

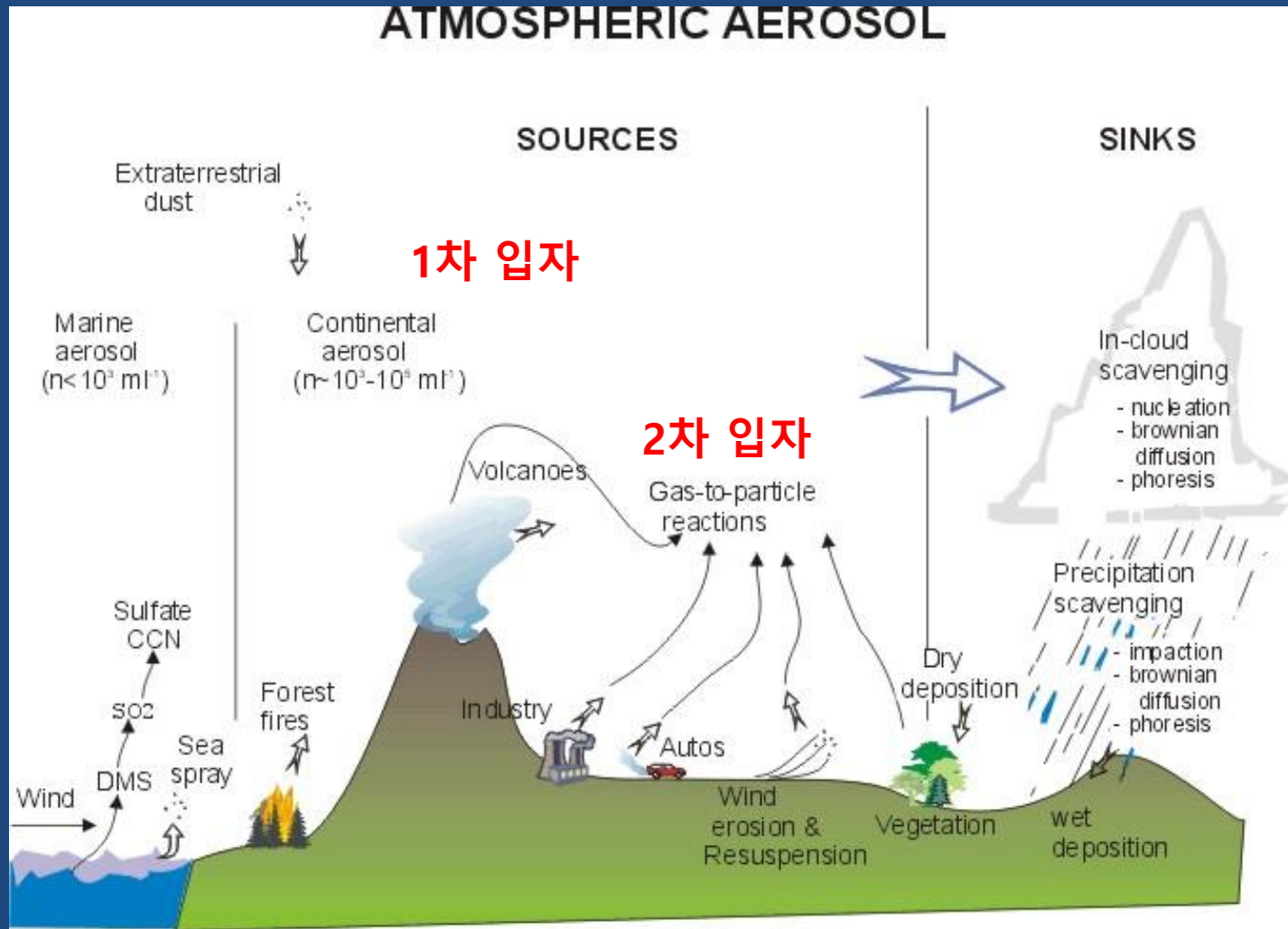
미세먼지와 호흡기관리

강원의대 내과

김우진

- 미세먼지의 생성
- 미세먼지의 호흡기 영향
 - 단기영향
 - 장기영향
 - 기전
- 호흡기 관리
 - Public health
 - In the clinic

미세먼지의 생성



정의와 구성

□ Definition according to the particle size:

- ❖ **PM:** Particulate matter, measuring unit: $\mu\text{g}/\text{m}^3$
- ❖ **PM₁₀:** Particles with an aerodynamic diameter $\leq 10 \mu\text{m}$
- ❖ **PM_{2.5}:** Particles with an aerodynamic diameter $\leq 2.5 \mu\text{m}$
- ❖ **UFP (ultrafine particles):** Particles with an aerodynamic $\leq 0.1 \mu\text{m}$, measuring unit: count/cm^3
- ❖ **Nanoparticles:** diameter $\leq 0.05 \mu\text{m}$

□ Definition according to chemical composition:

- ❖ **OC, EC:** organic and elemental carbon particles
- ❖ **Ionic compounds:** SO_4^{2-} , NO_3^- , NH_4^+
- ❖ **Trace elements:** Al, Si, Ca, Pb, Zn.....

대기 오염의 건강영향

Respiratory disease mortality

Respiratory disease morbidity

Lung cancer

Pneumonia

Upper and lower respiratory symptoms
Airway inflammation
Decreased lung function
Decreased lung growth

Insulin resistance

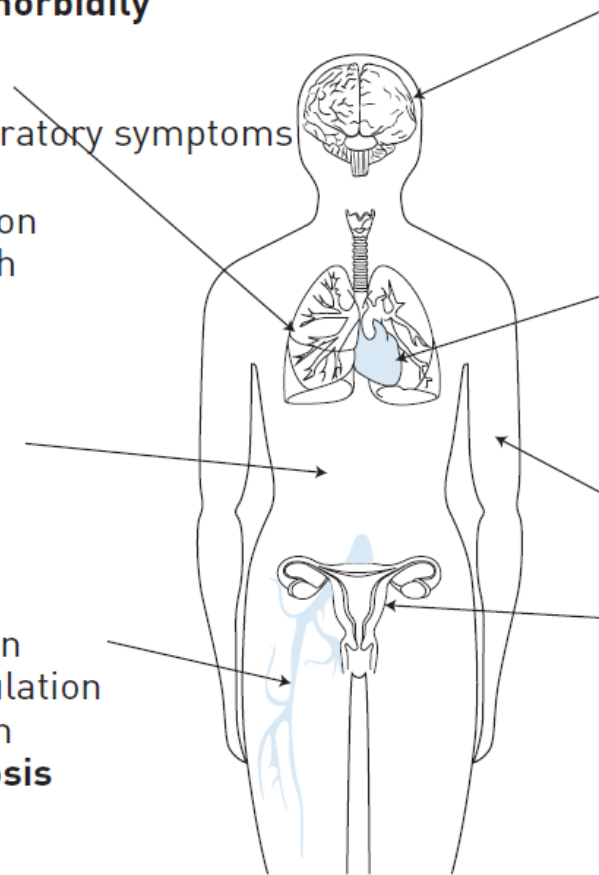
Type 2 diabetes

Type 1 diabetes

Bone metabolism

High blood pressure

Endothelial dysfunction
Increased blood coagulation
Systemic inflammation
Deep venous thrombosis



