Air Quality:

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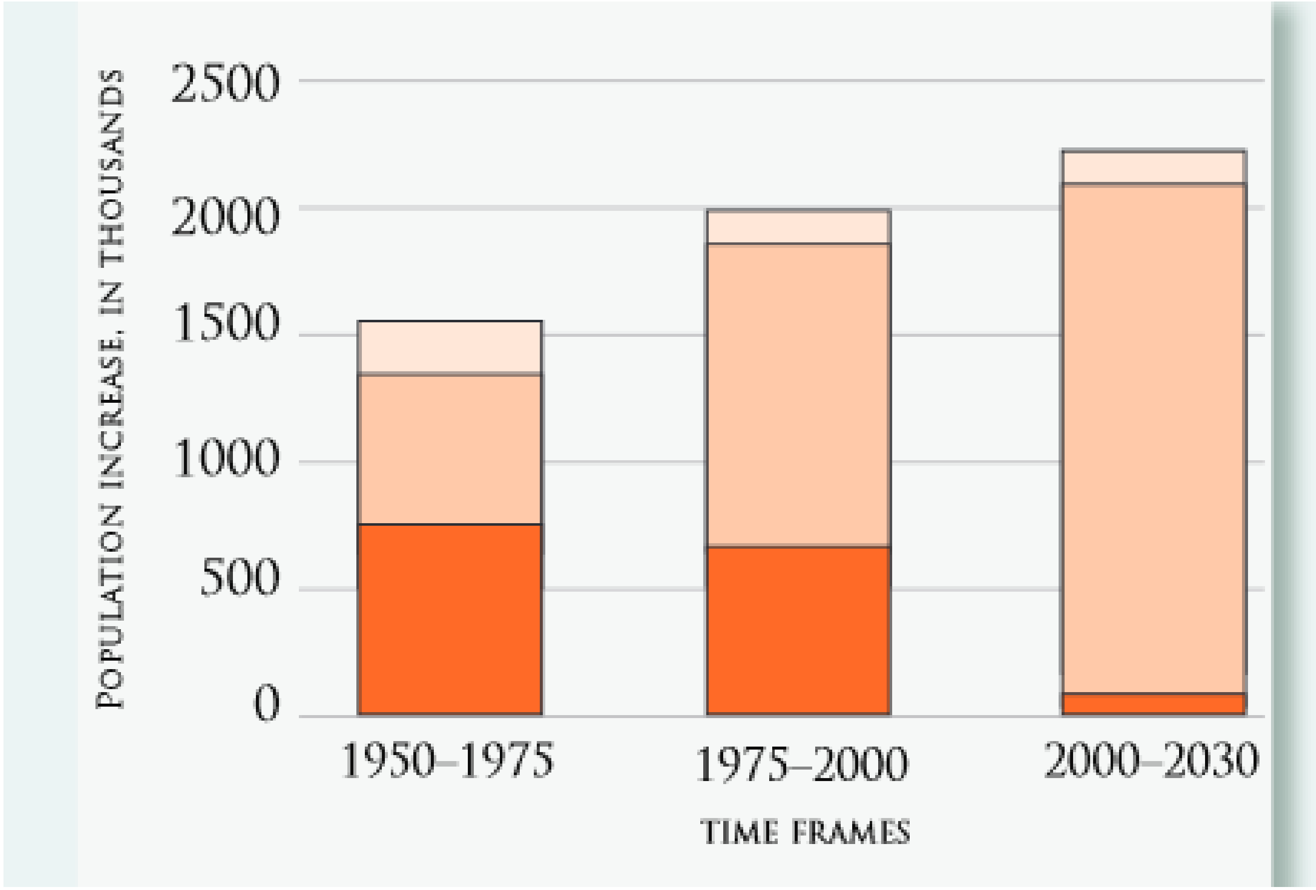
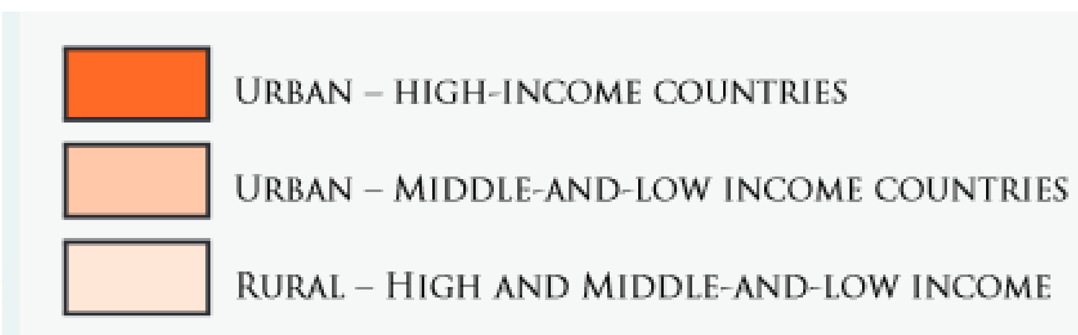
FUTURE AHEAD



www.who.int/world-health-day/2010



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Air quality deteriorating in many of the world's cities

News release

7 MAY 2014 | GENEVA - Air quality in most cities worldwide that monitor outdoor (ambient) air pollution fails to meet WHO guidelines for safe levels, putting people at additional risk of respiratory disease and other health problems.

WHO's urban air quality database covers 1600 cities across 91 countries – 500 more cities than the previous database (2011), revealing that more cities worldwide are monitoring outdoor air quality, reflecting growing recognition of air pollution's health risks.

Figure 3: *PM_{10} levels for selected cities by region, for the last available year in the period 2008-2012.*

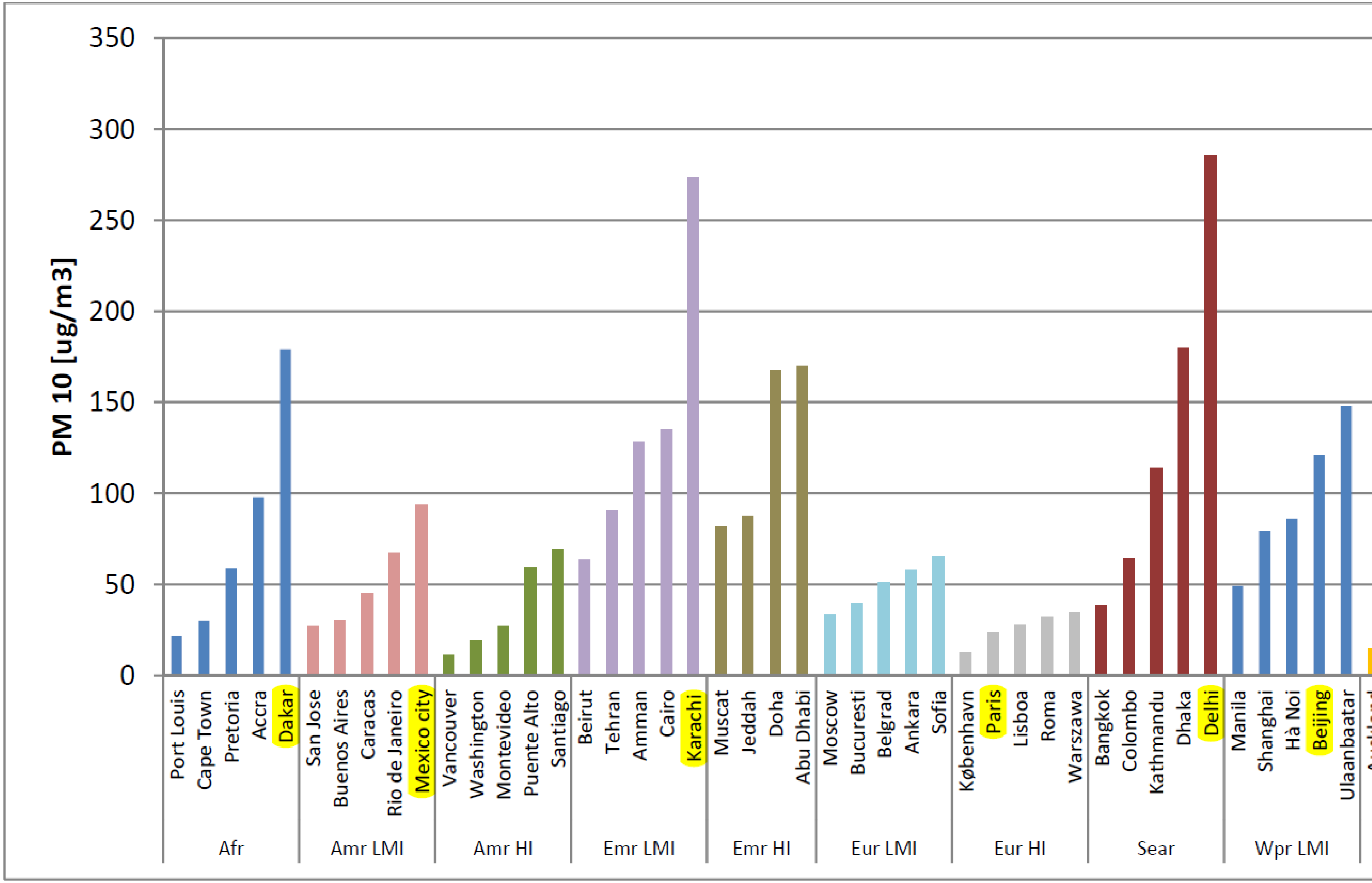
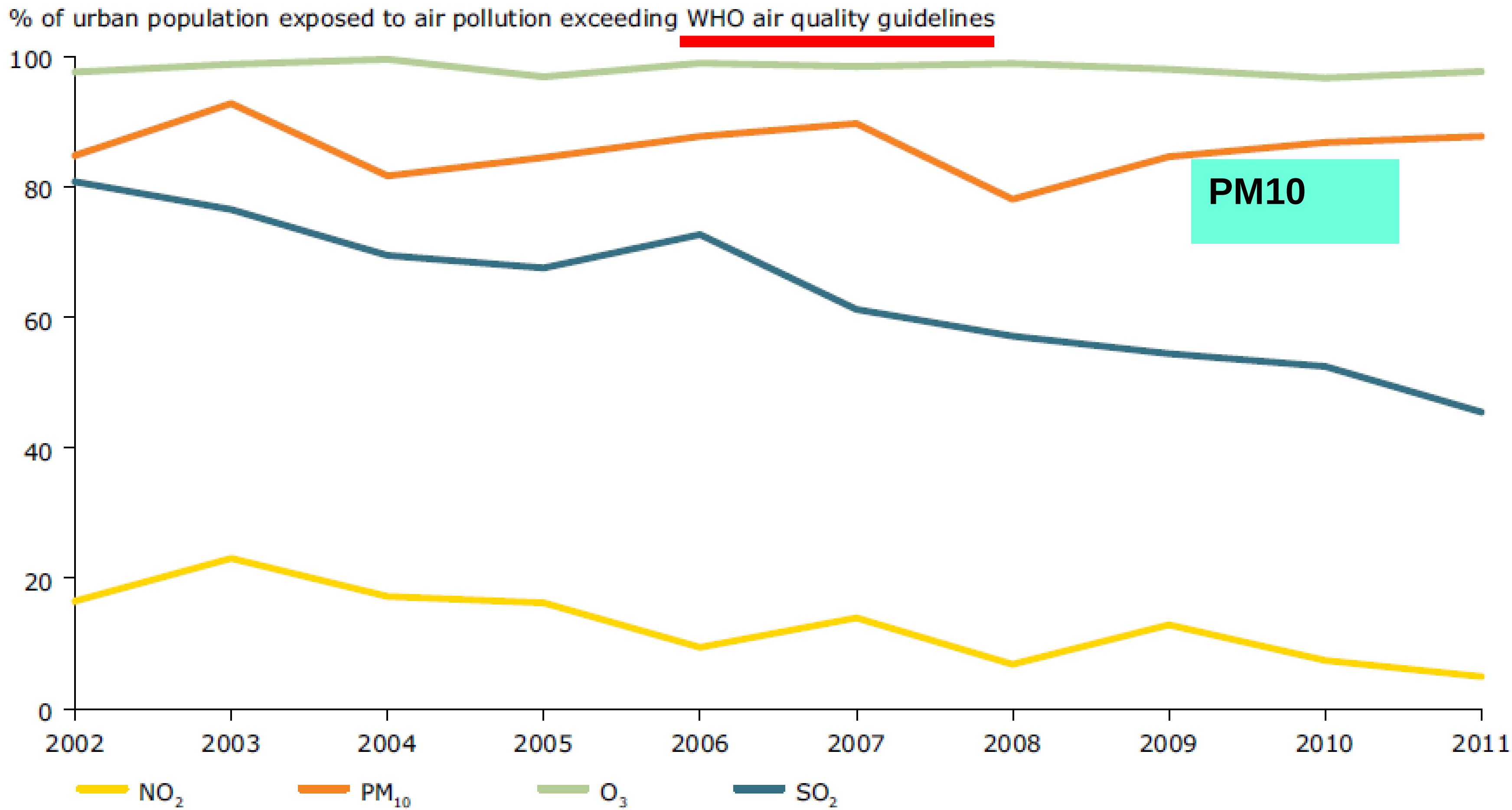


Figure 5: *Regional city-population weighted comparisons[1] in annual mean PM_{10} for a three-year period, by region, for cities present in both versions of the database*

Air quality in Europe — 2013 report



Source: EEA, 2013e (CSI 004).

EEA Report | No 9/2013

Brussels, 18.12.2013
COM(2013) 920 final

2013/0443 (COD)

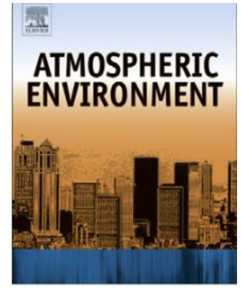
Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC

	SO_2	NO_x	(NM)VOC	NH_3	$PM_{2.5}$
Proposal reductions in % of 2005 emissions for 2020	59	42	28	6	22
Already achieved by 2011	42	24	20	5	13

NEW DIRECTIONS



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Clearly, the proposals from the Commission have been underpinned by numerical modelling of both air quality and health impacts, as well as cost-benefit analysis. However, the voluminous documentation produced by the Commission does not provide sufficient detail for independent assessment of the air quality modelling and there must be a strong suspicion that the conclusions drawn by the Commission on the basis of models are grossly over-optimistic. We suggest that downward revisions of some of the Limit Values, as implied by the advice of REVIHAAP (WHO, 2013) specifically in relation to $PM_{2.5}$, PM_{10}, NO_2 and long-term exposure to O_3, might provide a valuable complementary driver towards air quality improvement alongside more ambitious emissions limits, especially in the medium term to 2020.

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Atmospheric Environment 91 (2014) 172–174

Future research questions (just a few…)

- What happens at much higher concentrations?
- What happens at very low concentrations?
- What’s the role of PM Oxidative Potential?
- Role of PM composition?

