Online supplement

PM_{10} and children's respiratory symptoms and lung function in the PATY study

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The online supplement contains in order:

1. More specific explanation of exposure assessment
2. Tables 1 – 2 with more detail on methods of exposure assessment
3. Tables 3 -6 additional PM10 effect estimates not in the main text
4. References for the supplement

METHODS

Exposure assessment

Exposure assessment methods were assessed for comparability, including an evaluation of site selection for the monitors and the monitoring methods, especially for particulate matter. Tables 1 and 2 present the details for the included studies. In the evaluation it was taken into account that in the epidemiological analysis, analyses of the relationships between air pollution and respiratory health were made per country. Hence modest systematic differences in exposure assessment between studies do not directly affect the effect estimates. Although the overall conclusion was that exposure assessment was sufficiently comparable to allow summarizing air pollution effect estimates given a specific study design, some components of the studies were excluded from the analysis:

- Italian particle data, as a different fraction than PM_{10} was measured using different methods within the study, for which insufficient collocation with PM_{10} monitors existed
- One of the original four Bulgarian study areas was excluded because measurements used to representing an entire quarter of the city were made at a curbside of a major road
- One of the Russian study areas was excluded because the monitor was located on the premises of a major industrial site and too far away from the study area. A correlation analysis of daily samples supported this exclusion, as the PM concentrations from the excluded site did not correlate with other sites, whereas significant correlations were present among the other sites
- For some of the Austrian and Swiss sites recommendations were made to test the sensitivity of the epidemiological associations for presence of these sites, because there were concerns that these sites were too much affected by traffic on the nearest road

For those studies that did not directly measure PM_{10} with gravimetric methods, conversion factors were derived. In the Netherlands, $PM_{2.5}$ was measured at all 24 schools. At some of the sites, $PM_{2.5}$ measurements were co-located with PM_{10} measurements during the study. Therefore, $PM_{2.5}$ could be converted into PM_{10} using the formula: $PM_{10} = 9.37 + 1.21 * PM_{2.5}$ ($R^2 = 0.93$).(Janssen, 2001)[1]. In the German and Austrian study, TSP (total suspended particles) was measured in a routine monitoring network with beta attenuation continuous monitors. Site-specific comparisons were made with actual PM_{10} measurements shortly after the study, thus the original particle concentration could be transformed into PM_{10} concentrations. In Germany, the average PM_{10}/TSP was 0.77. In Austria, the average PM_{10}/TSP ratio was 0.77, 0.93 and 0.94 at three sites used in the current study.

We further recalculated the annual averages for the Russian study from the original daily data because in some areas the study period was shorter than the full year, resulting in potential bias in the exposure estimates because of seasonal variation. We used the average ratio of the annual average for the sites with complete study periods to the more restricted period to make adjustments.

Table S1 Overview of exposure assessment

Center	Data source	Assignment	Monitoring sites	Temporal coverage PM_{10}/TSP	Temporal coverage gases	Particle fraction	Particle composition	Other pollutants
Switzerland	*Gases*: routine network *PM_{10}*: study specific	1 fixed site in each community[A]	Background/ traffic	Weekly samples; 50/year	Continuous monitor, entire year	PM_{10}		SO_2, NO_2, O_3
Austria	Routine network	School assigned to nearest monitor	Background[B]	Continuous monitor, entire year	Continuous monitor, entire year	TSP		SO_2, NO_2, O_3, CO
CESAR	Study specific	1 fixed site in each community	Background	Daily samples; 1 per 6 days, one year	NA	PM_{10}	$PM_{2.5}$, soot	-
Germany	Routine network	1 fixed site in each community	Background/ industrial	Continuous monitor, entire year	Continuous monitor, entire year	TSP	--	SO_2
Italy	Routine networks	Schools within1km of a monitor	Background/ traffic	Continuous monitor, entire year	Continuous monitor, entire year	SP/PM_{10}		SO_2, NO_2
Netherlands	Study specific	1 fixed site per school	Traffic	Weekly samples; 5-10 per year	Weekly samples; 5-10 per year	$PM_{2.5}$	Soot	NO_2, VOC
Russia	Study specific	1 fixed site per study area	Background/ industrial	Weekly samples; period 7-12 months (differed per site)	Weekly samples, Nov. 1998 – May 1999	PM_{10}	$PM_{2.5}$	SO_2, NO_2, VOC
USA	Study specific / routine monitoring (ozone some sites)	1 fixed site in each community	Background	Daily samples, every other day	Continuous monitor, entire year	PM_{10}	$PM_{2.1}$, H^+, SO_4^{2-}	SO_2, O_3

CESAR includes study areas in Bulgaria, Czech Republic, Hungary, Poland and Slovakia

A More sites for NO_2 (five categories, from questionnaire); multiple sites for gaseous pollutants