Stroke

Neurological development
Mental health

Neurodegenerative diseases

Cardiovascular disease mortality

Cardiovascular disease morbidity

Myocardial infarction

Arrhythmia

Congestive heart failure

Changes in heart rate variability
ST-segment depression

Skin ageing

Premature birth

Decreased birthweight

Decreased fetal growth
Intrauterine growth retardation
Decreased sperm quality
Pre-eclampsia

Short-term effect of air pollution on respiratory system

- Respiratory-related death
- Respiratory infections
- Exacerbations of chronic respiratory disease
 - COPD
 - Asthma

Short-term Exposure to Ambient Fine Particulate Matter Increases Hospitalizations and Mortality in COPD

A Systematic Review and Meta-analysis

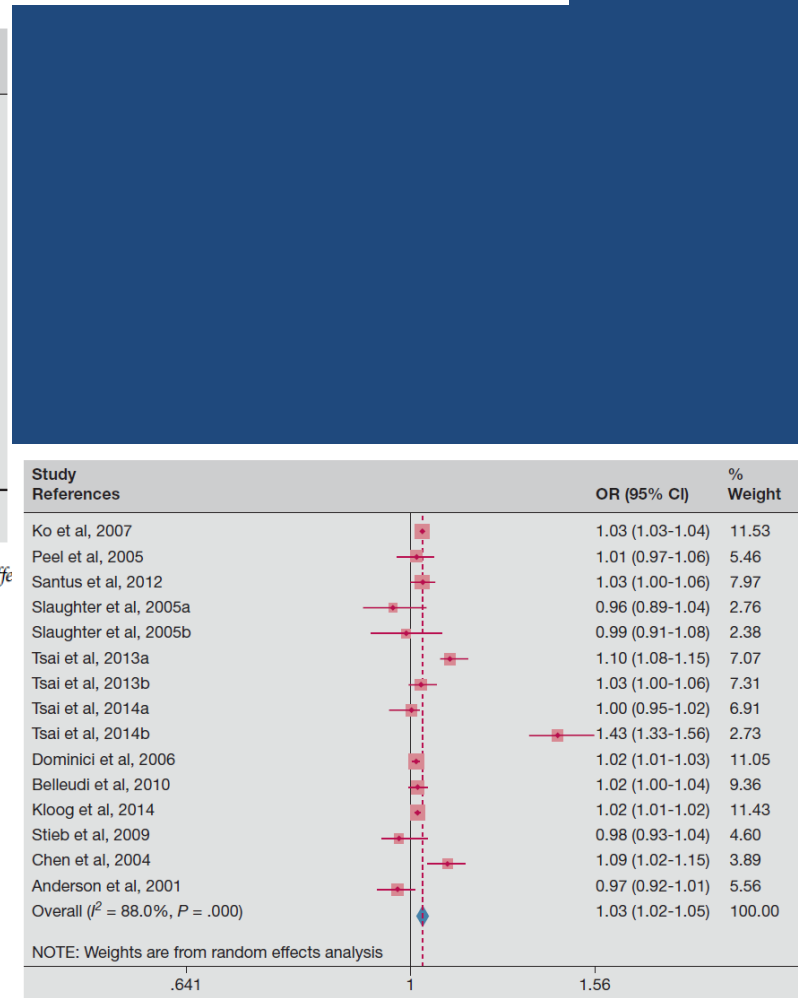
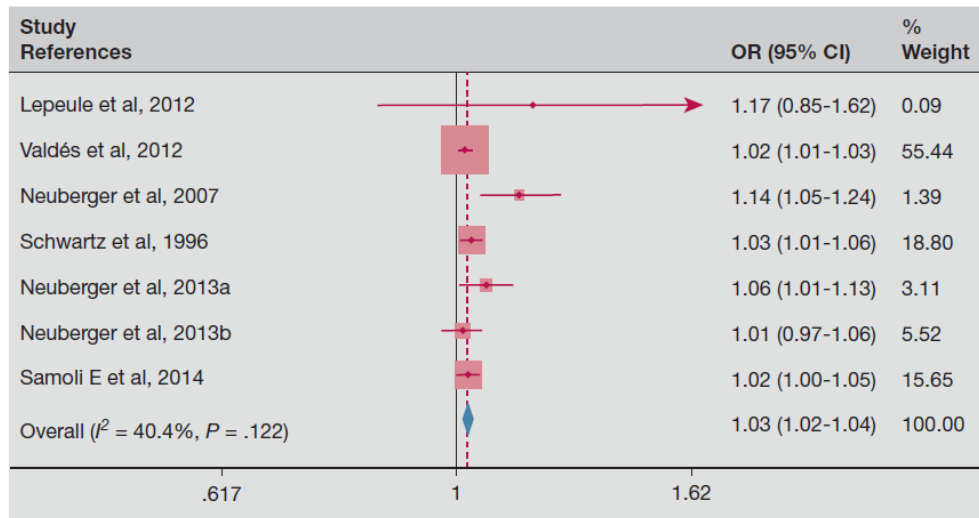


Figure 2 – Forest plot of COPD hospitalizations and particulate matter with aerodynamic diameters $\leq 2.5 \mu m (PM_{2.5})$ in the meta-analysis. Random effects models were used to calculate the pooled effect size for OR ($\chi^2 = 116.39$, degrees of freedom = 13, $I^2 = 88.0\%$, $P < .001$; and $Z = 4.04$, $P < .001$). The random pooled effect size (OR) for COPD hospitalizations caused by short-term exposure to a $10\text{-}\mu\text{g}/\text{m}^3$ increment of $PM_{2.5}$ was 1.031 (95% CI, 1.016-1.046).

Effects of particulate matter on respiratory disease and the impact of meteorological factors in Busan, Korea

Eun-Jung Jo ^{a,b}, Woo-Seop Lee ^c, Hyun-Young Jo ^{c,d}, Chang-Hoon Kim ^e, Jung-Seop Eom ^{a,b}, Jeong-Ha Mok ^{a,b}, Mi-Hyun Kim ^{a,b}, Kwangha Lee ^{a,b}, Ki-Uk Kim ^{a,b}, Min-Ki Lee ^{a,b}, Hye-Kyung Park ^{a,b,*}

Table 4

Adjusted IRR of PM_{2.5} and weather factors for hospitalization.