Particulate air pollution and mortality in a cohort of Chinese men

Maigeng Zhou [a], Yunning Liu [a], Lijun Wang [a], Xingya Kuang [b], Xiaohui Xu [c], Haidong Kan [d,e,f,*]

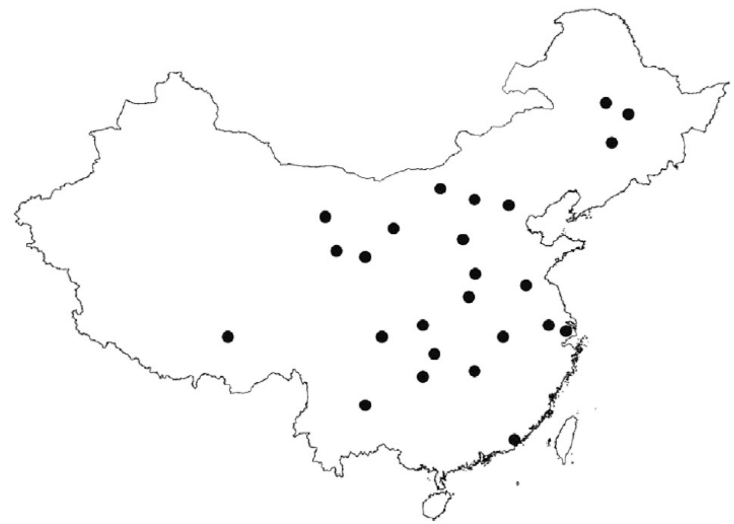
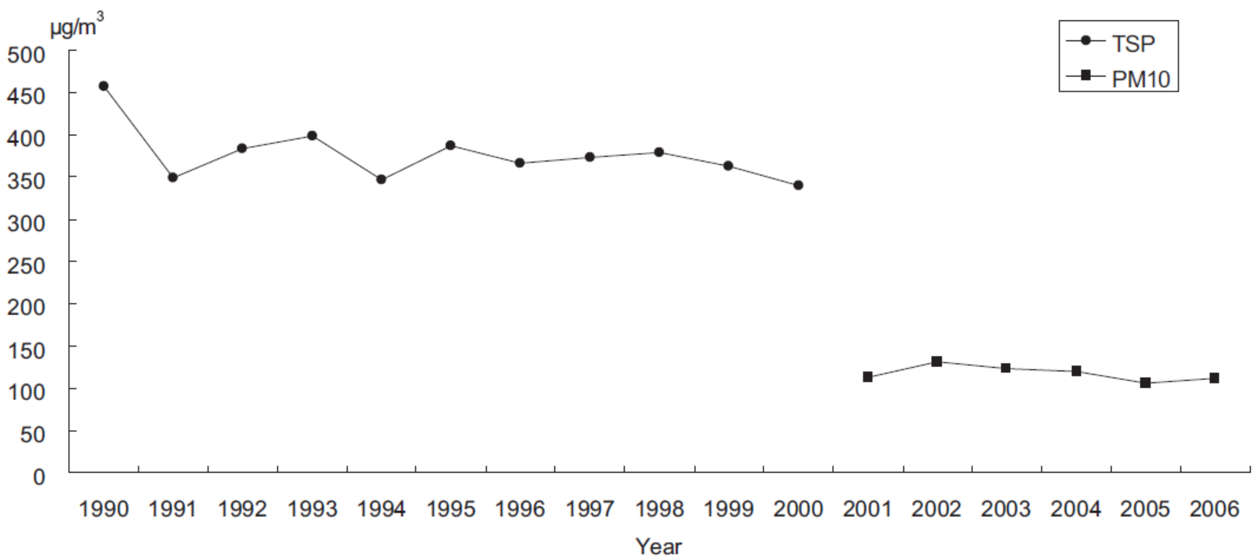


Fig. 1. Locations of selected Chinese cities.



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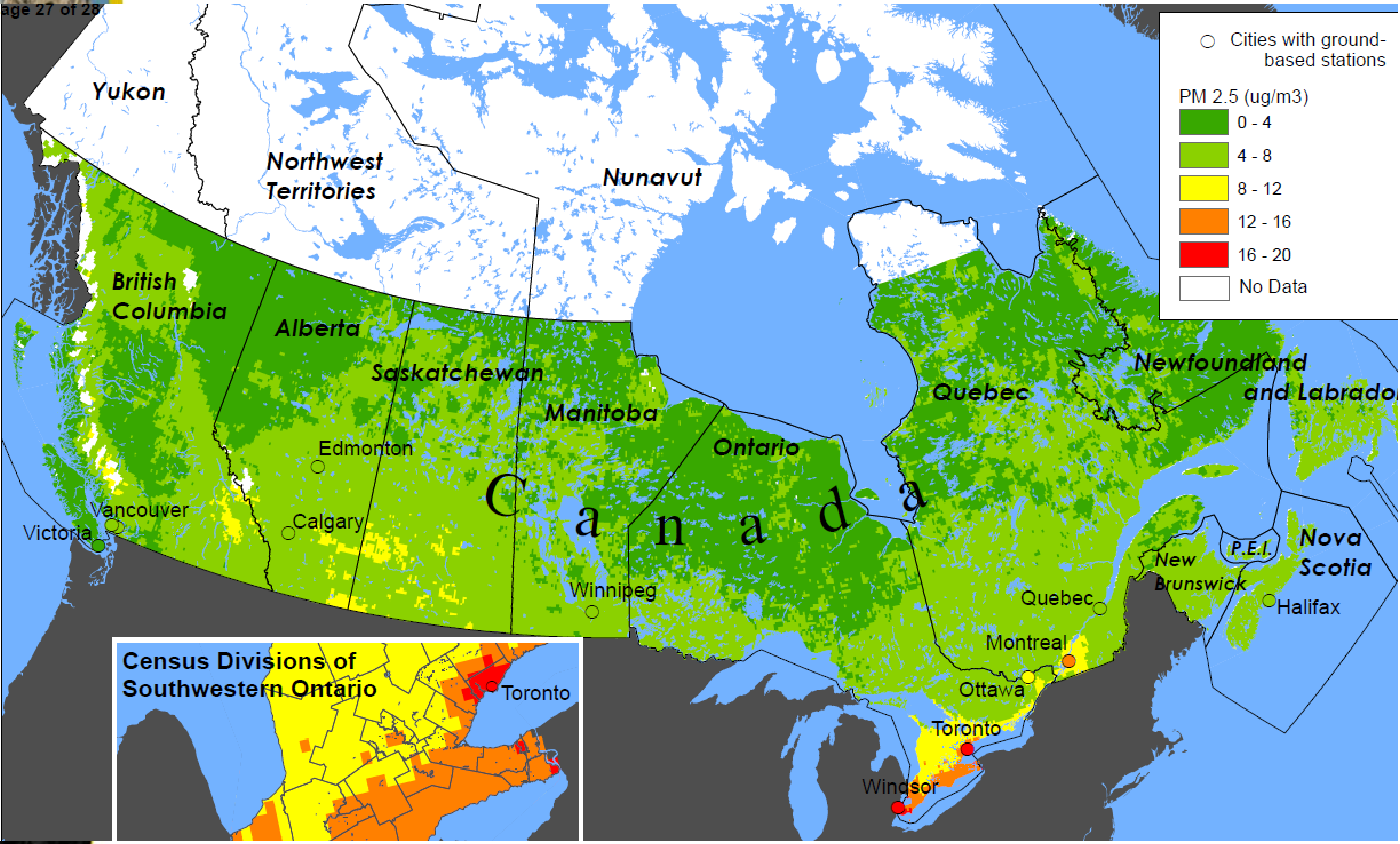
Environ Poll 2014

Table 4

Percent increase (mean and 95% CI) of mortality associated with 10 μg/m^3 increment of air pollutants concentrations in our study and studies in developed countries.

	Study site	Total mortality	Cardiovascular mortality	Respiratory mortality
TSP	Our study (25 Chinese cities)	0.4 (−0.1, 1.0)	1.0 (0.4, 1.7)	−0.2 (−0.9, 0.6)
	French PAARC survey (Filleul et al., 2005)	5 (2, 8)	6 (1, 12)[a]	
PM_{10}	Our study (25 Chinese cities)	1.6 (0.7, 2.6)	1.8 (0.8, 2.9)	1.7 (0.3, 3.2)
	California, USA (Abbey et al., 1999)[b]	4.6 (−0.8, 10.8)	4.2 (−2.5, 12.5)[a]	
$PM_{2.5}$	Our study (25 Chinese cities)[c]	2.5 (1.1, 4.0)	2.8 (1.2, 4.5)	2.6 (0.5, 4.9)
	ACS (Pope et al., 2002)	4 (1, 8)	6 (2, 10)[a]	
	Harvard six cities (Dockery et al., 1993)	13 (4, 23)	18 (6, 32)[a]	
	Women's Health Initiative (Miller et al., 2007)	–	76 (25, 147)	–

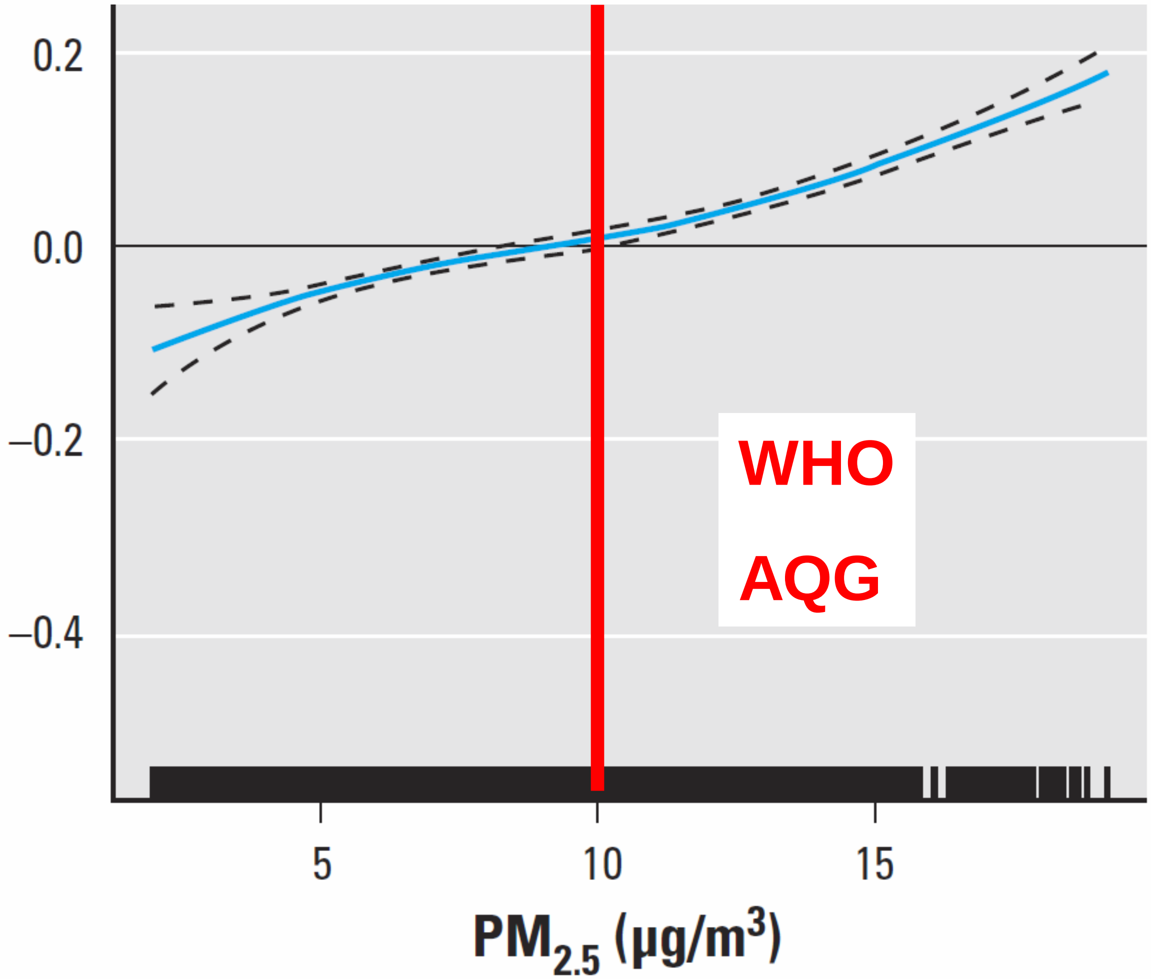
[a] Only cardiorespiratory mortality was reported.
[b] Only the results for men were presented here.
[c] Conversion as $PM_{2.5}/PM_{10} \approx 0.65$.



Crouse, EHP 2012

Risk of Nonaccidental and Cardiovascular Mortality in Relation to Long-term Exposure to Low Concentrations of Fine Particulate Matter: A Canadian National-Level Cohort Study

All-Cause Mortality



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Crouse, EHP 2012

PM_{10}-induced Hospital Admissions for Asthma and Chronic Obstructive Pulmonary Disease

The Modifying Effect of Individual Characteristics

Cristina Canova,[a] Christina Dunster,[b] Frank J. Kelly,[b] Cosetta Minelli,[c] Pallav L. Shah,[d,e] Cielito Caneja,[e] Michael K. Tumilty,[a] and Peter Burney[a]

TABLE 5. Adjusted[a] Association of COPD/Asthma Exacerbations for Each 10-$\mu g/m^3$ Increase in PM_{10} at Lag 0–3, by Individual Antioxidant Capacity, for 158 Chelsea and Westminster Hospital Admissions, 2008–2010

Effect Modifier	OR (95% CI)	Test for Interaction
Vitamin C		$P = 0.007$
<13 μmol/L	2.17 (1.38–3.43)	
≥13 μmol/L	0.90 (0.56–1.46)	
Uric acid		$P = 0.238$
<236 μmol/L	1.83 (1.18–2.84)	
≥236 μmol/L	1.13 (0.72–1.77)	
Vitamin A		$P = 0.697$
<2.2 μmol/L	1.37 (0.90–2.07)	
≥2.2 μmol/L	1.69 (1.04–2.75)	
Vitamin A (corrected for cholesterol)		$P = 0.153$
<0.5 μmol/L	1.18 (0.78–1.78)	
≥0.5 μmol/L	2.02 (1.22–3.36)	
Vitamin E		$P = 0.062$
<23.7 μmol/L	1.79 (1.19–2.68)	
≥23.7 μmol/L	1.12 (0.66–1.90)	
Vitamin E (corrected for cholesterol)		$P = 0.256$
<5.5 μmol/L	1.64 (1.09–2.47)	
≥5.5 μmol/L	1.37 (0.83–2.26)	

[a]Models adjusted for temperature and humidity.

Epidemiology

2012

Universitei

PM_{10} Oxidative Properties and Asthma and COPD

TABLE. Association[a] of Asthma/COPD Exacerbations with a Unit Increase in OP m^{-3} for Each Antioxidant (n = 160 Exacerbations; n = 156 Filters)

	OP^{AA}	OP^{UA}	OP^{GSH}
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Models with individual OP effects	0.98 (0.95–1.01)	1.00 (0.83–1.20)	0.96 (0.92–1.01)
Models with individual OP effects, adjusted for PM_{10} mass	0.97 (0.94–1.01)	0.97 (0.81–1.18)	0.95 (0.90–1.00)
Joint model with all OP effects, adjusted for PM_{10} mass	0.99 (0.95–1.03)	0.93 (0.76–1.14)	0.96 (0.89–1.03)

[a]All models are adjusted for temperature and humidity.

OP^{AA} indicates oxidative potential associated with ascorbic acid; OP^{UA}, oxidative potential associated with uric acid; OP^{GSH}, oxidative potential associated with glutathione; OR, odds ratio; CI, confidence interval.

Canova, EPIDEMIOLOGY 2014

Respiratory Health Effects of Airborne Particulate Matter: The Role of Particle Size, Composition, and Oxidative Potential—The RAPTES Project

Maciej Strak,[1,2] Nicole A.H. Janssen,[1] Krystal J. Godri,[3,4] Ilse Gosens,[1] Ian S. Mudway,[3] Flemming R. Cassee,[1] Erik Lebret,[1,2] Frank J. Kelly,[3] Roy M. Harrison,[4,5] Bert Brunekreef,[2,6] Maaike Steenhof,[2] and Gerard Hoek[2]

Table 2. Spearman's rank correlation coefficients (r_S) between PM characteristics.

