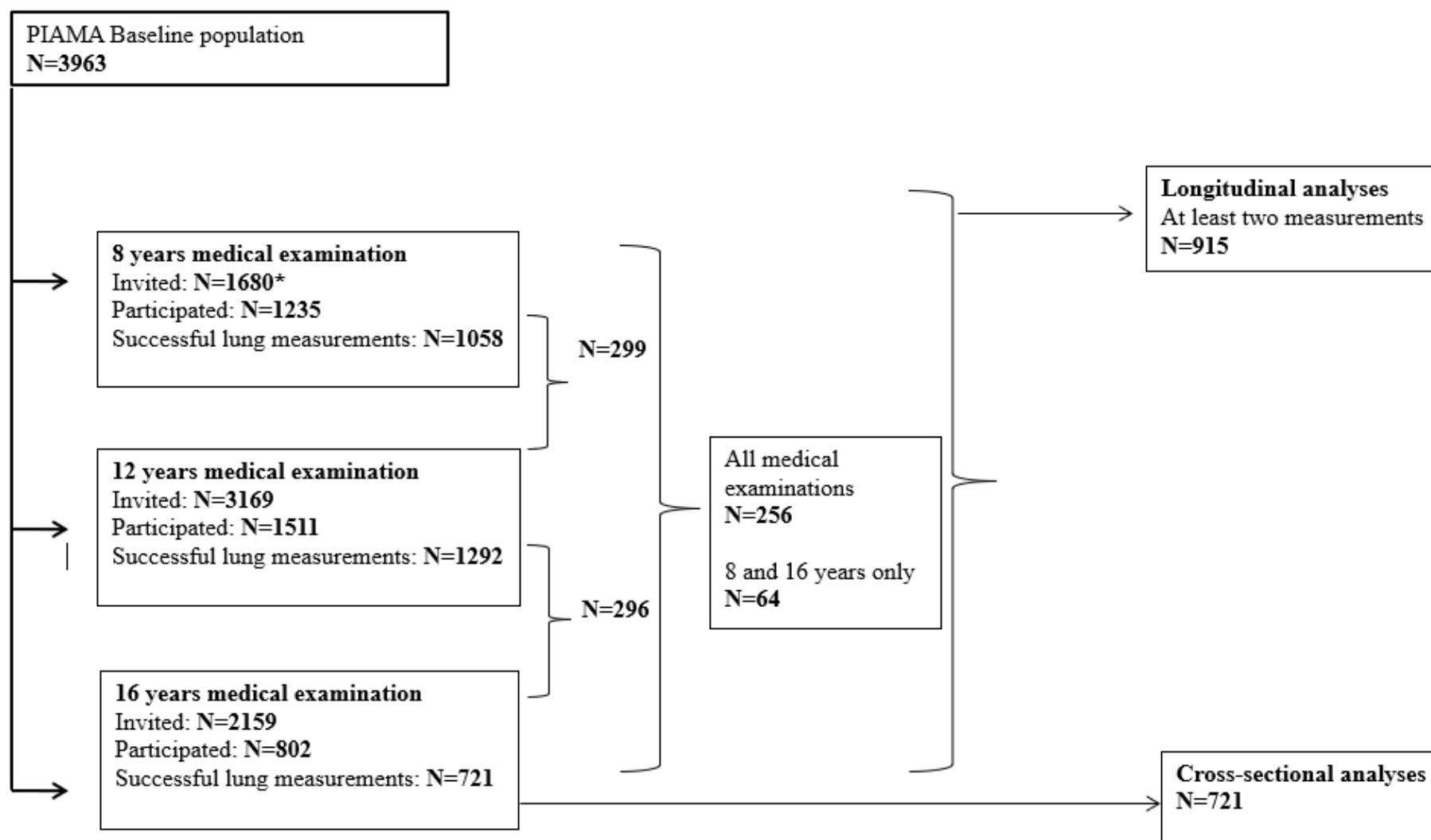*Studies with comparable exposure assessment

Table S14. Correlation between exposure at school and home addresses for primary and secondary school time windows air pollution exposure (N=627)

School address	Home address NO$_2$ primary	NO$_2$ secondary	PM$_{2.5}$ absorbance primary	PM$_{2.5}$ absorbance secondary	PM$_{2.5}$ primary	PM$_{2.5}$ secondary	PM$_{10}$ primary	PM$_{10}$ secondary	PM$_{coarse}$ primary	PM$_{coarse}$ secondary
NO$_2$										
Primary	**0.88**									
Secondary		0.69								
PM$_{2.5}$ absorbance										
Primary			**0.82**							
Secondary				0.62						
PM$_{2.5}$										
Primary					**0.85**					
Secondary						0.73				
PM$_{10}$										
Primary							0.68			
Secondary								0.35		
PM$_{coarse\_}$										
Primary									0.76	
Secondary										0.36