Respiratory disease	IRR	
	PM _{2.5}	Relative humidity
Total respiratory diseases	1.008 (1.007–1.009)*	0.991 (0.990–0.991)*
Acute bronchitis	1.025 (1.023–1.027)*	0.978 (0.977–0.980)*
Allergic rhinitis	1.014 (1.012–1.017)*	0.982 (0.980–0.984)*
Asthma	1.010 (1.007–1.013)*	0.992 (0.990–0.994)*

The analysis included PM_{2.5}, temperature anomaly, relative humidity, and age group.

**P* < 0.05.

Table 6

Adjusted IRR of age group for hospitalization.

Respiratory disease	IRR		
	0–15 years	16–64 years (ref)	≥65 years
Total respiratory diseases	1.636 (1.606–1.667)*	1.000	3.118 (3.067–3.170)*
Acute bronchitis	2.547 (2.420–2.681)*	1.000	1.884 (1.767–2.009)*
Allergic rhinitis	2.346 (2.214–2.485)*	1.000	1.253 (1.153–1.362)*
Asthma	7.685 (7.178–8.229)*	1.000	6.245 (5.782–6.746)*

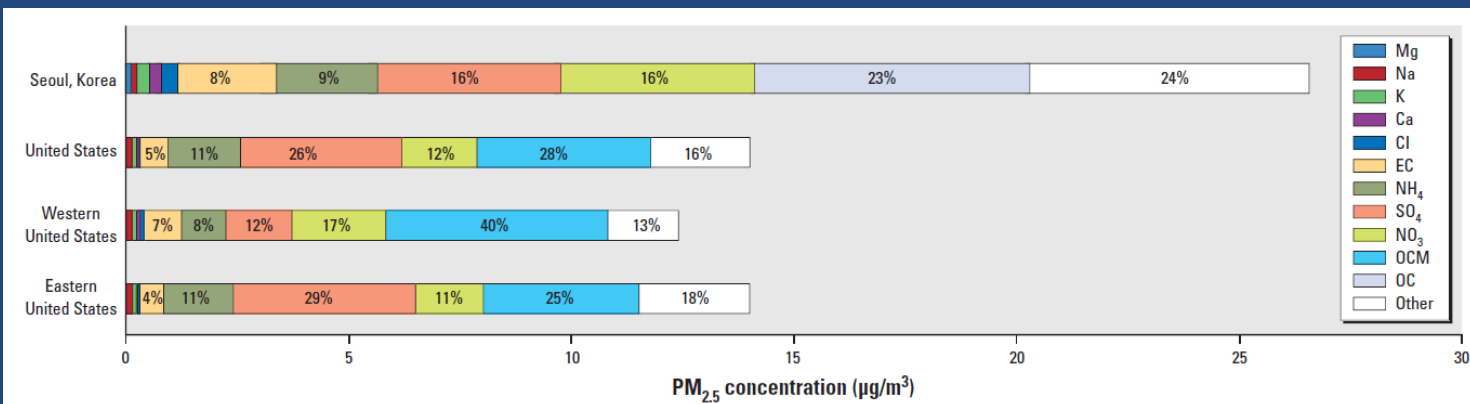
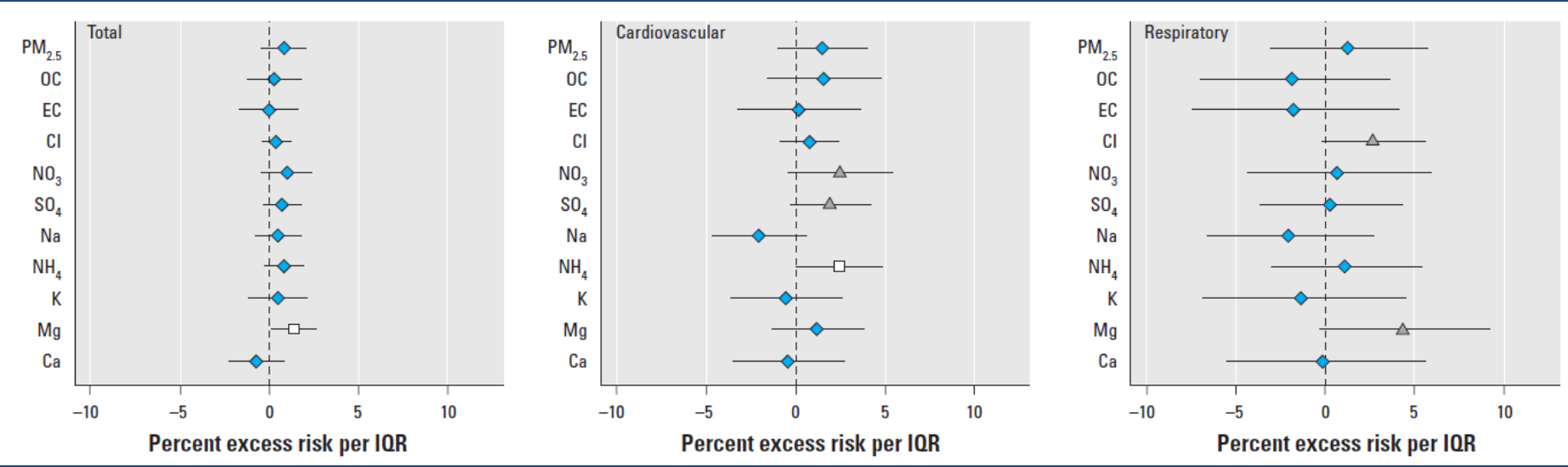
This analysis included PM_{2.5}, temperature anomaly, relative humidity, and age group.

**P* < 0.05.

Characterization of Fine Particulate Matter and Associations between Particulate Chemical Constituents and Mortality in Seoul, Korea

Ji-Young Son,¹ Jong-Tae Lee,² Ki-Hyun Kim,³ Kweon Jung,⁴ and Michelle L. Bell¹

¹School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut, USA; ²Department of Environmental Health, College of Health Science, Korea University, Seoul, Korea; ³Department of Environment and Energy, Sejong University, Seoul, Korea; ⁴Seoul Metropolitan Institute of Public Health and Environment, Seoul, Korea



Epidemiological study of PM_{2.5} and risk of COPD-related hospital visits in association with particle constituents in Chuncheon, Korea

Percentage increase in hospital visits and 95% CI as PM_{2.5} increases 10 µg/m³

	Lag1		Lag2		Lag3		Lag4		Lag5	
	% increase	95% CI	% increase	95% CI	% increase	95% CI	% increase	95% CI	% increase	95% CI
Total	0.11	-0.07, 0.30	0.26*	0.06, 0.46	0.26*	0.04, 0.44	0.25*	0.05, 0.44	0.10	-0.08, 0.28
Male	0.02	-0.20, 0.23	0.15	-0.07, 0.38	0.32*	0.10, 0.53	0.25*	0.02, 0.48	0.07	-0.14, 0.28
Female	0.40*	0.01, 0.78	0.58*	0.17, 0.99	0.09	-0.27, 0.44	0.25	-0.14, 0.63	0.17	-0.19, 0.53