B Two sites more traffic impact, sensitivity analysis agreed with investigators

Table S2 Monitoring methods

	PM principle	Monitor	Conversion to PM_{10}	SO_2	NO_2
Switzerland	Gravimetric	Harvard impactor	NA	UV Fluorescence*	Chemiluminescence**
Austria	Beta attenuation	EberlineFH63I-N	Co-located measurements several sites	UV Fluorescence	Chemiluminescence
CESAR	Gravimetric	Harvard impactor	NA	NA	NA
Germany	Beta attenuation	FAGFH-62-IN	Co-located measurements with PM_{10} in two of the areas one year later and Erfurt	UV Fluorescence	NA
Italy	Diverse	Diverse	Not possible, too diverse		
Netherlands	Gravimetric	Harvard impactor	Co-located measurements $PM_{2.5}$ and PM_{10} several schools during study	NA	Palmes tube
Russia	Gravimetric	Harvard impactor	NA	Ogawa badge	Ogawa badge
USA	Gravimetric	Harvard impactor	NA	Denuder	NA

NA not available
* DOAS (Differential Optical Absorption Spectroscopy) at one site (Biel) and no data at one site (Langnau)
** DOAS (Differential Optical Absorption Spectroscopy) at one site (Biel) and passive samplers (Langnau)

Table S3 Results from meta-regression analyses stratified by study characteristic for phlegm (8 studies). Odds ratios per 10 μg/m^3 PM_{10}.

Phlegm	No. of studies	Mean odds ratio (95% CI)	p-heterogeneity
Original evidence of heterogeneity			0.03
Study design: Between- or within-towns (or a mixture)			0.30
between towns	4	1.09 (0.91 - 1.30)	
within towns	1	1.06 (0.96 - 1.16)	
mixture	3	1.46 (1.17 - 1.82)	
Season of questionnaire			0.03
<2/3 in spring	3	1.22 (0.83 - 1.80)	
2/3+ in spring	5	1.15 (1.00 - 1.33)	
Variability of date of questionnaire			0.01
high variability	1	1.41 (0.64 - 3.13)	
low variability	7	1.14 (1.01 - 1.30)	
East or West[5]			0.03
East	6	1.21 (1.04 - 1.40)	
West	2	0.98 (0.84 - 1.14)	
Period of study			0.04
pre 95 studies	1	0.97(0.83 - 1.13)	
95 onwards	7	1.21(1.05 - 1.39)	
Response rate			0.01
response rate 80+%	3	1.18(0.84 - 1.66)	
response rate <80%	5	1.16(1.00 - 1.35)	
Response rate variability			0.01
low variability	5	1.18(0.98 - 1.41)	
med. variability	2	1.16(0.86 - 1.57)	
high variability	1	1.41(0.64 - 3.13)	
Proportion of young children (aged 6-8)			0.01
low (<20%)	2	1.20(0.74 - 1.94)	
Medium	6	1.15(1.01 - 1.32)	

Table S4 Combined estimates of PM_{10} effect by age-group and gender.

Symptom	Age		Gender	
	Older children (9 - 12 yr)	**Young children (6- 8 yr)**	**Boys**	**Girls**
Wheeze	1.00(0.95-1.07)	0.99(0.89-1.11)	1.02 (0.92-1.13)^{H}	0.99 (0.92-1.06)
Asthma	1.05(0.98-1.14)	0.98(0.88-1.09)	1.01 (0.90-1.13)	1.03 (0.94-1.13)
Bronchitis	1.06(1.00-1.13)	1.12(0.98-1.27)	1.08 (0.98-1.18)	1.06 (0.96-1.18)
Phlegm	1.16(1.00-1.35)^{H}	1.13(0.91-1.41)^{H}	1.09 (0.99-1.20)	1.13 (0.98-1.32)^{H}
Nocturnal cough	1.14(1.02-1.29)^{H}	1.15(0.97-1.36)^{H}	1.20 (1.02-1.41)^{H}	1.08 (0.93-1.27)^{H}
Morning cough	1.16(1.03-1.31)^{H}	1.11(0.95-1.29)^{H}	1.14 (1.02-1.27)^{H}	1.12 (0.98-1.28)^{H}
Hay fever	1.03(0.95-1.11)	0.97(0.84-1.11)^{H}	1.08 (0.90-1.30)	1.36 (1.02-1.83)
Sensitivity to inhaled allergens	1.30(1.00-1.68)	1.04(0.79-1.36)	1.01 (0.91-1.13)^{H}	1.03 (0.95-1.12)
Itchy rash	1.07(0.96-1.20)	1.03(0.87-1.22)^{H}	1.06 (0.91-1.24)^{H}	1.06 (0.95-1.18)
Woken by wheeze	0.99(0.89-1.10)	1.07(0.96-1.21)	1.07 (0.95-1.21)	0.94 (0.86-1.04)
Allergy to pets	1.29(0.95-1.74)^{H}	1.00(0.81-1.23)	1.26 (0.97-1.63)^{H}	1.08 (0.91-1.28)