	PM_{10}	$PM_{2.5}$	$PM_{2.5–10}$	PNC	Abs[a]	EC(C)	EC(F)	OC(C)	OC(F)	Fe(tot)	Fe(sol)	Cu(tot)	Cu(sol)	Ni(tot)	Ni(sol)	V(tot)	V(sol)	Endo	NO_3^{-}[a]	SO_4^{2-}[a]	OP^{AA}	OP^{GSH}	OP^{TOTAL}	O_3	NO_2	NO_x
PM_{10}		0.94	0.82	0.22	0.74	0.70	0.69	0.76																		
$PM_{2.5}$	0.88		0.67	0.15	0.68	0.66	0.64	0.68																		
$PM_{2.5–10}$	0.55	0.22		0.21	0.71	0.68	0.67	0.78																		
PNC	0.19	0.07	0.15		0.65	0.60	0.67	0.00																		
Abs[a]	0.37	0.22	0.31	0.84		0.88	0.98	0.48																		
EC(C)	0.28	0.17	0.26	0.77	0.73		0.89	0.45																		
EC(F)	0.25	0.13	0.19	0.86	0.96	0.77		0.42																		
OC(C)	0.52	0.39	0.57	−0.06	0.00	−0.04	−0.13																			
OC(F)	0.59	0.72	0.06	−0.20	0.05	−0.26	−0.07	0.08																		
Fe(tot)	0.24	0.04	0.27	0.90	0.83	0.77	0.81	0.07																		
Fe(sol)	−0.05	−0.11	−0.01	0.86	0.65	0.59	0.66	−0.23																		
Cu(tot)	0.28	0.12	0.26	0.82	0.76	0.82	0.77	0.12	−0.23	0.93	0.89		0.92	0.53	0.24	0.67	−0.17	−0.05	−0.24	−0.46	0.76	0.75	0.76	−0.70	0.24	0.57
Cu(sol)	0.55	0.41	0.37	0.71	0.85	0.83	0.80	0.15	0.09	0.78	0.55	0.82		0.63	0.19											
Ni(tot)	0.40	0.27	0.49	−0.09	0.11	−0.11	−0.01	0.22	0.37	−0.10	−0.11	−0.16	0.13		0.07											
Ni(sol)	−0.01	−0.06	0.00	0.46	0.35	0.43	0.46	−0.22	−0.37	0.27	0.49	0.36	0.26	0.11												
V(tot)	0.14	0.19	−0.05	0.20	0.19	0.47	0.29	−0.18	−0.18	0.04	0.06	0.21	0.22	0.16	0.75											
V(sol)	0.04	0.07	0.00	0.19	0.14	0.42	0.24	−0.17	−0.30	0.00	0.11	0.13	0.13	0.16	0.81											
Endo	0.22	0.22	0.22	−0.37	−0.30	−0.49	−0.31	0.40	0.13	−0.52	−0.45	−0.49	−0.42	0.20	0.08											
NO_3^{-}[a]	0.56	0.74	−0.10	−0.26	−0.12	−0.05	−0.21	0.11	0.64	−0.22	−0.27	−0.09	0.11	0.18	−0.13											
SO_4^{2-}[a]	0.50	0.72	−0.12	−0.14	0.08	−0.07	0.05	0.12	0.54	−0.32	−0.29	−0.19	0.10	0.33	0.20											
OP^{AA}	0.75	0.79	0.32	0.28	0.51	0.47	0.45	0.40	0.38	0.26	0.03	0.35	0.56	0.24	0.07											
OP^{GSH}	0.54	0.48	0.44	0.12	0.27	0.39	0.28	0.50	−0.01	0.14	−0.15	0.35	0.47	0.15	0.02											
OP^{TOTAL}	0.73	0.73	0.40	0.22	0.42	0.50	0.35	0.56	0.24	0.23	−0.11	0.38	0.59	0.28	−0.07											
O_3	−0.21	−0.15	−0.18	−0.35	−0.57	−0.33	−0.57	0.07	−0.06	−0.18	−0.14	−0.26	−0.35	−0.20	−0.54											
NO_2	0.49	0.45	0.28	0.56	0.74	0.60	0.67	0.06	0.26	0.52	0.34	0.52	0.71	0.28	0.28											
NO_x	0.32	0.21	0.25	0.75	0.87	0.71	0.87	−0.11	0.01	0.70	0.53	0.66	0.72	0.14	0.47											

Abbreviations: Abs, absorbance; C, coarse PM fraction; Endo, endotoxin; F, fine PM fraction; sol, water-soluble metal extraction; tot, total. V

[a]Measured in $PM_{2.5}$.

0.88 0.82 0.89

0.91 0.79 0.88

−0.78 0.32

−0.69 0.14

−0.72 0.28

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EHP 2012

Table 3. Two-pollutant models of associations between air pollution exposure and percentage changes (postexposure – preexposure) in FE_{NO} immediately after exposure (all sites).

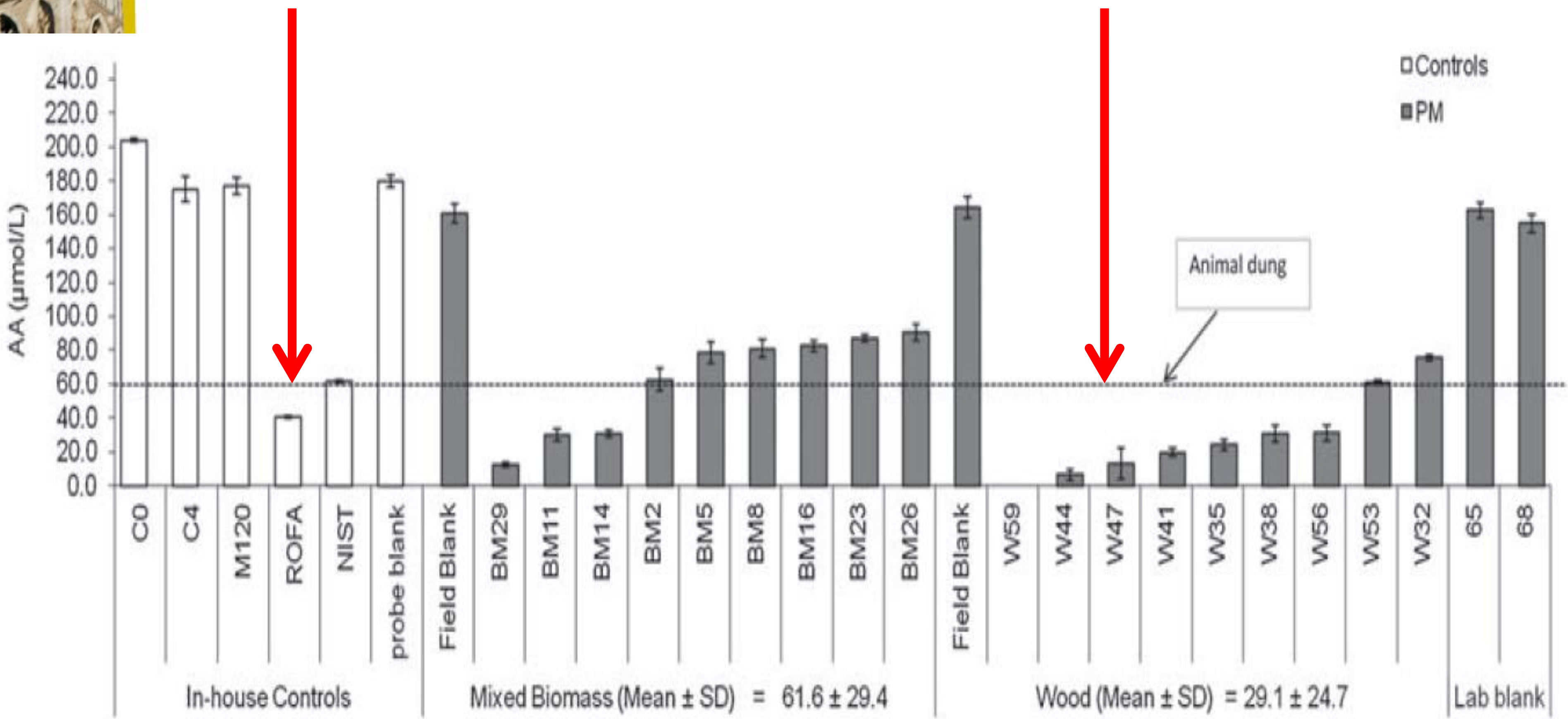
	IQR	Adjustment pollutant														
		PM_{10}	$PM_{2.5}$	$PM_{2.5-10}$	PNC	Abs[a]	EC(F)	EC(C)	OC(F)	OC(C)	Fe(tot)	Fe(sol)	Cu(tot)	Cu(sol)	Ni(tot)	Ni(sol)
PM_{10}	13.50	0.09	0.68	–1.00	–0.02	–1.27**	–1.35**	0.40	0.28	0.22	0.73	0.09	0.93	0.23	0.58	0.07
$PM_{2.5}$	11.54	–1.43	0.17	–0.86	–0.02	–2.43**	–2.64**	0.10	0.57	0.38	–0.03	0.15	1.03	0.44	0.73	0.12
$PM_{2.5-10}$	8.23	1.02	0.41	0.10	–0.02	–1.17**	–1.23**	0.41	0.28	0.22	0.99	0.09	0.80	0.23	0.63	0.08
PNC	32,906	11.28**	11.26**	11.30**	11.24**	11.80**	11.44**	11.28**	11.57**	11.07**	11.17**	11.56**	11.23**	11.30**	11.06**	11.30**
Abs[a]	3.49	10.74**	8.76**	10.68**	–0.55	2.41	–13.81	11.51**	4.45**	3.42*	12.39**	2.90	11.21**	3.95**	7.07**	2.37
EC(F)	4.35	12.75**	10.61**	12.58**	–0.21	18.26	2.92*	11.80**	4.87**	4.19**	15.33**	3.36*	13.09**	4.32**	8.84**	2.88
EC(C)	0.40	–0.41	0.07	–0.46	–0.11	–1.91**	–1.70**	0.12	0.42	0.18	–0.03	0.08	0.88	0.38	0.45	0.07
OC(F)	1.82	–2.81	–2.48	–2.91	–1.92	–4.58*	–4.23*	–2.90	–1.10	–1.04	–2.44	–2.38	–2.31	–2.05	–1.72	–1.24
OC(C)	0.79	–0.79	–0.53	–0.88	0.28	–1.42	–1.58	–0.38	0.33	0.12	–0.48	–0.02	–0.18	0.25	–0.03	–0.13
Fe(tot)	895.10	–0.10	0.02	–0.15	–0.01	–0.24**	–0.26**	0.02	0.04	0.02	0.01	0.01	0.18	0.03	0.08	0.01
Fe(sol)	32.09	0.18	0.25	0.15	–0.66	–0.68	–0.62	0.22	1.21	0.41	0.23	0.40	0.39	1.39	0.42	0.25
Cu(tot)	57.96	–0.18	–0.08	–0.17	–0.02	–0.29**	–0.30**	–0.12	0.05	0.02	–0.24	0.00	0.01	0.03	0.04	0.00
Cu(sol)	8.65	–0.05	–0.04	–0.05	–0.04	–0.10	–0.09	–0.07	0.04	–0.01	–0.04	–0.07	–0.04	0.00	–0.02	–0.02
Ni(tot)	3.53	–0.71	–0.33	–0.83	–0.02	–1.11**	–1.25**	–0.37	0.21	0.05	–0.67	–0.01	–0.18	0.11	0.05	–0.01
Ni(sol)	1.82	1.05	1.15	1.00	–0.79	–0.06	–0.08	1.14	1.71	1.43	1.12	1.18	1.32	1.59	1.38	1.34
V(tot)	2.04	–0.38	–0.12	–0.47	–0.11	–1.45*	–1.55**	–0.09	0.33	0.18	–0.27	0.07	0.15	0.21	0.25	–0.06
V(sol)	1.94	2.65	2.70	2.62	2.22	2.44	2.38	2.74	2.73	3.15	2.71	2.86	2.78	2.95	2.82	2.79
Endo	0.19	–0.07	–0.07	–0.07	–0.01	–0.05	–0.05	–0.07	–0.08*	–0.07	–0.07	–0.07	–0.07	–0.08	–0.07	–0.06
NO_3^{-a}	5.19	–2.12	–2.21	–2.08	0.46	–1.68	–1.59	–2.09	–2.09	–2.31	–2.06	–2.09	–2.09	–2.11	–2.12	–2.03
SO_4^{2-a}	2.99	–1.99	–2.02	–1.97	–0.44	–1.54	–1.43	–2.09	–2.05	–2.15	–2.09	–2.12	–2.14	–2.15	–2.23	–2.04
OP^{AA}	19.08	–0.16	–0.12	–0.16	–0.03	–0.38**	–0.37**	–0.15	0.08	–0.04	–0.13	–0.02	–0.07	0.02	–0.06	0.00
OP^{GSH}	15.53	–0.12	–0.03	–0.17	–0.02	–0.31**	–0.27**	–0.07	0.10	–0.03	–0.06	0.00	0.01	0.04	–0.01	0.00
OP^{TOTAL}	38.71	–0.20	–0.09	–0.22	–0.03	–0.45**	–0.40**	–0.17	0.11	–0.04	–0.14	–0.01	–0.04	0.04	–0.04	0.00
O_3	9.74	–2.16	–2.72	–1.64	1.56	10.61**	9.52**	–2.12	–2.90	–1.61	–2.16	–1.09	–2.96	–2.06	–2.47	–0.90
NO_2	10.54	6.87	6.98	6.81	–7.40	4.42	4.12	6.54	7.94*	6.53	6.49	6.46	6.71	6.87	6.62	6.28
NO_x	28.05	5.31	5.49	5.18	–5.77	2.00	1.52	5.49	5.95*	4.65	5.00	4.87	5.58	6.23	5.15	4.19