Percentage increase in COPD-related hospital visits and 95% CI in males and females as each particle constituent increased 10 µg/m³

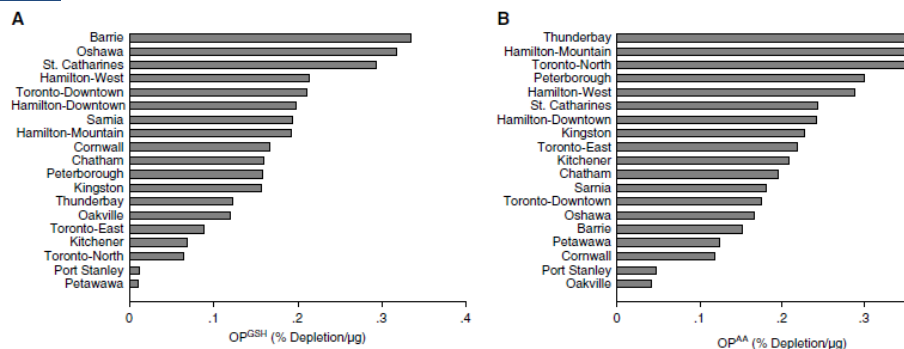
	Lag1		Lag2		Lag3		Lag4		Lag5	
	% increase	95% CI	% increase	95% CI	% increase	95% CI	% increase	95% CI	% increase	95% CI
Male										
Na	-0.031	-0.106, 0.045	-0.023	-0.152, 0.106	0.003	-0.081, 0.087	-0.042	-0.107, 0.022	0.130	-0.094, 0.355
Mg	0.059*	0.001, 0.116	0.376	-0.291, 1.043	0.711	-0.546, 1.968	-0.373	-0.724, -0.023	1.316	-1.291, 3.923
Al	0.021*	0.002, 0.039	0.182*	0.002, 0.361	0.010	-0.097, 0.117	-0.126	-0.265, 0.014	-0.122	-0.367, 0.123
Si	0.009*	0.001, 0.018	0.078*	0.008, 0.148	0.008	-0.035, 0.052	-0.063	-0.133, 0.005	-0.060	-0.178, 0.057
Cl	-0.077	-0.225, 0.070	0.036	-0.137, 0.209	-0.142	-0.343, 0.060	-0.068	-0.231, 0.094	-0.119	-0.397, 0.158
K	0.021	-0.032, 0.075	0.110	-0.006, 0.227	0.013	-0.072, 0.098	-0.096	-0.186, -0.008	-0.099	-0.294, 0.097
Ca	0.028*	0.002, 0.053	0.229	-0.063, 0.521	-0.018	-0.243, 0.208	-0.192	-0.401, 0.016	-0.234	-0.658, 0.190
Ti	0.324*	0.031, 0.617	1.699*	0.197, 3.202	0.310	-0.741, 1.362	-1.981	-3.916, -0.045	-1.886	-5.375, 1.603
V	3.355	-2.110, 8.819	-3.661	-11.135, 3.814	-7.785	-15.965, 0.398	5.262	-3.669, 14.193	-3.829	-15.626, 7.968
Cr	1.708	-1.336, 4.049	2.035	-1.350, 4.720	2.735	-2.297, 5.174	-0.056	-2.130, 2.010	-0.493	-4.570, 3.584
Mn	0.855	-0.177, 1.886	1.371	-1.394, 4.134	-0.825	-2.890, 1.239	-0.754	-2.920, 1.412	-1.192	-4.253, 1.869
Fe	0.030*	0.001, 0.059	0.137	-0.037, 0.311	-0.020	-0.126, 0.086	-0.069	-0.189, 0.052	-0.083	-0.267, 0.100
Ni	-5.920	-10.281, -1.561	-3.030	-8.205, 2.147	-2.283	-6.722, 2.158	-0.910	-5.944, 4.123	7.795	-18.351, 22.811
Cu	-0.359	-0.919, 0.201	0.601	-0.064, 1.265	0.746	-0.030, 1.523	-1.514	-2.584, -0.445	-0.189	-2.165, 1.788
Zn	-0.079	-0.511, 0.352	0.279	-0.295, 0.853	-0.164	-0.577, 0.249	-0.139	-0.578, 0.301	-0.270	-0.884, 0.346
As	-3.351	-7.512, 0.809	8.714*	0.045, 17.383	0.530	-4.614, 5.673	-6.099	-12.773, 0.576	-6.173	-17.761, 5.418
Se	-5.232	-11.914, 1.448	-1.564	-8.819, 5.692	-7.275	-15.630, 1.077	0.490	-7.550, 8.530	-3.745	-15.376, 7.885
Br	-0.856	-3.447, 1.734	3.876*	0.340, 7.410	1.302	-1.635, 4.238	-6.840	-12.238, -1.442	-8.630	-22.321, 5.063
Pb	0.091	-0.926, 1.107	0.179	-1.208, 1.567	-1.205	-2.942, 0.533	-0.569	-1.890, 0.751	-0.858	-3.227, 1.513
OC	-0.122	-0.458, 0.216	0.120	-0.163, 0.404	-0.012	-0.336, 0.310	-0.135	-0.582, 0.312	-0.260	-0.632, 0.111
EC	0.888	-0.454, 2.230	1.489*	0.206, 2.770	0.443	-1.004, 1.890	-1.458	-3.046, 0.130	0.165	-1.078, 1.407

Fine Particulate Matter and Emergency Room Visits for Respiratory Illness

Effect Modification by Oxidative Potential

Scott A. Weichenthal^{1,2}, Eric Lavigne¹, Greg J. Evans³, Krystal J. Godri Pollitt⁴, and Richard T. Bumett¹

¹Health Canada, Ottawa, Ontario, Canada; ²Department of Epidemiology, Biostatistics, and Occupational Health, McGill University, Montreal, Quebec, Canada; ³University of Toronto, Toronto, Ontario, Canada; and ⁴University of Massachusetts, Amherst, Massachusetts



Air Pollutant	Mean (SD)	Median	IQR	Range
PM _{2.5} , µg/m ³	7.10 (6.25)	5.21	5.92	<1 to 56.8
PM _{2.5} × OP ^{GSH}	0.992 (1.10)	0.63	0.89	<1 to 13.5
PM _{2.5} × OP ^{AA}	1.62 (1.50)	1.17	1.37	<1 to 20.4