≥0.80=high correlation

Figure S1. Flow diagram of study population from the baseline population

PIAMA Baseline population
N=3963

8 years medical examination
Invited: N=1680*
Participated: N=1235
Successful lung measurements: N=1058

N=299

12 years medical examination
Invited: N=3169
Participated: N=1511
Successful lung measurements: N=1292

N=296

16 years medical examination
Invited: N=2159
Participated: N=802
Successful lung measurements: N=721

All medical examinations
N=256

8 and 16 years only
N=64

Longitudinal analyses
At least two measurements
N=915

Cross-sectional analyses
N=721

* Participants invited for the extensive medical follow-up including lung function measurements

REFERENCES

1. Gauderman WJ, McConnell R, Gilliland F, London S, Thomas D, Avol E, Vora H, Berhane K, Rappaport EB, Lurmann F, Margolis HG, Peters J. Association between air pollution and lung function growth in southern California children. *Am J Respir Crit Care Med* 2000; 162: 1383-1390.

2. Gauderman WJ, Gilliland GF, Vora H, Avol E, Stram D, McConnell R, Thomas D, Lurmann F, Margolis HG, Rappaport EB, Berhane K, Peters JM. Association between air pollution and lung function growth in southern California children: results from a second cohort. *Am J Respir Crit Care Med* 2002; 166: 76-84.

3. Gauderman WJ, Avol E, Gilliland F, Vora H, Thomas D, Berhane K, McConnell R, Kuenzli N, Lurmann F, Rappaport E, Margolis H, Bates D, Peters J. The effect of air pollution on lung development from 10 to 18 years of age. *N Engl J Med* 2004; 351: 1057-1067.

4. Gauderman WJ, Vora H, McConnell R, Berhane K, Gilliland F, Thomas D, Lurmann F, Avol E, Kunzli N, Jerrett M, Peters J. Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. *Lancet* 2007; 369: 571-577.

5. Schultz ES, Hallberg J, Bellander T, Bergstrom A, Bottai M, Chiesa F, Gustafsson PM, Gruzieva O, Thunqvist P, Pershagen G, Melen E. Early-Life Exposure to Traffic-related Air Pollution and Lung Function in Adolescence. *Am J Respir Crit Care Med* 2016; 193: 171-177.

6. Rice MB, Rifas-Shiman SL, Litonjua AA, Oken E, Gillman MW, Kloog I, Luttmann-Gibson H, Zanobetti A, Coull BA, Schwartz J, Koutrakis P, Mittleman MA, Gold DR. Lifetime Exposure to Ambient Pollution and Lung Function in Children. *Am J Respir Crit Care Med* 2016; 193: 881-888.

7. Schultz ES, Gruzieva O, Bellander T, Bottai M, Hallberg J, Kull I, Svartengren M, Melen E, Pershagen G. Traffic-related air pollution and lung function in children at 8 years of age: a birth cohort study. *Am J Respir Crit Care Med* 2012; 186: 1286-1291.

8. Gehring U, Gruzieva O, Agius RM, Beelen R, Custovic A, Cyrys J, Eeftens M, Flexeder C, Fuertes E, Heinrich J, Hoffmann B, de Jongste JC, Kerkhof M, Klumper C, Korek M, Molter A, Schultz ES, Simpson A, Sugiri D, Svartengren M, von Berg A, Wijga AH, Pershagen G, Brunekreef B. Air pollution exposure and lung function in children: the ESCAPE project. *Environ Health Perspect* 2013; 121: 1357-1364.

9. Oftedal B, Brunekreef B, Nystad W, Madsen C, Walker SE, Nafstad P. Residential outdoor air pollution and lung function in schoolchildren. *Epidemiology* 2008; 19: 129-137.

10. Peters JM, Avol E, Gauderman WJ, Linn WS, Navidi W, London SJ, Margolis H, Rappaport E, Vora H, Gong H, Jr., Thomas DC. A study of twelve Southern California communities with differing levels and types of air pollution. II. Effects on pulmonary function. *Am J Respir Crit Care Med* 1999; 159: 768-775.

11. Fuertes E, Bracher J, Flexeder C, Markevych I, Klumper C, Hoffmann B, Kramer U, von Berg A, Bauer CP, Koletzko S, Berdel D, Heinrich J, Schulz H. Long-term air pollution exposure and lung function in 15 year-old adolescents living in an urban and rural area in Germany: The GINIplus and LISAplus cohorts. *Int J Hyg Environ Health* 2015; 218: 656-665.