Table 3. continued

	Adjustment pollutant										
	V(tot)	V(sol)	Endo	NO_3^{-a}	SO_4^{2-a}	OP^{AA}	OP^{GSH}	OP^{TOTAL}	O_3	NO_2	NO_x
PM_{10}	0.28	0.08	0.00	0.10	0.06	0.56	0.54	0.69	–0.11	0.00	–0.08
$PM_{2.5}$	0.34	0.15	–0.03	0.25	0.12	0.98	0.42	0.83	–0.42	–0.05	–0.27
$PM_{2.5–10}$	0.30	0.08	0.01	0.09	0.06	0.52	0.68	0.70	–0.04	0.01	–0.06
PNC	11.17**	10.94**	10.93**	11.55**	11.02**	14.66**	14.58**	14.63**	12.04**	14.66**	14.85**
Abs[a]	6.60**	2.27	1.69	2.16	2.09	10.10**	10.51**	11.53**	9.58**	1.62	1.73
EC(F)	7.91**	2.76	2.18	2.63	2.54	11.16**	10.39**	11.85**	9.96**	2.12	2.35
EC(C)	0.17	0.10	–0.04	0.11	0.07	0.71	0.46	0.79	–0.15	0.00	–0.17
OC(F)	–1.68	–0.66	–2.21	–1.04	–1.10	–2.88	–4.11	–3.63	–2.77	–1.98	–2.37
OC(C)	–0.20	–0.30	0.06	0.52	0.00	1.28	1.37	1.37	–0.40	–0.01	–0.35
Fe(tot)	0.03	0.01	0.00	0.01	0.01	0.07	0.05	0.08	–0.02	0.00	–0.01
Fe(sol)	0.33	0.41	–0.18	0.37	0.32	0.66	0.36	0.49	0.14	0.07	–0.33
Cu(tot)	0.00	0.01	–0.01	0.01	0.00	0.06	0.00	0.04	–0.04	–0.01	–0.03
Cu(sol)	–0.02	–0.01	–0.04	0.00	0.00	–0.01	–0.04	–0.02	–0.04	–0.02	–0.06
Ni(tot)	–0.10	0.02	–0.08	–0.01	–0.06	0.34	0.15	0.27	–0.23	–0.03	–0.16
Ni(sol)	1.54	0.06	0.92	1.09	0.64	1.29	1.21	1.26	0.95	0.50	0.52
V(tot)	0.13	0.00	–0.05	0.11	0.03	0.11	–0.08	0.03	–0.35	–0.06	–0.14
V(sol)	2.84	2.84	2.75	4.09	3.14	2.47	2.35	2.42	2.54	1.67	1.98
Endo	–0.07	–0.07	–0.07	–0.07	–0.07	–0.07	–0.06	–0.07	–0.07	–0.05	–0.05
NO_3^{-a}	–2.09	–2.66	–1.93	–2.11	–1.07	–4.08*	–4.13*	–4.10*	–2.17	–2.19	–1.89
SO_4^{2-a}	–2.13	–2.26	–1.94	–1.32	–2.05	–2.86	–2.83	–2.84	–2.06	–2.26	–1.91
OP^{AA}	0.00	0.01	–0.02	0.01	–0.01	0.01	–0.09	–0.19	–0.07	–0.02	–0.05
OP^{GSH}	0.02	0.01	–0.01	0.02	0.01	0.08	0.01	0.15	–0.03	–0.01	–0.03
OP^{TOTAL}	0.01	0.01	–0.02	0.02	0.00	0.20	–0.18	0.01	–0.07	–0.01	–0.05
O_3	–2.65	–0.88	–0.04	–1.37	–1.25	–2.88	–2.15	–2.71	–1.23	0.92	1.40
NO_2	6.71	5.93	4.89	7.03	7.33	6.56	6.43	6.51	8.02	6.88	5.03
NO_x	4.82	3.98	2.95	4.33	4.40	5.82	5.47	5.68	6.13	1.63	4.65

Oxidative potential of smoke from burning wood and mixed biomass fuels

O. P. Kurmi[1], C. Dunster[2], J. G. Ayres[3] & F. J. Kelly[2]



FRR 2013

Inhalation Toxicology

http://informahealthcare.com/iht
ISSN: 0895-8378 (print), 1091-7691 (electronic)

Inhal Toxicol, 2013; 25(14): 802–812
 DOI: 10.3109/08958378.2013.850127

informa healthcare

REVIEW ARTICLE

Particulate matter beyond mass: recent health evidence on the role of fractions, chemical constituents and sources of emission

Flemming R. Cassee[1,2], Marie-Eve Héroux[3], Miriam E. Gerlofs-Nijland[1], and Frank J. Kelly[4]

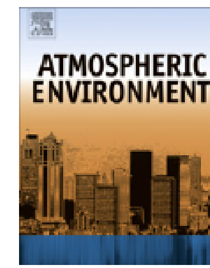
Atmospheric Environment 60 (2012) 504–526

ELSEVIER

Contents lists available at SciVerse ScienceDirect

Atmospheric Environment

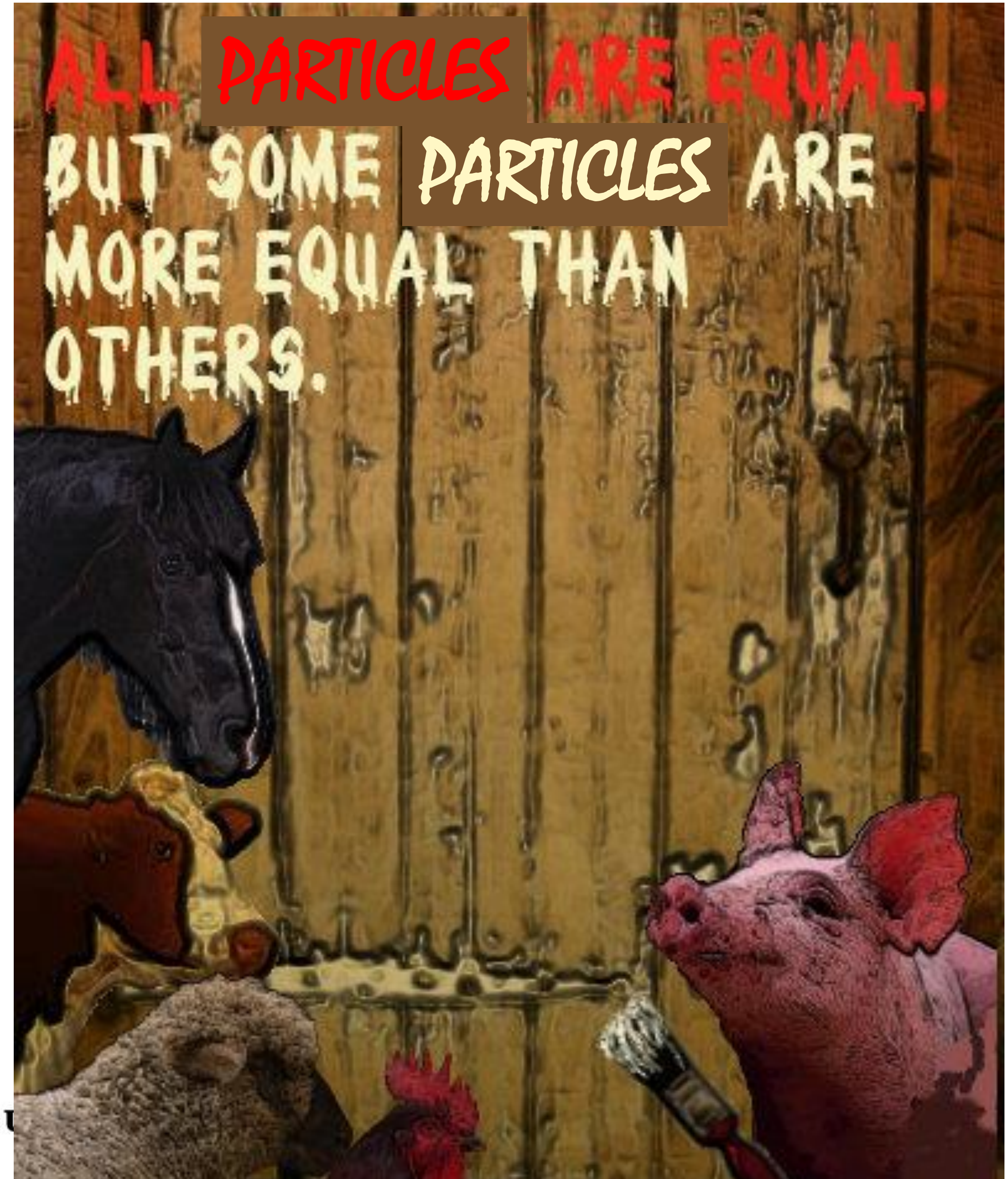
journal homepage: www.elsevier.com/locate/atmosenv



Review

Size, source and chemical composition as determinants of toxicity attributable to ambient particulate matter

Frank J. Kelly*, Julia C. Fussell


ALL PARTICLES ARE EQUAL.
BUT SOME PARTICLES ARE MORE EQUAL THAN OTHERS.


Here & Now

Saharan Rain: 12 Incredible Pictures Of London Shrouded In Smog

Huffington Post, April 2 2014

The Economist

Car ban in the French capital

Paris in the smog

Mar 17th 2014, 12:33 by S.P. | PARIS

Timekeeper · Like 193 · Tweet 33

Tiannanmen Square, January 2014

Mortality Associations with Long-Term Exposure to Outdoor Air Pollution in a National English Cohort

Iain M. Carey[1], Richard W. Atkinson[1], Andrew J. Kent[2], Tjeerd van Staa[3,4], Derek G. Cook[1], and H. Ross Anderson[1,5]

TABLE 3. HAZARD RATIOS FOR ALL-CAUSE MORTALITY IN 2003–2007 FOR AN INTERQUARTILE RANGE CHANGE IN 2002 POLLUTANT CONCENTRATIONS

	PM_{10} (*n* = 830,842)		$PM_{2.5}$ (*n* = 830,842)		SO_2 (*n* = 823,442)		NO_2 (*n* = 830,429)		O_3 (*n* = 824,654)	
Baseline Variables Adjusted For	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
+ age, sex	1.08	1.05–1.11	1.09	1.06–1.12	1.07	1.05–1.09	1.09	1.06–1.12	0.93	0.90–0.96
+ age, sex, smoking, BMI	1.06	1.04–1.09	1.07	1.05–1.10	1.06	1.04–1.08	1.07	1.04–1.11	0.94	0.91–0.96
+ age, sex, smoking, BMI, income*	1.02	1.00–1.04	1.02	1.00–1.05	1.04	1.03–1.05	1.03	1.00–1.05	0.93	0.90–0.96
+ age, sex, smoking, BMI, employment*	1.04	1.01–1.06	1.04	1.02–1.07	1.03	1.02–1.05	1.04	1.01–1.07	0.94	0.91–0.97
+ age, sex, smoking, BMI, education*	1.04	1.02–1.06	1.04	1.02–1.06	1.03	1.01–1.05	1.06	1.03–1.08	0.96	0.93–0.98
10 unit change (income model)	1.07	0.99–1.16	1.13	1.00–1.27	1.20	1.12–1.28	1.02	1.00–1.05	0.86	0.78–0.94

AJRCCM 2013

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TABLE 4. HAZARD RATIOS FOR SPECIFIC CAUSES OF MORTALITY IN 2003–2007 FOR AN INTERQUARTILE RANGE CHANGE IN 2002 POLLUTANT CONCENTRATIONS

	PM_{10} (*n* = 830,842)		$PM_{2.5}$ (*n* = 830,842)		SO_2 (*n* = 823,442)		NO_2 (*n* = 830,429)		O_3 (*n* = 824,654)	
Cause of Death and Baseline Variables Adjusted For	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Circulatory*										
+ age, sex	1.06	1.03–1.09	1.07	1.03–1.10	1.07	1.05–1.09	1.07	1.03–1.10	0.94	0.91–0.97
+ age, sex, smoking, BMI	1.05	1.02–1.08	1.05	1.02–1.09	1.06	1.04–1.08	1.05	1.02–1.09	0.95	0.92–0.97
+ age, sex, smoking, BMI, income†	1.00	0.97–1.03	1.00	0.97–1.03	1.04	1.03–1.06	1.00	0.97–1.03	0.96	0.94–0.99
+ age, sex, smoking, BMI, education†	1.02	0.99–1.04	1.02	1.00–1.05	1.03	1.01–1.05	1.03	1.00–1.07	0.96	0.94–0.98
Respiratory*										
+ age, sex	1.19	1.14–1.24	1.20	1.15–1.25	1.13	1.09–1.17	1.22	1.16–1.27	0.89	0.85–0.94
+ age, sex, smoking, BMI	1.16	1.12–1.21	1.17	1.12–1.22	1.12	1.09–1.15	1.17	1.12–1.23	0.91	0.87–0.95
+ age, sex, smoking, BMI, income†	1.08	1.04–1.12	1.09	1.05–1.13	1.09	1.06–1.12	1.09	1.04–1.14	0.94	0.90–0.97
+ age, sex, smoking, BMI, education†	1.11	1.08–1.15	1.12	1.08–1.16	1.07	1.04–1.10	1.15	1.10–1.20	0.93	0.90–0.96
Lung cancer*										
+ age, sex	1.12	1.05–1.20	1.14	1.07–1.22	1.10	1.05–1.15	1.20	1.12–1.27	0.89	0.84–0.95
+ age, sex, smoking, BMI	1.07	1.02–1.13	1.08	1.03–1.14	1.07	1.03–1.11	1.13	1.07–1.19	0.92	0.88–0.97
+ age, sex, smoking, BMI, income†	1.01	0.96–1.06	1.02	0.97–1.07	1.05	1.01–1.08	1.06	1.00–1.12	0.94	0.90–0.99
+ age, sex, smoking, BMI, education†	1.03	0.98–1.08	1.04	0.99–1.09	1.03	0.99–1.06	1.11	1.05–1.17	0.94	0.90–0.98

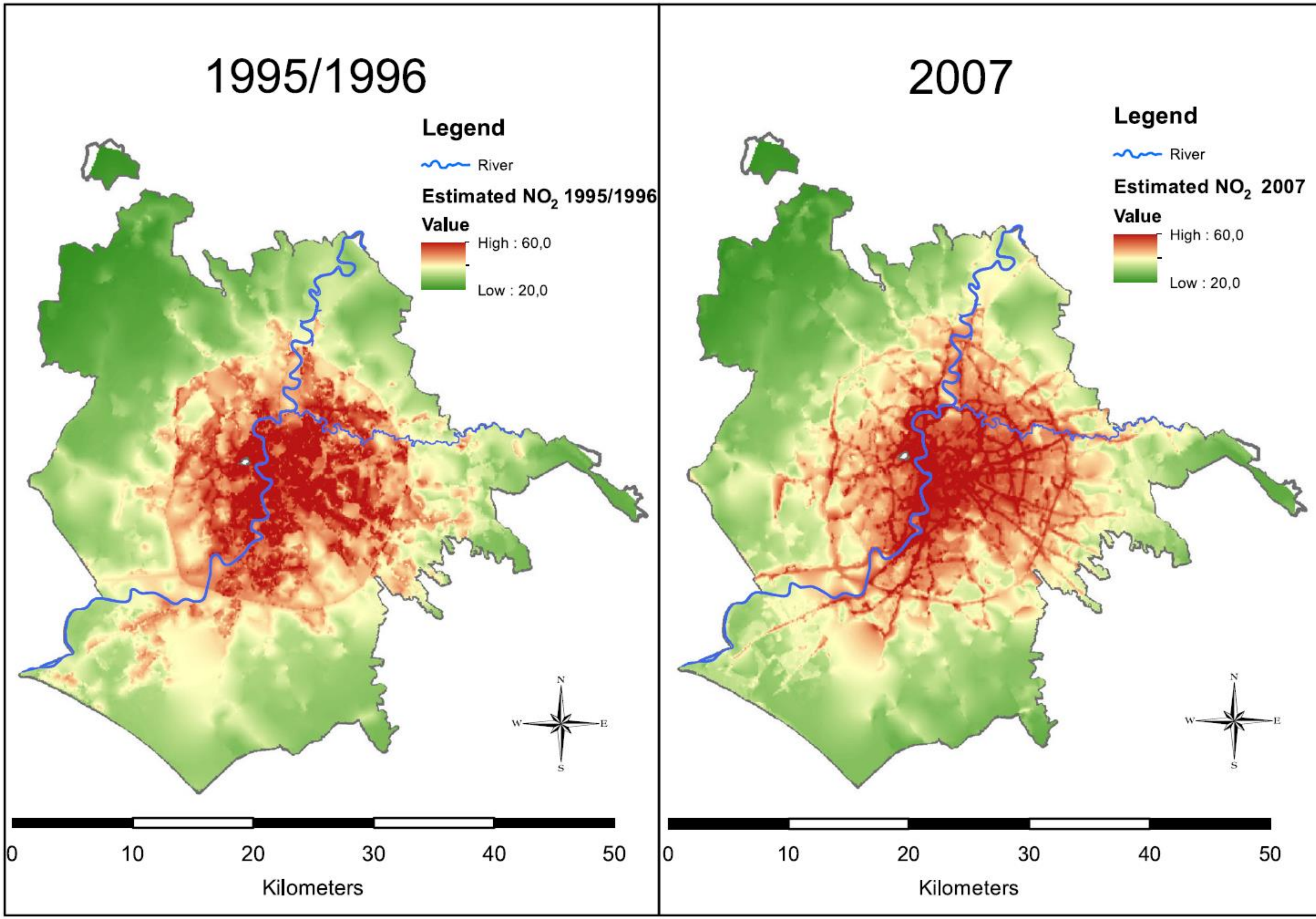

Figure 3 Maps of Rome with predicted NO_2 levels in 1995/96 and in 2007.