Outcome	Lag	Exposure		
		PM _{2.5} [% Change (95% CI)]	PM _{2.5} × OP ^{GSH} [% Change (95% CI)]	PM _{2.5} × OP ^{AA} [% Change (95% CI)]
Asthma	0	1.1 (0.79–1.4)	0.87 (0.48–1.3)	1.0 (0.67–1.4)
	1	2.1 (1.5–2.7)	1.6 (1.0–2.2)	1.9 (1.1–2.7)
	2	2.4 (1.6–3.3)	1.9 (1.2–2.7)	2.2 (1.3–3.2)
	3-d mean	3.5 (2.7–4.3)	2.6 (1.8–3.5)	3.1 (2.0–4.2)
COPD	0	1.0 (0.61–1.4)	0.85 (0.45–1.3)	0.91 (0.43–1.4)
	1	1.3 (0.76–1.8)	0.93 (0.54–1.3)	1.1 (0.48–1.8)
	2	1.2 (0.74–1.6)	0.91 (0.52–1.3)	1.1 (0.55–1.6)
	3-d mean	2.2 (1.4–2.9)	1.6 (0.98–2.2)	1.9 (0.2–2.8)
All respiratory	0	0.97 (0.70–1.2)	0.85 (0.63–1.1)	0.83 (0.55–1.1)
	1	1.2 (0.66–1.7)	0.91 (0.39–1.4)	1.0 (0.52–1.5)
	2	0.99 (0.58–1.4)	0.83 (0.42–1.3)	0.92 (0.56–1.3)
	3-d mean	1.9 (1.3–2.5)	1.5 (0.93–2.1)	1.6 (1.1–2.2)

Outcome	Percentile of OP ^{GSH}				Interaction P Value
	<25th [% Change (95% CI)]	25th–50th [% Change (95% CI)]	>50th–75th [% Change (95% CI)]	>75th [% Change (95% CI)]	
Asthma	0.92 (–0.35 to 2.2)	3.6 (0.0 to 7.5)	4.6 (–1.5 to 11)	5.9 (3.0 to 8.9)	0.007
COPD	0.76 (–2.4 to 4.1)	0.82 (–3.7 to 5.5)	2.8 (–0.10 to 5.7)	3.5 (2.1 to 4.9)	0.09
All respiratory	0.47 (–0.40 to 1.4)	2.2 (1.7 to 2.8)	2.7 (0.096 to 5.5)	2.8 (1.5 to 2.0)	0.001

Long-term effect of air pollution on respiratory system

- Lung function
- Lung function decline
- Risk of COPD and asthma
- Lung cancer incidence and mortality

Outdoor air pollution and lung function in adults

Traffic exposure and lung function in adults: the Atherosclerosis Risk in Communities study

Haidong Kan, Gerardo Heiss, Kathryn M Rose, Eric Whitsel, Fred Lurmann, Stephanie J London

Thorax 2007;**62**:873–879. doi: 10.1136/thx.2006.073015

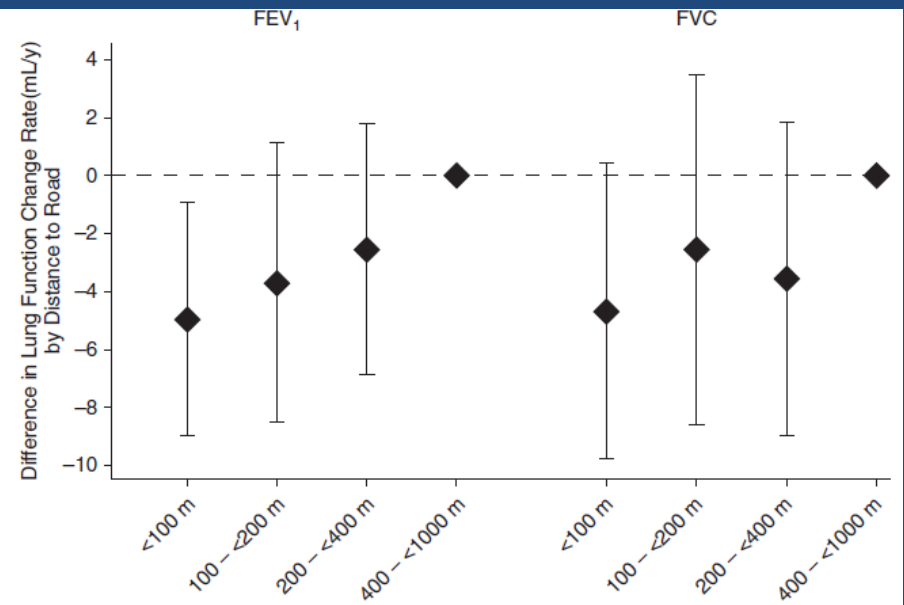
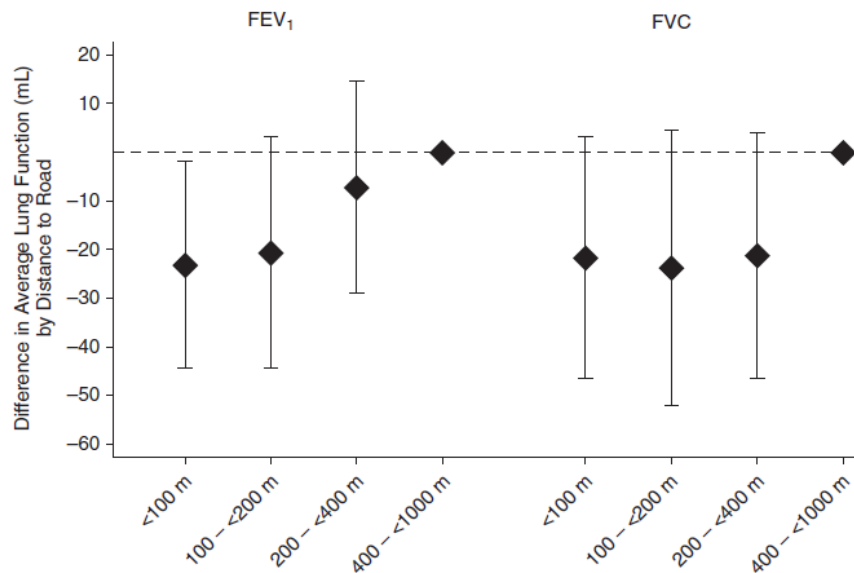
Long term effects of exposure to automobile exhaust on the pulmonary function of female adults in Tokyo, Japan

K Sekine, M Shima, Y Nitta, M Adachi

Occup Environ Med 2004;**61**:350–357. doi: 10.1136/oem.2002.005934

Long-Term Exposure to Traffic Emissions and Fine Particulate Matter and Lung Function Decline in the Framingham Heart Study

Mary B. Rice¹, Petter L. Ljungman^{1,2}, Elissa H. Wilker¹, Kirsten S. Dorans^{1,3}, Diane R. Gold⁴, Joel Schwartz⁴, Petros Koutrakis⁴, George R. Washko^{5,6}, George T. O'Connor^{6,7}, and Murray A. Mittleman^{1,3}




Outdoor air pollution and COPD in adults

Long-term air pollution exposure and living close to busy roads are associated with COPD in women

Tamara Schikowski*¹, Dorothea Sugiri¹, Ulrich Ranft¹, Ulrike Gehring^{2,3,4}, Joachim Heinrich², H-Erich Wichmann^{2,3} and Ursula Krämer¹