Combined effect estimates calculated from country-specific estimates using random effects model.
'H' indicates evidence of between study heterogeneity ($p<0.10$)
Odds ratios and 95% confidence intervals are per 10 μg/m^3 PM_{10}

Table S5 Description of lung function data

	Austria	Czech Republic	Germany	Hungary	Netherlands	North America	Poland	Slovakia
N*	2,898	806	1,788	1,260	1,735	12,737	615	970
Age								
6-9 years (%)	100	17.5	56.8	11.9	50.1	42.3	34.2	24.0
10-12 yr (%)	0	82.5	43.2	88.1	49.9	47.7	65.8	76.0
Height (m)**	1.25 (0.64)	1.44 (0.69)	1.41 (0.15)	1.46 (0.71)	1.43 (0.10)	1.42 (0.76)	1.41 (0.70)	1.45 (0.73)
Weight (kg)**	26 (5)	38 (8)	35 (12)	38 (9)	36 (9)	39 (10)	36 (8)	37 (8)
FVC (l)**	1.44 (0.26)	2.49 (0.37)	2.39 (0.71)	2.50 (0.41)	2.38 (0.51)	2.49 (0.43)	2.31 (0.40)	2.48 (0.40)
FEV_1 (l)**	1.35 (0.23)	2.18 (0.31)	2.20 (0.59)	2.23 (0.35)	2.11 (0.43)	2.13 (0.36)	2.04 (0.33)	2.21 (0.34)
FEF_{25-75} ($l.s^{-1}$)**	1.92 (0.48)	2.54 (0.58)	-	2.73 (0.59)	2.35 (0.65)	2.37 (0.62)	2.46 (0.57)	2.68 (0.62)
PEF ($l.s^{-1}$)**	3.03 (0.62)	4.50 (0.78)	4.30 (1.27)	4.78 (0.78)	4.56 (1.07)	4.65 (0.92)	4.43 (0.78)	4.62 (0.89)
FVC%pred.)***	86 (10)	100 (9)	100 (11)	97 (11)	98 (11)	104 (11)	98 (11)	99 (11)
FEV_1 %pred***	90 (11)	101 (10)	103 (12)	100 (11)	99 (11)	102 (12)	100 (10)	101 (11)
FEF_{25-75}%pred***	102 (24)	98 (21)		103 (20)	93 (21)	95 (23)	99 (21)	103 (22)

* number of children with valid lung function test

** Mean and standard deviation in parentheses

*** Mean and standard deviation in parentheses of percent predicted lung function. Predicted using equations from Stanojevic (2009)[2]

Table S6 Combined estimates for the fully adjusted effect of 10 µg/m^3 increase in PM_{10} on lung function

	FVC (% diff and 95% CI)	**FEV_1 (% diff and 95% CI)**	**FEF_{25-75} (% diff and 95% CI)**	**PEF (% diff and 95% CI)**
Original analysis, all centres	0.1 (-0.6, 0.8)	0.3 (-0.5, 1.1)	0.7 (-0.8, 2.3)	0.0 (1.2, 1.3)
Original analysis, without CESAR centres**	0.2 (-1.0, 1.3)	0.0 (-0.9, 0.9)	-0.5 (-1.6, 0.6)	-0.4 (-2.0, 1.2)
Analysis with Stanojevic prediction equations, all centres***	-0.0, (-0.7, 0.7)	0.2 (-0.6, 1.1)	0.8 (-0.7, 2.2)	NA

* $p < 0.05$
** exclusion because of small number of valid tests
*** percent predicted lung function dependent variable. Prediction using equations from Stanojevic (2009)[2]
Combined effect estimates calculated from country-specific estimates using random effects model.
NA=not available

References online supplement

1. Janssen NAH, van Vliet PHN, Aarts F, Harssema H, Brunekreef B. Assessment of exposure to traffic related air pollution of children attending schools near motorways. Atmospheric Environment 2001;35, 22: 3875-3884.

2. Stanojevic S, Wade A, Cole TJ, Lum S, Custovic A, Silverman M, Hall GL, Welsh L, Kirkby J, Nystad W, Badier M, Davis S, Turner S, Piccioni P, Vilozni D, Eigen H, Vlachos-Mayer H, Zheng J, Tomalak W, Jones M, Hankinson JL, Stocks J. Spirometry centile charts for young Caucasian children: The asthma UK collaborative initiative. American Journal of Respiratory and Critical Care Medicine 2009; 180: 547-552.