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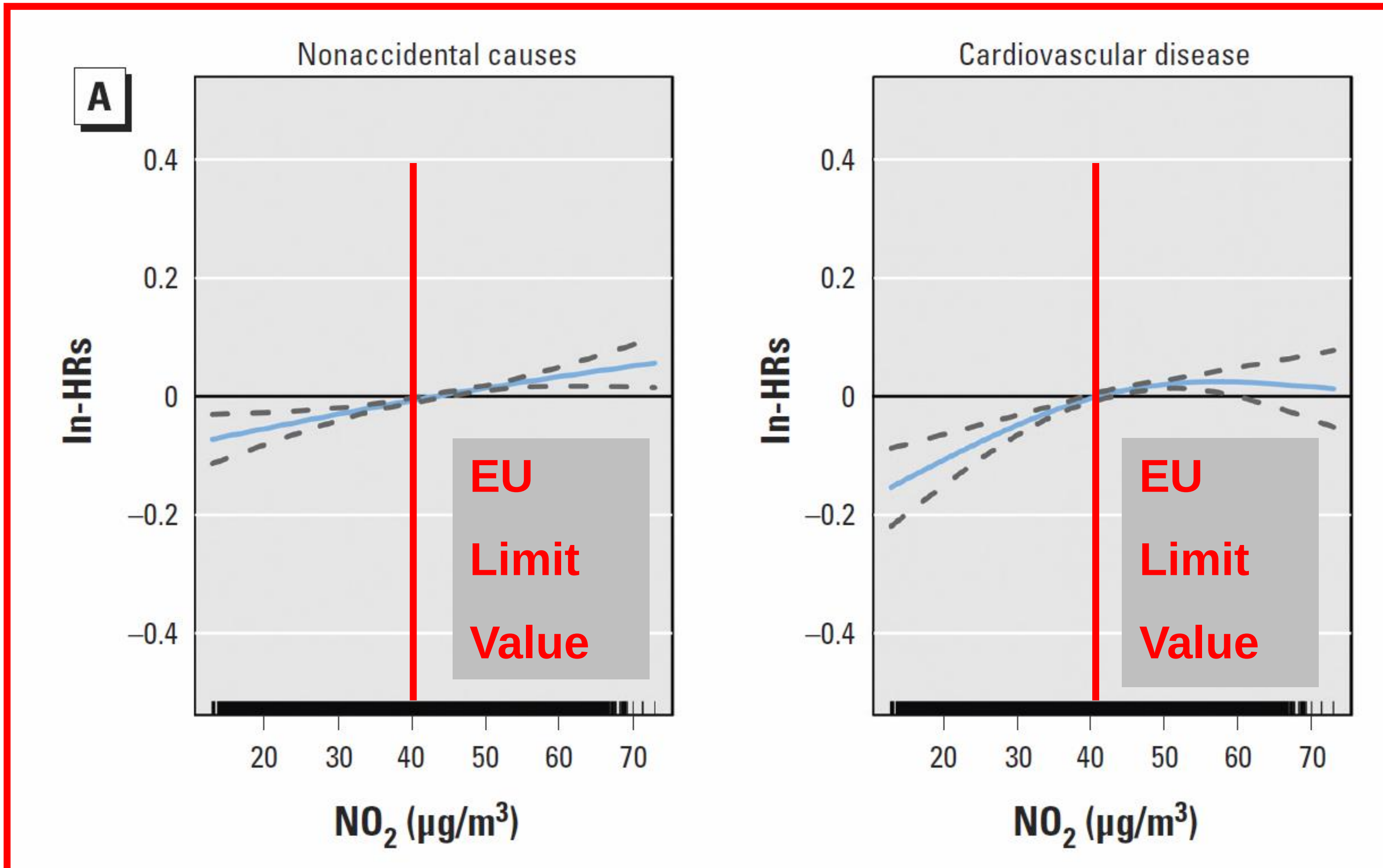
Cesaroni, Environ Health 2012

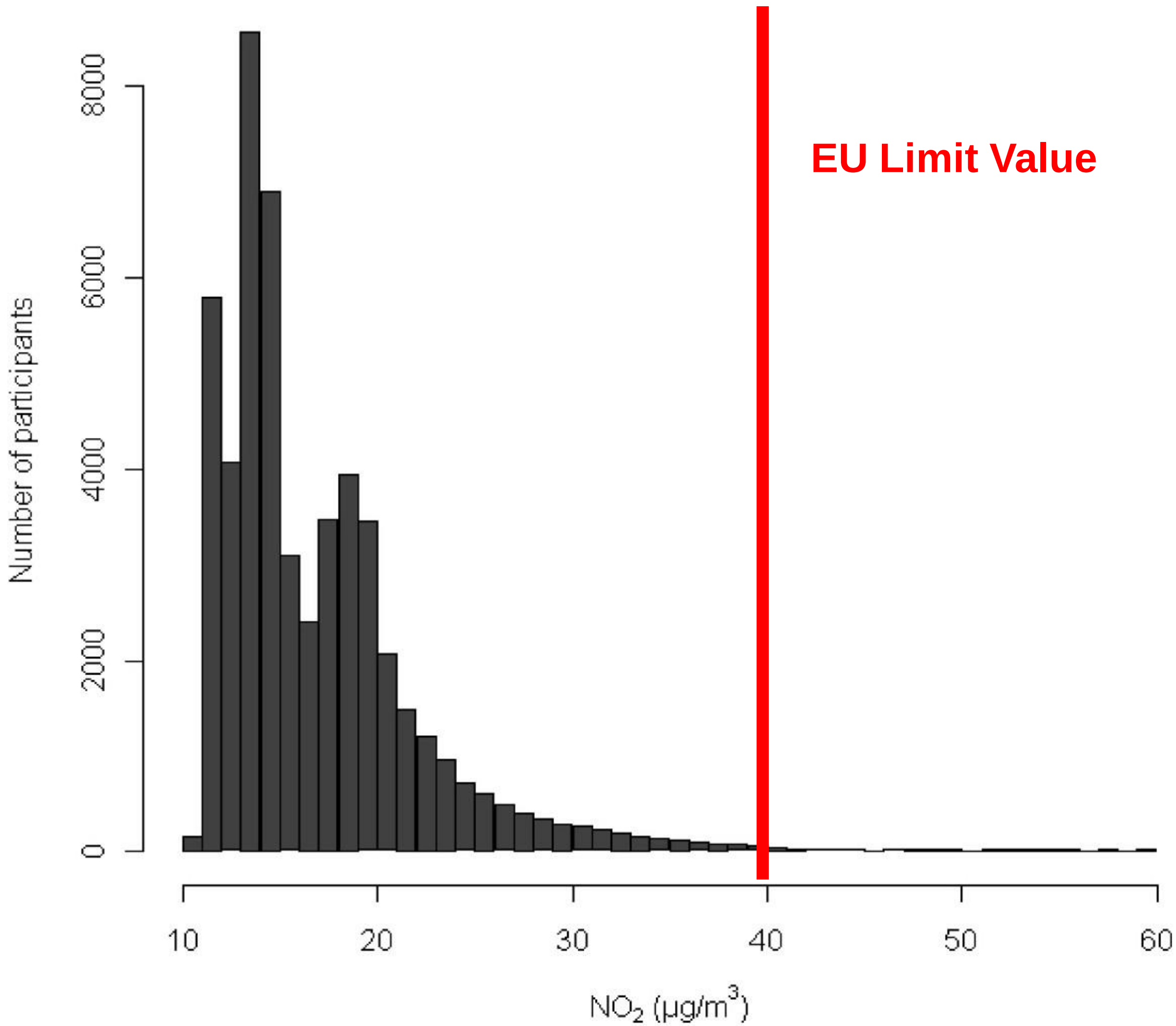
Long-Term Exposure to Urban Air Pollution and Mortality in a Cohort of More than a Million Adults in Rome

Giulia Cesaroni,[1] Chiara Badaloni,[1] Claudio Gariazzo,[2] Massimo Stafoggia,[1] Roberto Sozzi,[3] Marina Davoli,[1] and Francesco Forastiere[1]

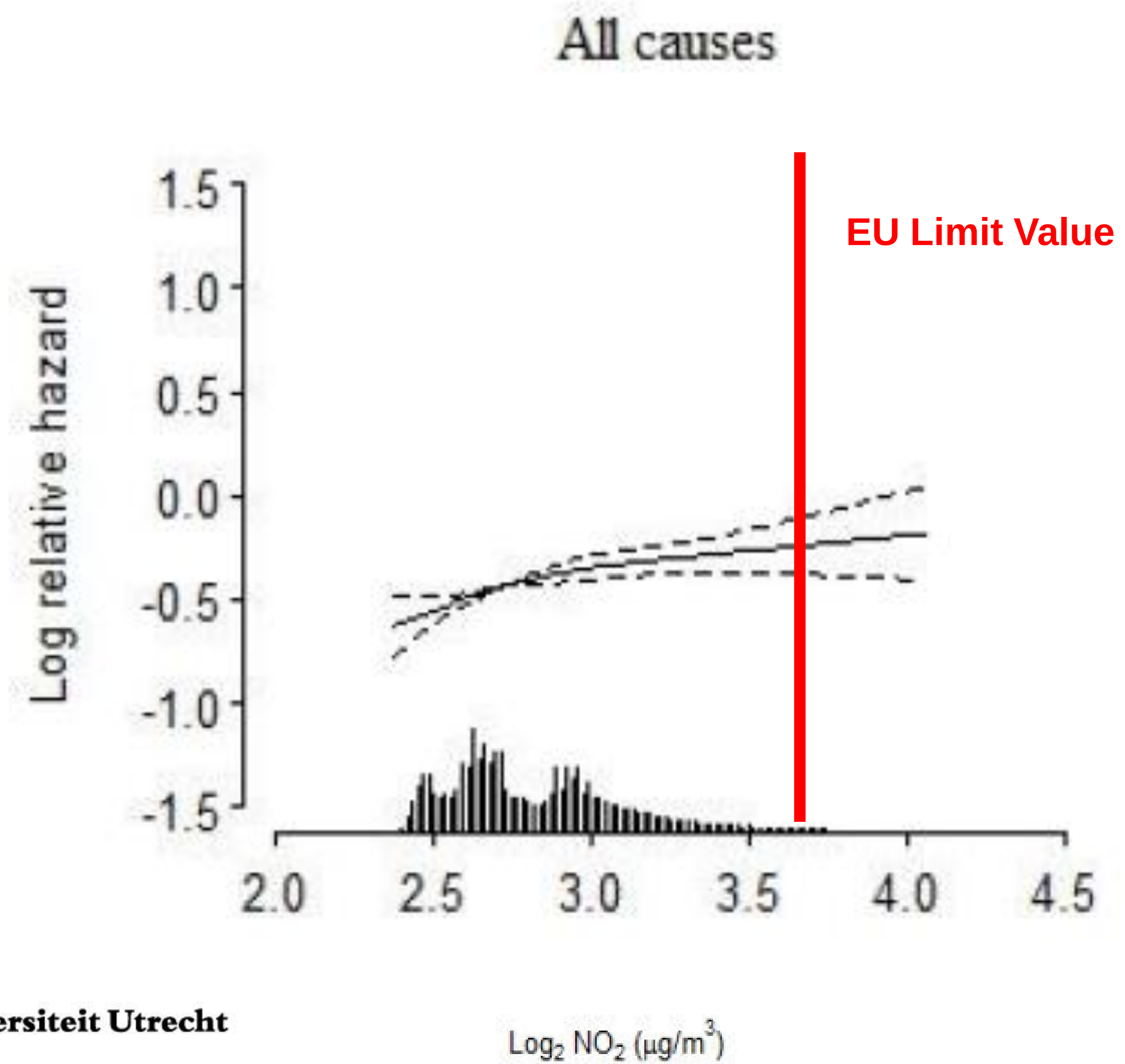


EHP 2013

Traffic air pollution and mortality from cardiovascular disease and all causes: a Danish cohort study



Traffic air pollution and mortality from cardiovascular disease and all causes: a Danish cohort study



ESCAPE

European Study of Cohorts for Air Pollution Effects

2008 - 2012

SEVENTH FRAMEWORK PROGRAMME

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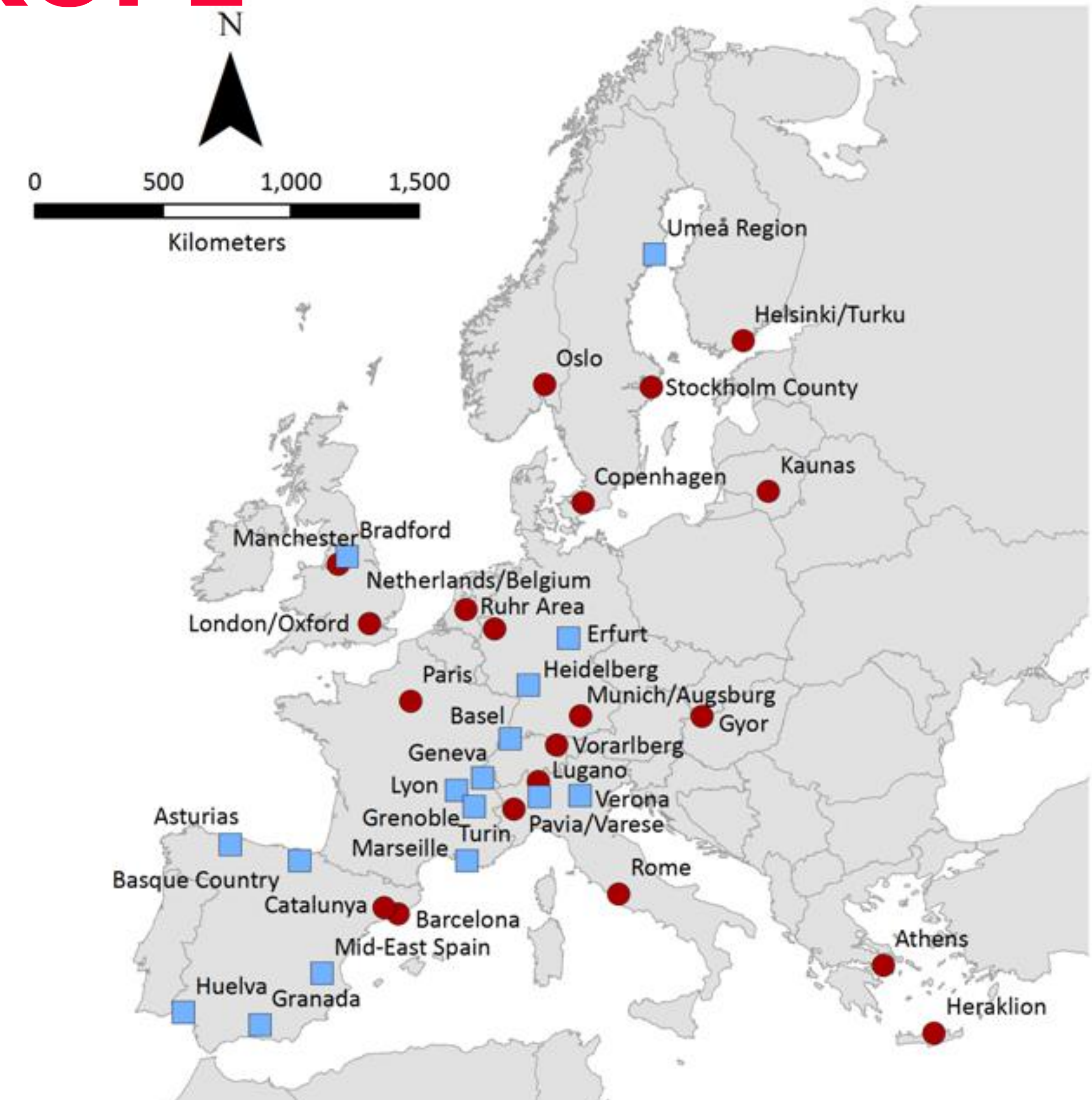
ESCAPE study