Respir Res 2005;6:152 SALIA

Lung function reductions associated with motor vehicle density in chronic obstructive pulmonary disease: a cross-sectional study

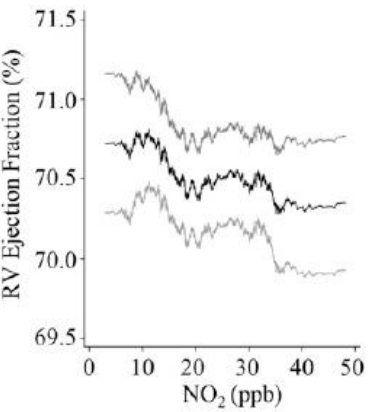
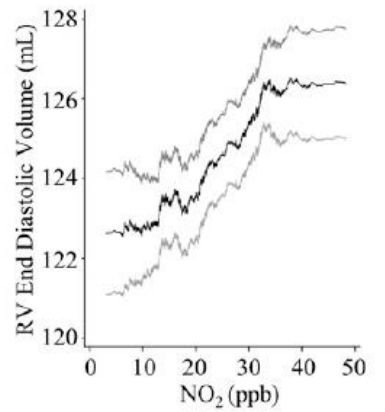
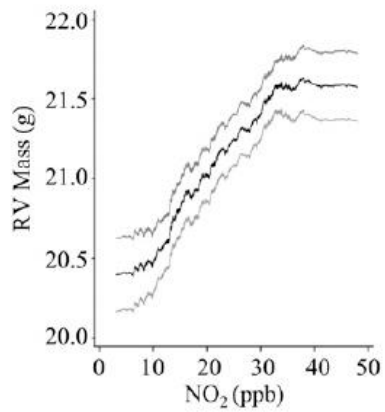
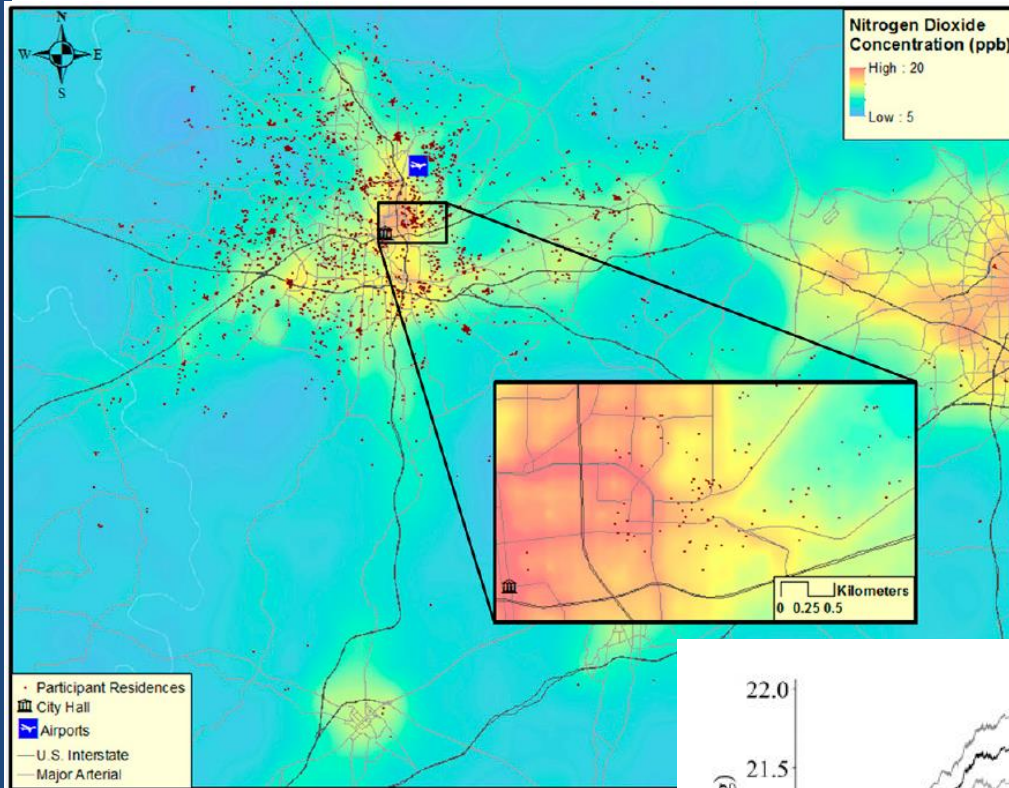
Monika Nitschke^{1*} , Sarah L. Appleton², Qiaoyu Li³, Graeme R. Tucker¹, Pushan Shah⁴, Peng Bi³, Dino L. Pisaniello³ and Robert J. Adams²

Respir Res 2016;17:138 NWAHS

Traffic-related Air Pollution and the Right Ventricle

The Multi-ethnic Study of Atherosclerosis

Peter J. Leary¹, Joel D. Kaufman^{1,2,3}, R. Graham Barr^{4,5}, David A. Bluemke⁶, Cynthia L. Curl², Catherine L. Hough¹, Joao A. Lima^{7,8}, Adam A. Szpiro⁹, Victor C. Van Hee¹⁰, and Steven M. Kawut¹¹



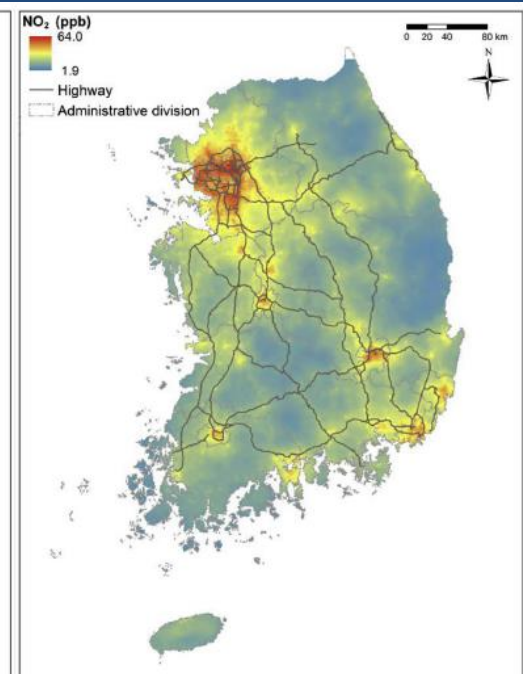
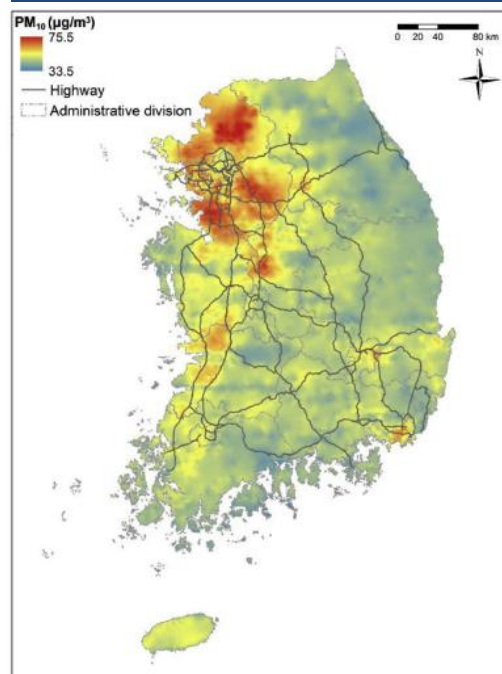
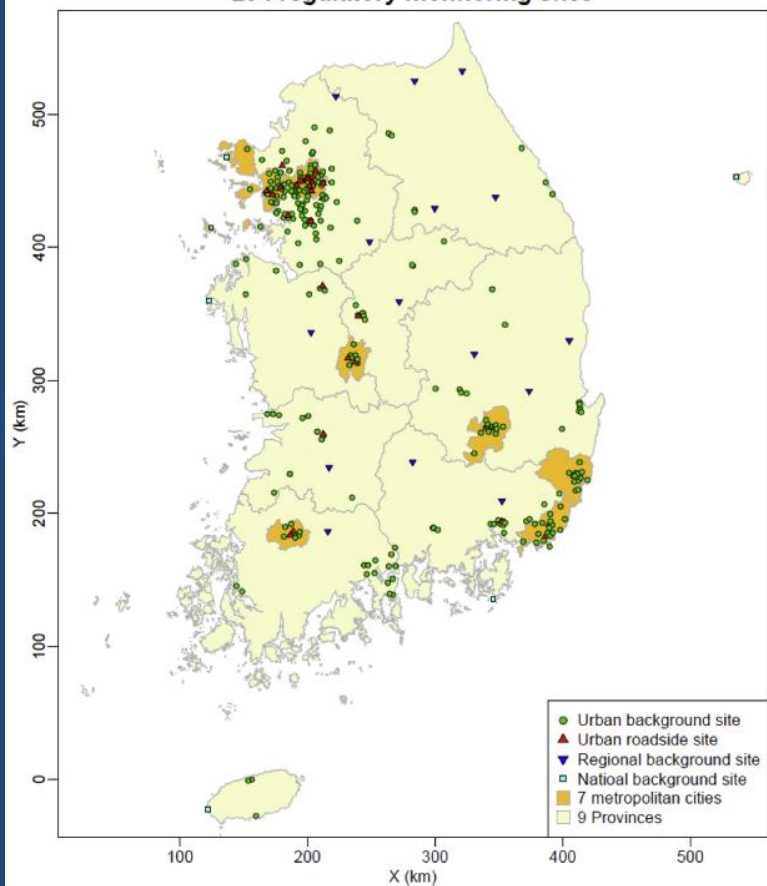
National-scale exposure prediction for long-term concentrations of particulate matter and nitrogen dioxide in South Korea[☆]

Sun-Young Kim ^{a, *}, Insang Song ^b

^a Institute of Health and Environment, Seoul National University, Seoul, South Korea

^b Department of Geography, Seoul National University, Seoul, South Korea

294 regulatory monitoring sites



Air pollution: a potentially modifiable risk factor for lung cancer

Laís Fajersztajn, Mariana Veras, Ligia Vizeu Barrozo and Paulo Saldiva

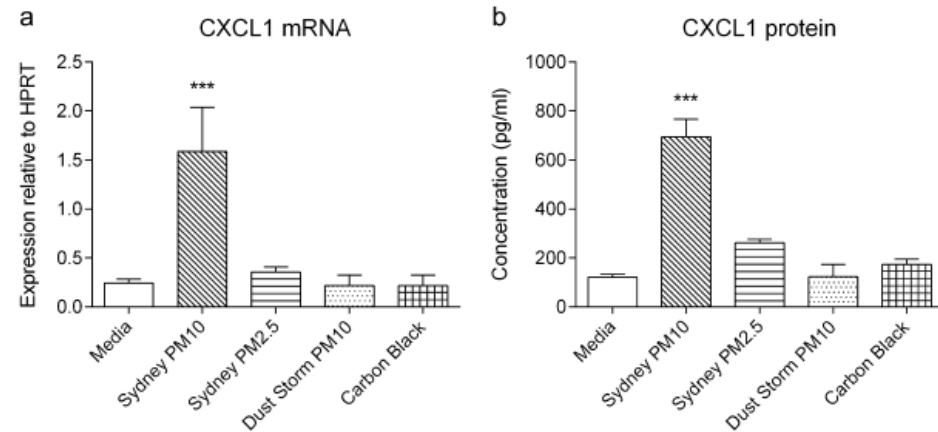
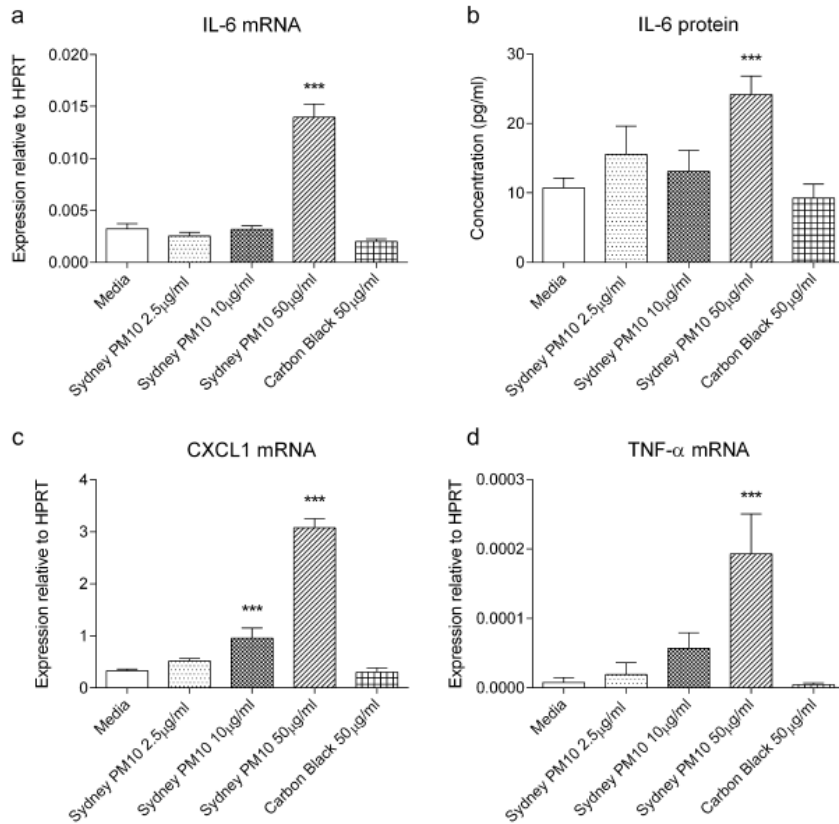
North America					
Dockery <i>et al.</i> ³¹	United States	8,111 (1974–1991)	PM _{2.5} (18.6 µg per m ³)	AMR (95% CI) = 1.37 (0.81–2.31)	Age, sex, smoking status, education, occupational exposure and medical history
Jerrett <i>et al.</i> ³²	United States	22,905 (1982–2000)	PM _{2.5} (10 µg per m ³)	HR (95% CI) = 1.44 (0.98–2.11)	Forty-four individual level covariates, including income, race and SES
Krewski <i>et al.</i> ⁹	United States	1,200,000 (1999–2000)	PM _{2.5} (10 µg per m ³)	HR (95% CI) = 1.142 (1.057–1.234)	Forty-four individual level covariates, including income, race and social factors
Pope <i>et al.</i> ³	United States	1,200,000 (1979–1983)	PM _{2.5} (10 µg per m ³)	RR (95% CI) = 1.08 (1.01–1.16)	Age, sex, smoking status, marital status, education, occupational exposure, race, BMI, alcohol consumption and diet
		1,200,000 (1999–2000)	PM _{2.5} (10 µg per m ³)	RR (95% CI) = 1.13 (1.04–1.22)	
		1,200,000 (1982–1998)	PM _{2.5} (10 µg per m ³)	RR (95% CI) = 1.14 (1.04–1.23)	
Turner <i>et al.</i> ¹⁰	United States	188,699 (1979–1983)	PM _{2.5} (10 µg per m ³)	HR (95% CI) = 1.15 (0.99–1.35)	Age, sex, passive smoking, marital status, education, occupational exposure, race, BMI, diet, prevalent lung disease and radon exposure
		188,699 (1999–2000)	PM _{2.5} (10 µg per m ³)	HR (95% CI) = 1.27 (1.03–1.56)	
		188,699 (1982–2008)	PM _{2.5} (10 µg per m ³)	HR (95% CI) = 1.19 (0.97–1.47)	
Asia					
Cao <i>et al.</i> ³³	China	70,947 (1991–2000)	SO ₂ (10 µg per m ³)	ΔM (95% CI) = 4.2 (2.3–6.2)	Age, sex, smoking status, education, BMI, alcohol consumption, physical activity and hypertension
Kantanoda <i>et al.</i> ³⁴	Japan	63,520 (1974–1983)	PM _{2.5} (10 µg per m ³)	HR (95% CI) = 1.23 (1.09–1.38)	Age, sex, smoking status, diet and indoor charcoal or briquette braziers used for heating
			SO ₂ (10 µg per m ³)	HR (95% CI) = 1.19 (0.97–1.45)	
			NO ₂ (10 µg per m ³)	HR (95% CI) = 1.15 (1.06–1.24)	
Yorifuji <i>et al.</i> ³⁵	Japan	14,001 (1999–2009)	NO ₂ (10 µg per m ³)	HR (95% CI) = 1.20 (1.03–1.40)	Age, sex, smoking status, BMI, hypertension, diabetes, financial capability and area mean income