- > 30 existing cohorts
- Birth and pregnancy outcomes
- Respiratory morbidity
- Cardiovascular morbidity
- Cancer & mortality
- **PM / NOx monitoring & modeling in 20 / 36 EU areas**

ESCAPE study areas in EUROPE

PM+NOx

NOx only



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Air pollution measurements
~400 PM, ~1,500 NOx locations

Measurement of nitrogen oxides with passive samplers

Measurement of fine particles with pump and sampling head

Exposure modeling

- PM: 20 sites in 20 areas, 3 * 2 weeks hot/cold/intermediate seasons
- NOx: 40 sites in 36 areas, same frequency
- Continuous one background site 1 yr/area
- PM2.5 & PM10
- PM2.5 & PM10 composition, Black Carbon (PM2.5 absorbance)
- LUR modeling with central & local GIS data

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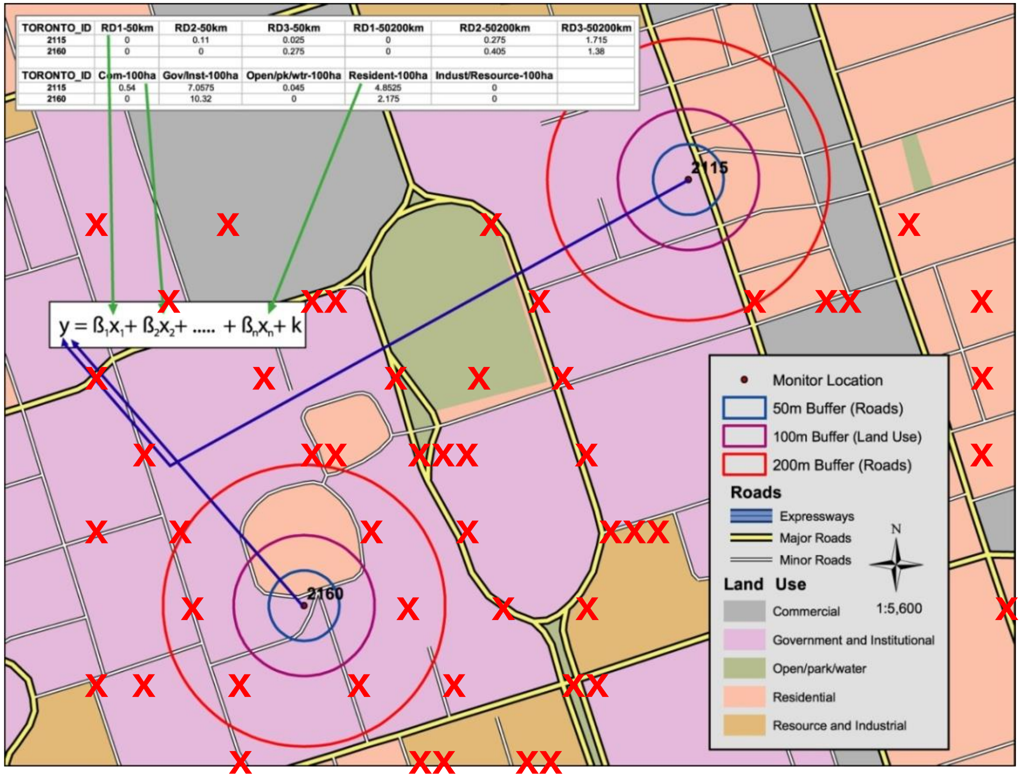
Exposure assessment: Land Use Regression Modeling

- Data on land use from existing geographic databases
- Land use data typically: road networks, traffic density and composition, residential – industrial – commercial – green space etc. land use, elevation
- Spatial distribution of air pollution concentrations explained by regression model



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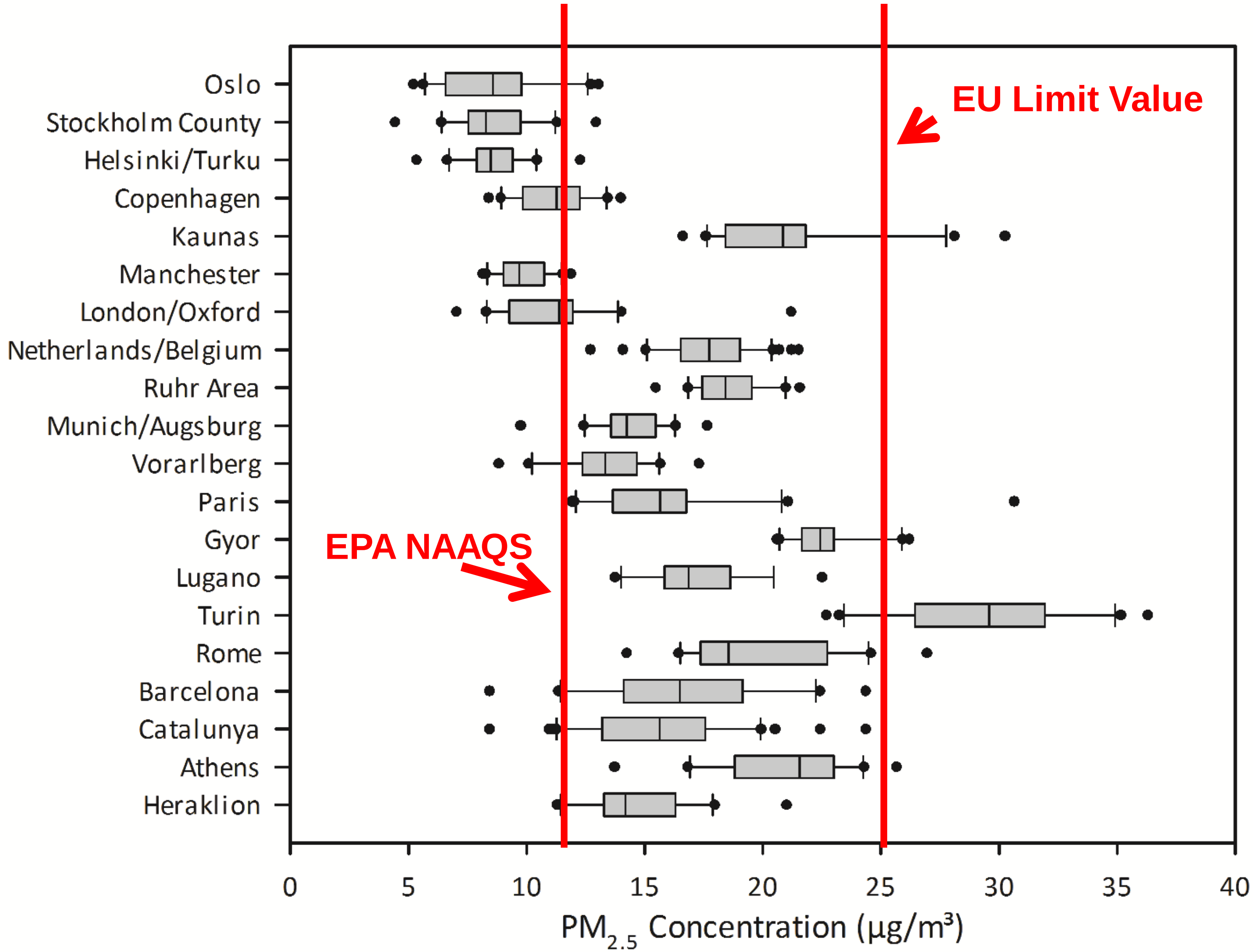
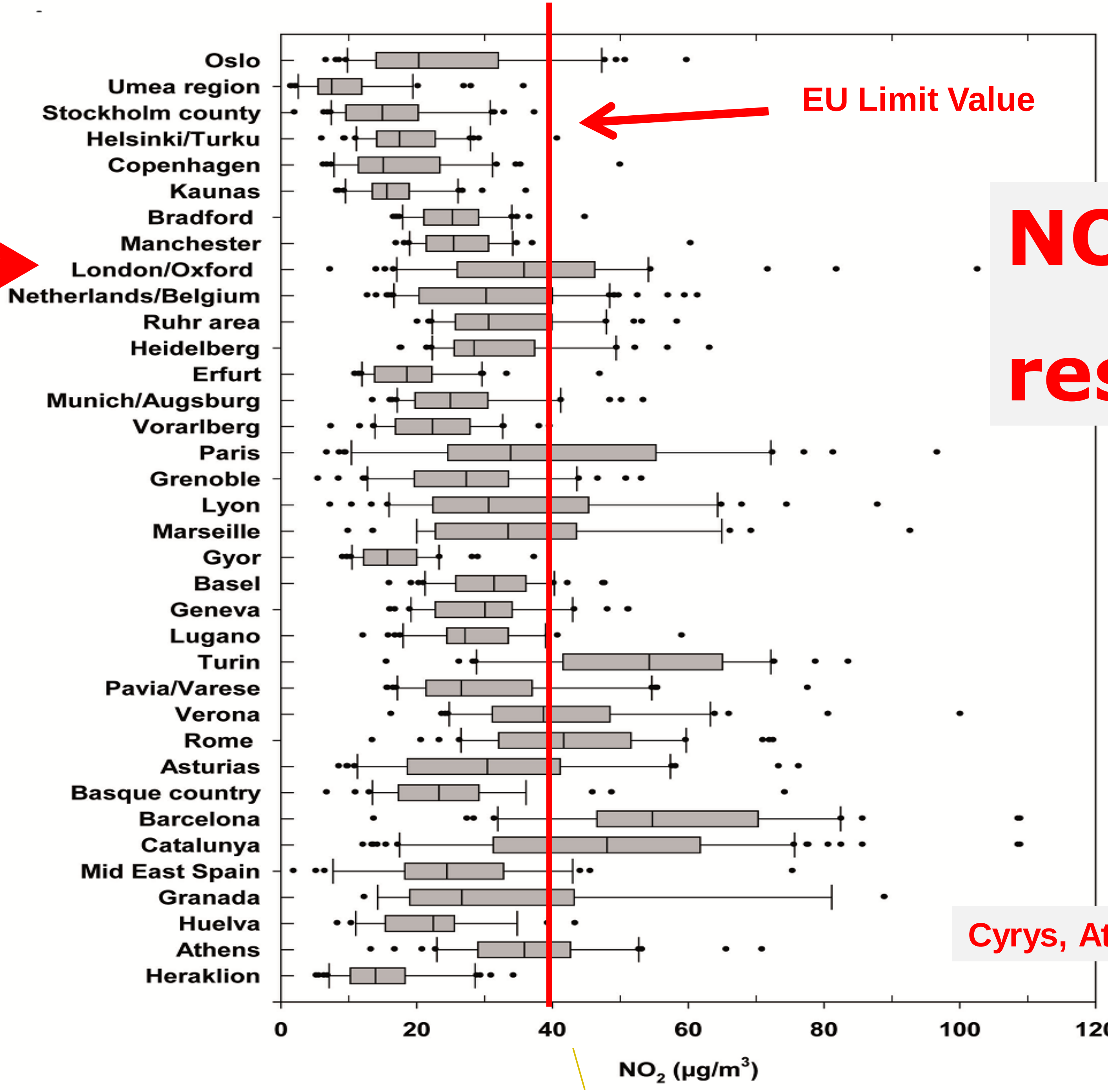
PM2.5 results



Eeftens, Atm Env 2012

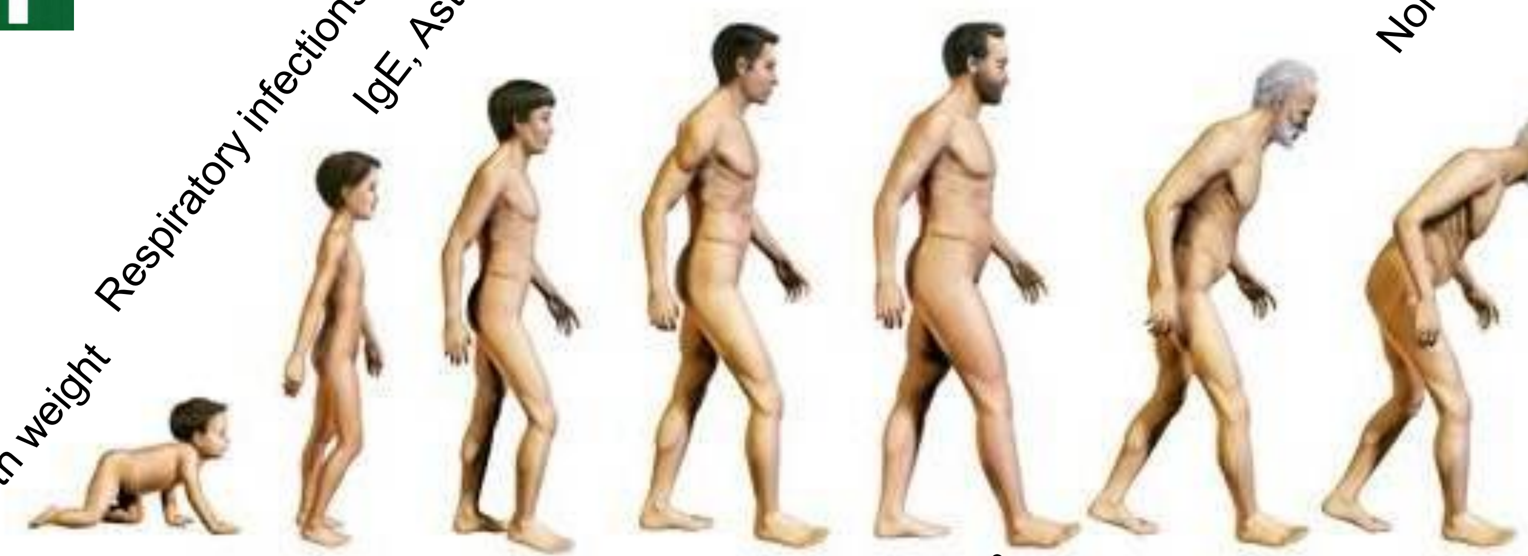
NO_2 results



Cyrys, Atm Env 2012

EFFECTS: 18 hypotheses

- FOR INSTANCE: air pollution is NOT associated with asthma in school children (NULL hypothesis)
- Emphasis on EFFECT ESTIMATION: relative risks with 95% confidence intervals for fixed pollution increments
- Analysis models highly specified IN ADVANCE OF ANALYSES
- For the 18 different hypotheses: 4 – 22 cohorts available
- In total: 170 cohort specific analyses
- About 9 cohorts per hypothesis
- Each cohort contributed to about 5 hypotheses on average


Birth weight
Respiratory infections
IgE, Asthma, Lung Function
Chronic Bronchitis
COPD
Coronary events
Stroke
Non-accidental Mortality
Child development
Asthma
Lung Function
Systemic Inflammation
Blood Pressure, IMT
Lung Cancer Incidence
Cardiovascular,
Respiratory Mortality

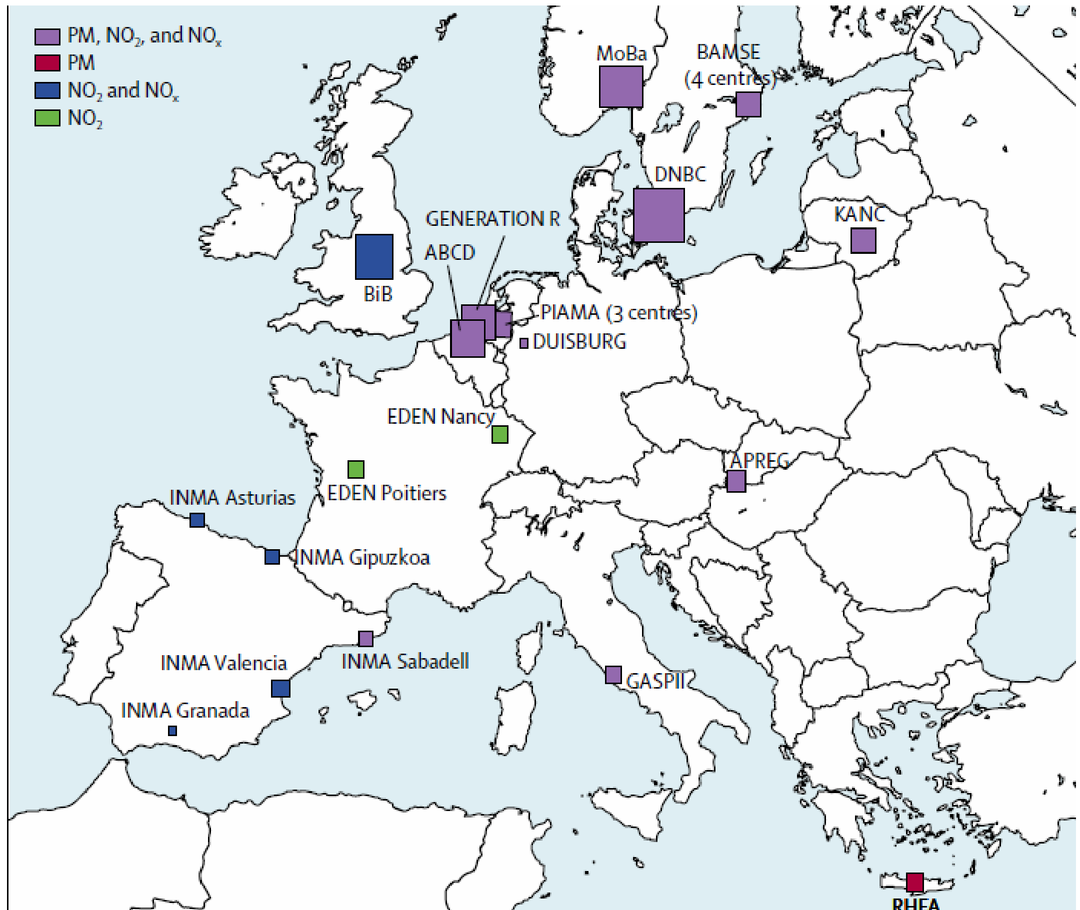
Primary focus of analysis

- Analysis methods & routines developed in advance
- Cohort specific analysis performed locally
- Meta-analysis of cohort-specific effect estimates
- Pooled analysis in birth outcome paper

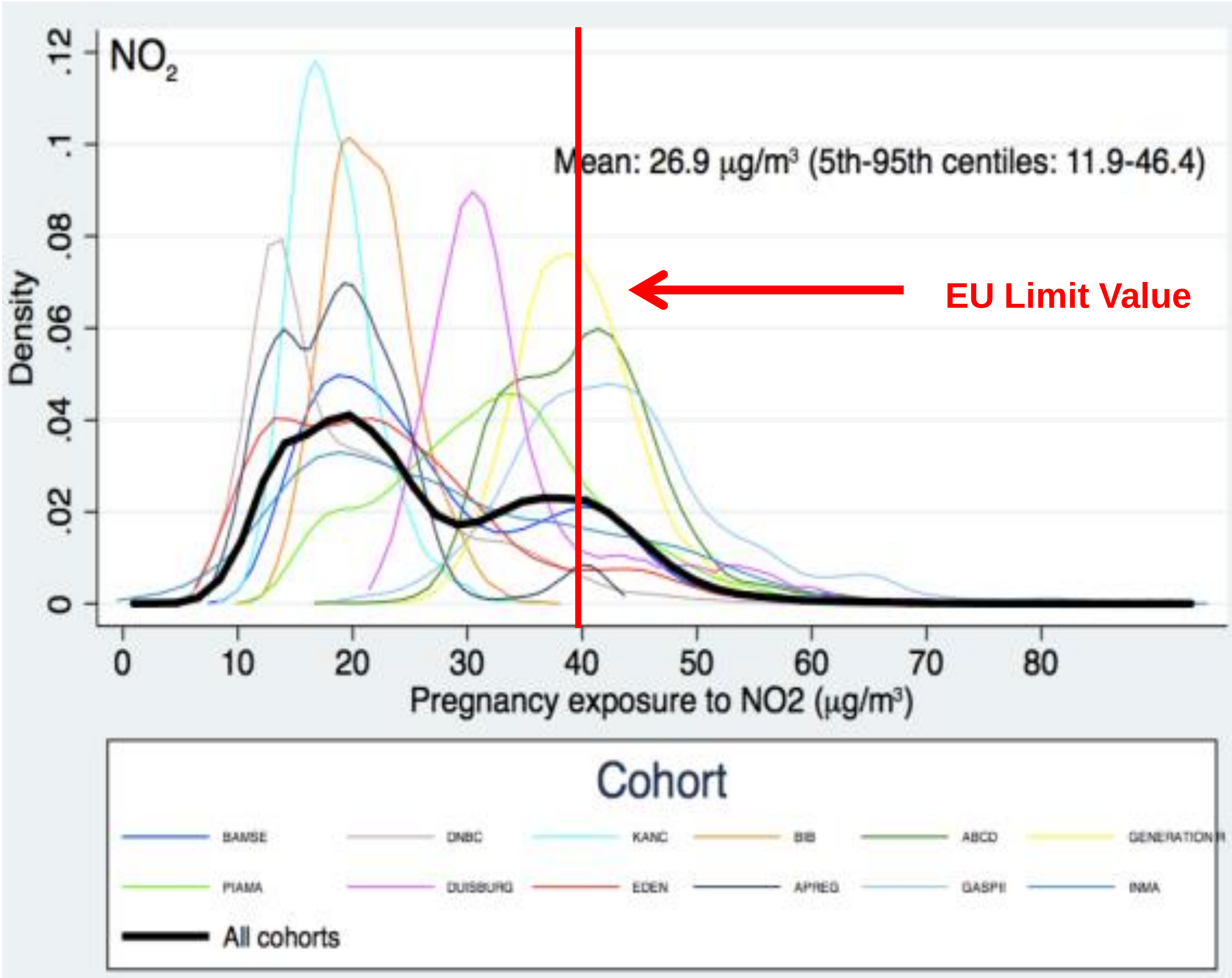
Ambient air pollution and low birthweight: a European cohort study (ESCAPE)

Marie Pedersen, Lise Giorgis-Allemand, Claire Bernard, Inmaculada Aguilera, Anne-Marie Nybo Andersen, Ferran Ballester, Rob M J Beelen, Leda Chatzi, Marta Cirach, Asta Danileviciute, Audrius Dedele, Manon van Eijsden, Marisa Estarlich, Ana Fernández-Somoano, Mariana F Fernández, Francesco Forastiere, Ulrike Gehring, Regina Grazuleviciene, Olena Gruzieva, Barbara Heude, Gerard Hoek, Kees de Hoogh, Edith H van den Hooven, Siri E Håberg, Vincent W V Jaddoe, Claudia Klümper, Michal Korek, Ursula Krämer, Aitana Lerchundi, Johanna Lepeule, Per Nafstad, Wenche Nystad, Evridiki Patelarou, Daniela Porta, Dirkje Postma, Ole Raaschou-Nielsen, Peter Rudnai, Jordi Sunyer, Euripides Stephanou, Mette Sørensen, Elisabeth Thiering, Derek Tuffnell, Mihály J Varró, Tanja G M Vrijkotte, Alet Wijga, Michael Wilhelm, John Wright, Mark J Nieuwenhuijsen, Göran Pershagen, Bert Brunekreef, Manolis Kogevinas*, Rémy Slama*

Lancet Respiratory Medicine 2013;1:695-704

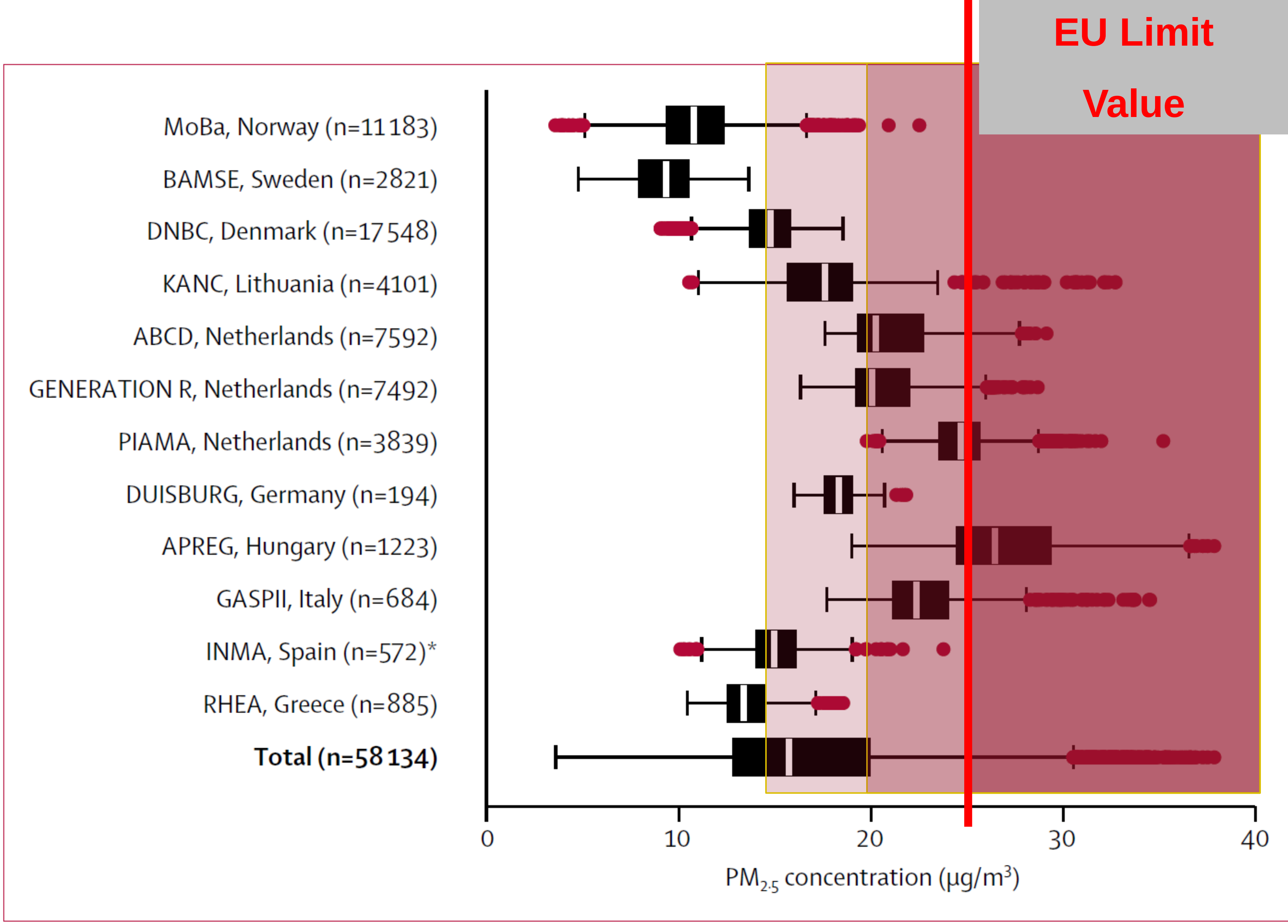


NO_2 exposures in pregnancy outcome cohorts



Effect estimates for Term Low Birth Weight and Birth Head Circumference

	Term low birth weight			Birth head circumference		
Pollutant	**N**	**RR**	**95% CI**	**N**	**ß* (cm)**	**95% CI**
NO_2 (per 10 µg/m^3)	**52,291**	**1.09**	**1.00 - 1.19**	**36,010**	**-0.08**	**-0.10 to -0.07**
NO_X (per 20 µg/m^3)	**51,150**	**1.04**	**0.97 - 1.11**	**34,818**	**-0.06**	**-0.07 to -0.05**
PM10 (per 10 µg/m^3)	**40,947**	**1.16**	**1.00 - 1.35**	**25,022**	**-0.13**	**-0.18 to -0.09**
PM2.5 (per 5 µg/m^3)	**40,947**	**1.18**	**1.06 - 1.33**	**25,022**	**-0.08**	**-0.12 to -0.03**
PM-C (per 5 µg/m^3)	**40,914**	**1.01**	**0.88 - 1.15**	**24,988**	**-0.09**	**-0.12 to -0.05**
PM2.5 absorbance (per 1 10^{-5}/m)	**41,727**	**1.17**	**0.95 - 1.39**	**25,724**	**-0.18**	**-0.22 to -0.13**



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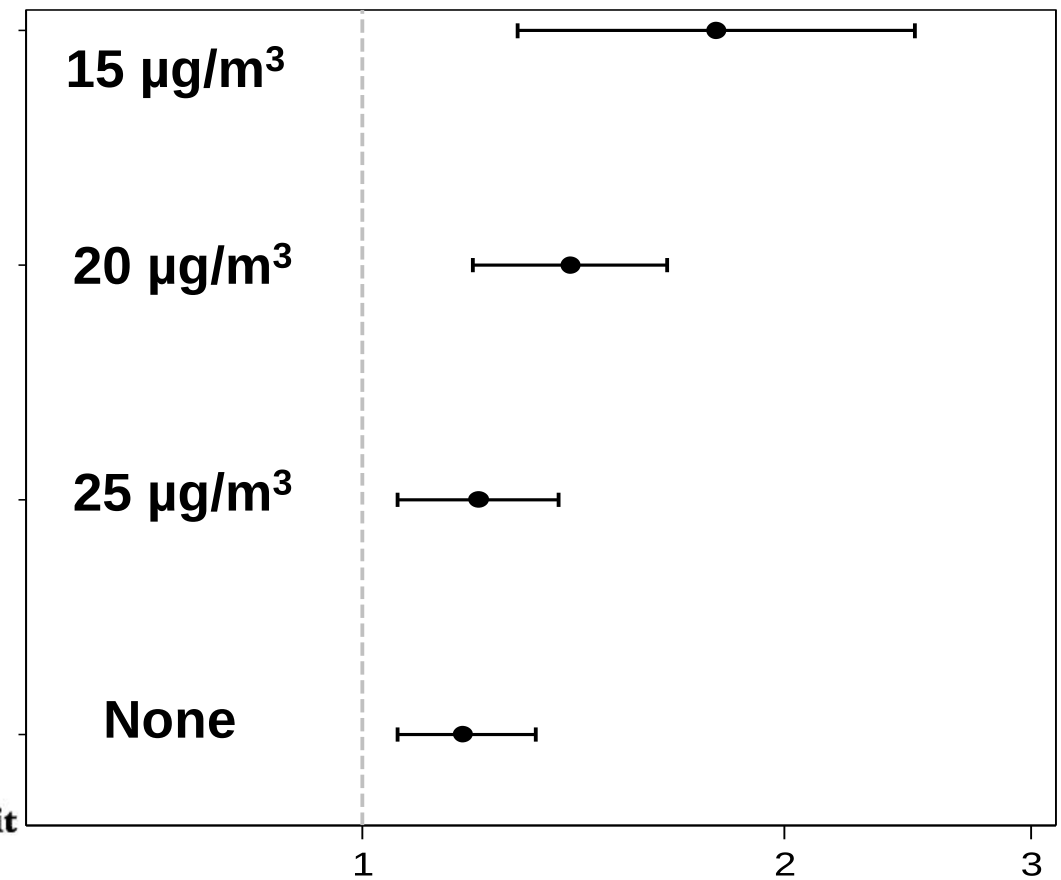
Associations between $PM_{2.5}$ exposure during pregnancy and term low birth weight in analyses restricted to levels below certain values



OR for

PM2.5 per

5 µg/m^3

Universiteit

BMJ 2014;348:f7412

BMJ 2013;348:f7412 doi: 10.1136/bmj.f7412

RESEARCH

Long term exposure to ambient air pollution and incidence of acute coronary events: prospective cohort study and meta-analysis in 11 European cohorts from the ESCAPE Project

Giulia Cesaroni *senior researcher*[1], Francesco Forastiere *research director*[1], Massimo Stafoggia *senior researcher*[1], Zorana J Andersen *associate professor in epidemiology*[2 3], Chiara Badaloni *research fellow*[1], Rob Beelen *senior researcher*[4], Barbara Caracciolo *researcher*[5 6], Ulf de Faire *senior professor of cardiovascular epidemiology*[7], Raimund Erbel *professor*[8], Kirsten T Eriksen *researcher*[2], Laura Fratiglioni *professor in geriatric epidemiology*[5 9 10], Claudia Galassi *medical epidemiologist*[11], Regina Hampel *research fellow*[12], Margit Heier *research fellow*[12 13], Frauke Hennig *research fellow*[14], Agneta Hilding *researcher*[15], Barbara Hoffmann *professor*[14 16], Danny Houthuijs *senior researcher*[17], Karl-Heinz Jöckel *professor*[18], Michal Korek *doctoral student*[7], Timo Lanki *chief researcher*[19], Karin Leander *researcher*[7], Patrik K E Magnusson *professor*[20], Enrica Migliore *epidemiologist*[11], Caes-Göran Ostenson *professor*[15], Kim Overvad *professor*[21 22], Nancy L Pedersen *professor of genetic epidemiology*[20], Juha Pekkanen J *professor*[19], Johanna Penell *researcher*[7], Göran Pershagen *professor*[7], Andrei Pyko *research fellow*[7], Ole Raaschou-Nielsen *head of research group*[2], Andrea Ranzi *project manager in environmental epidemiology*[23], Fulvio Ricceri *research fellow*[24], Carlotta Sacerdote *medical epidemiologist*[11], Veikko Salomaa *research professor*[25], Wim Swart *researcher*[17], Anu W Turunen *researcher*[19], Paolo Vineis *professor in epidemiology*[24 26], Gudrun Weinmayr *research associate*[14 27], Kathrin Wolf *research fellow*[12], Kees de Hoogh *senior research officer*[26], Gerard Hoek *associate professor*[4], Bert Brunekreef *professor*[4 28], Annette Peters *professor*[12]

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ESCAPE effects on Coronary Events

Pollutant	Relative Risk (95% C.I.)
PM10 (per 10 µg/m3)	1.12 (1.01-1.25)
PM2.5 (per 5 µg/m3)	1.13 (0.98-1.30)
PM absorbance (per m^{-1})	1.10 (0.98-1.24)
NO2 (per 10 µg/m3)	1.03 (0.97-1.08)

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Cesaroni, BMJ 2014;348:f7412

ESCAPE effects on Coronary Events

Pollutant	Relative Risk (95% C.I.)
PM10 full range (per 10 µg/m3)	1.12 (1.01-1.25)
PM10 below 40 µg/m3	1.15 (1.02-1.30)
PM10 below 30 µg/m3	1.12 (0.98-1.27)
PM10 below **20 µg/m3**	**1.20 (1.01-1.41)**
PM2.5 full range (per 5 µg/m3)	1.13 (0.98-1.30)
PM2.5 below 25 µg/m3	1.23 (1.04-1.46)
PM2.5 below 20 µg/m3	1.23 (1.04-1.46)
PM2.5 below **15 µg/m3**	**1.19 (1.00-1.42)**

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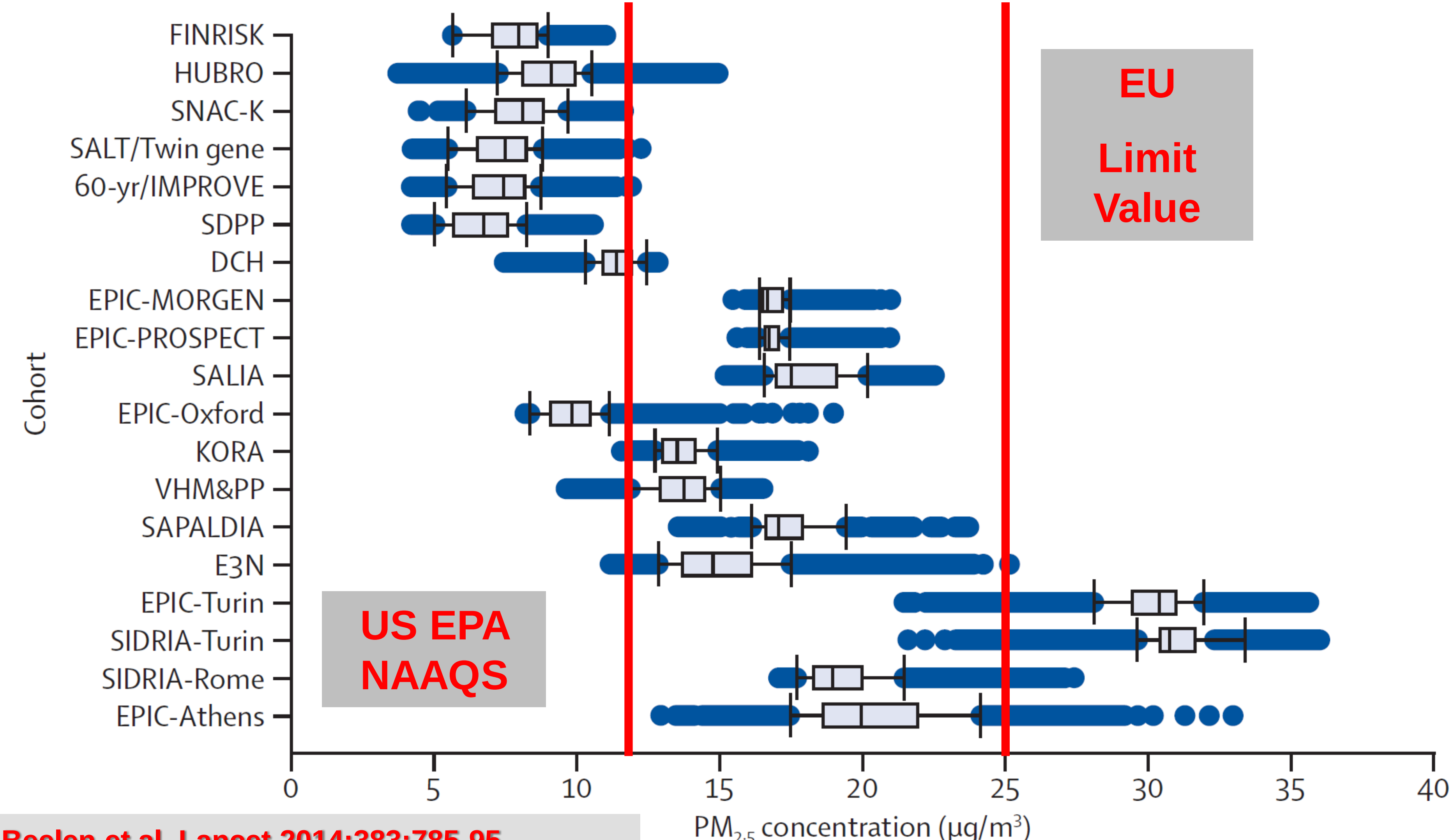
Cesaroni, BMJ 2014;348:f7412

Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project



Beelen et al, Lancet 2014;383:785-95

Relative Risk of natural cause mortality associated with exposure to air pollution and traffic indicators, based on 19 cohorts in Europe

Exposure	Relative Risk (95% c.i.)
NO_2 (10 µg/m^3)	1.01 (0.99-1.03)
NO_x (20 µg/m^3)	1.02 (1.00-1.04)
PM2.5 (5 µg/m^3)	1.07 (1.02-1.13)
PM2.5 abs (1 10^{-5} m^{-1})	1.02 (0.97-1.07)
PM10 (10 µg/m^3)	1.04 (1.00-1.09)
PM coarse (5 µg/m^3)	1.04 (0.98-1.10)
Traffic nearest street (5000 veh.day^{-1})	1.01 (1.00-1.03)

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Beelen, Lancet 2014

Relative Risk of natural cause mortality associated with exposure to PM2.5 (per 5 $\mu g/m^3$) below various threshold values

Threshold	N of cohorts	PM2.5
10 $\mu g/m^3$	9	1.018 (0.873-1.187)
15 $\mu g/m^3$	11	1.042 (0.976-1.113)
20 $\mu g/m^3$	17	1.070 (1.012-1.131)
25 $\mu g/m^3$	17	1.060 (1.004-1.118)

Beelen, Lancet 2014

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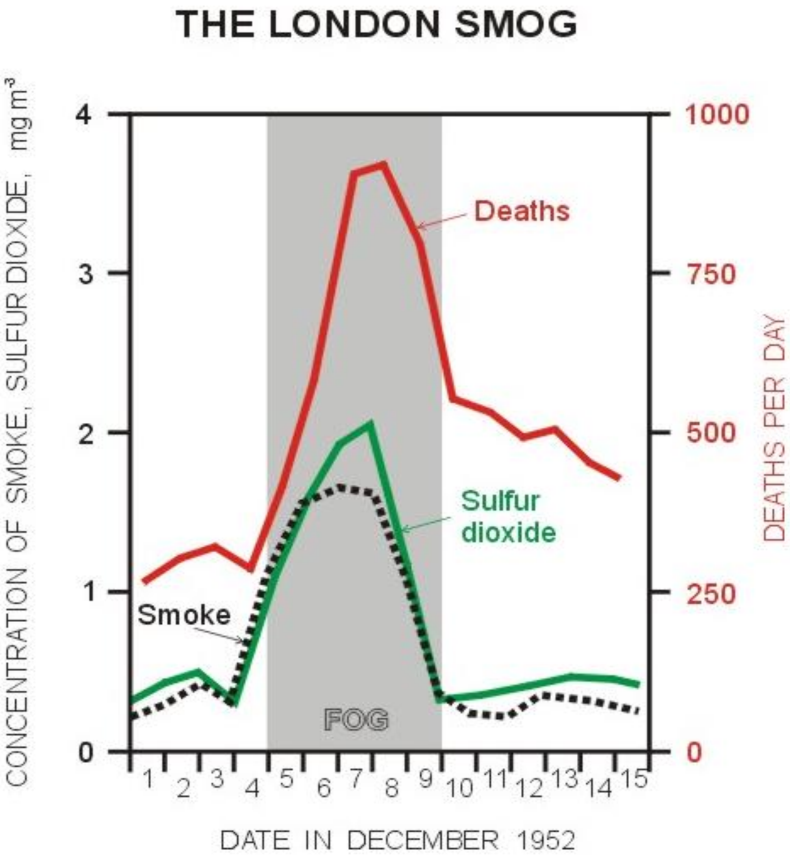
the
past
the

Smoke in the Lancet

- 1881: ‘acidity destroys public buildings and statues’
- **1890: ‘sewer air is cleaned by fog-air with a fairly potent purifier’**
- 1891-1893: three reports on ‘perfect combustion and smoke prevention’
- 1901: ‘audiences could not see the actors’
- 1903: ‘need smoke be “black” to constitute and offence?’
- **1925: ‘it may require the death from fog of three cabinet ministers before any action is taken’**

London 1952 Smog Episode



An Anti-Smog Bottle (1)

‘If sulphuric acid was a major toxic agent in smog, the smog could be rendered harmless by adding to it sufficient ammonia to neutralize the acid’

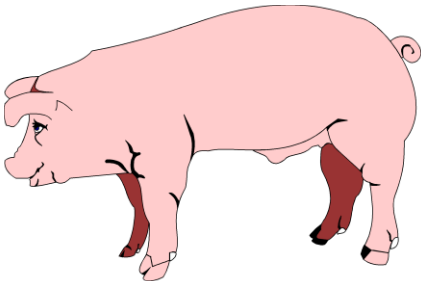
‘It is tempting (...) to apply these results to the Smithfield Show, in which scrupulously clean cattle suffered and perished whereas pigs and sheep in less hygienic surroundings were unaffected’

BMJ 1955; ii: 1135

An Anti-Smog Bottle (2)

‘E.T. Wilkins (...) has devised *an elegant alternative to an indwelling pig*. By means of an adjustable wick in a bottle of ammonia the air in a room may be kept neutral or alkaline’

‘(...) patients with chronic bronchitis and members of the staff are now trying the bottles at home’



BMJ 1955; ii: 1135

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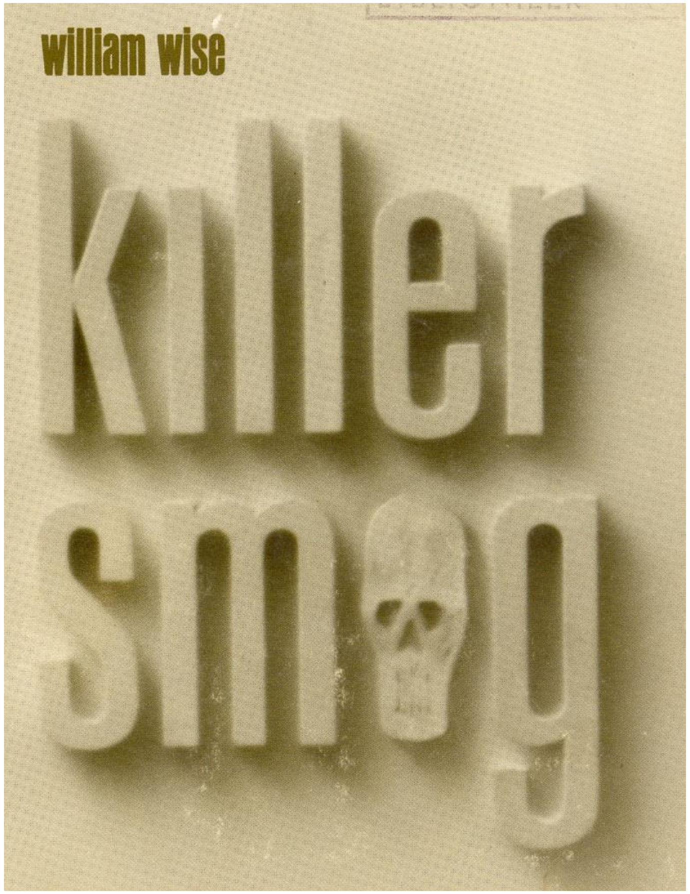

Rand McNally 1968

“No subsequent report would ever touch on the point, but many London policemen knew, from their own experience, that when the smog came down, anyone poor, sickly and alone was extremely vulnerable”

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Thank you for your attention!!

Monet, Houses of Parliament, London, 1905