Mechanisms of PM effects on respiratory epithelium

- Oxidative stress
- Cause inflammation
- DNA damage
- Epigenetic alteration

Differential injurious effects of ambient and traffic-derived particulate matter on airway epithelial cells

RAKESH K. KUMAR,¹ ALEXANDER M. SHADIE,¹ MARTIN P. BUCKNALL,² HELEN RUTLIDGE,³ LINDA GARTHWAITE,¹ CRISTAN HERBERT,¹ BRENDAN HALLIBURTON,⁴ KRISTY S. PARSONS⁵ AND PETER A.B. WARK⁵



Long-term outdoor air pollution and DNA methylation in circulating monocytes: results from the Multi-Ethnic Study of Atherosclerosis (MESA)



Gloria C. Chi^{1*}, Yongmei Liu², James W. MacDonald³, R. Graham Barr^{4,5}, Kathleen M. Donohue^{4,5}, Mark D. Hensley¹, Lifang Hou⁶, Charles E. McCall⁷, Lindsay M. Reynolds², David S. Siscovick⁸ and Joel D. Kaufman^{1,3}

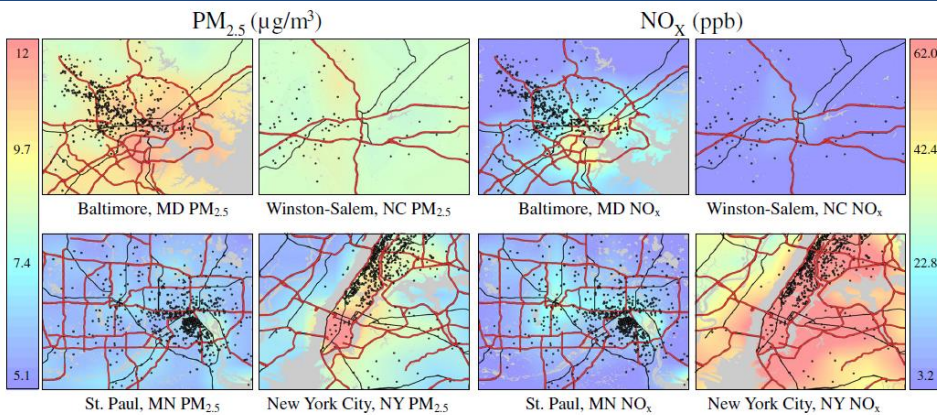


Fig. 2 Maps of estimated PM_{2.5} and NO_x concentrations by MESA Air study site. The maps show smoothed air pollution predictions, which may reduce the visibility of fine-scale variation in concentrations. Black dots represent participant locations and are jittered to protect participant confidentiality.

ANKHD1, LGALS2, ANKRD11

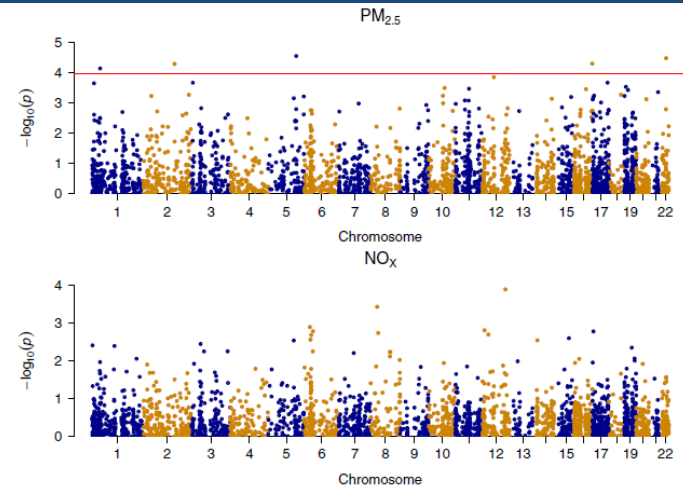


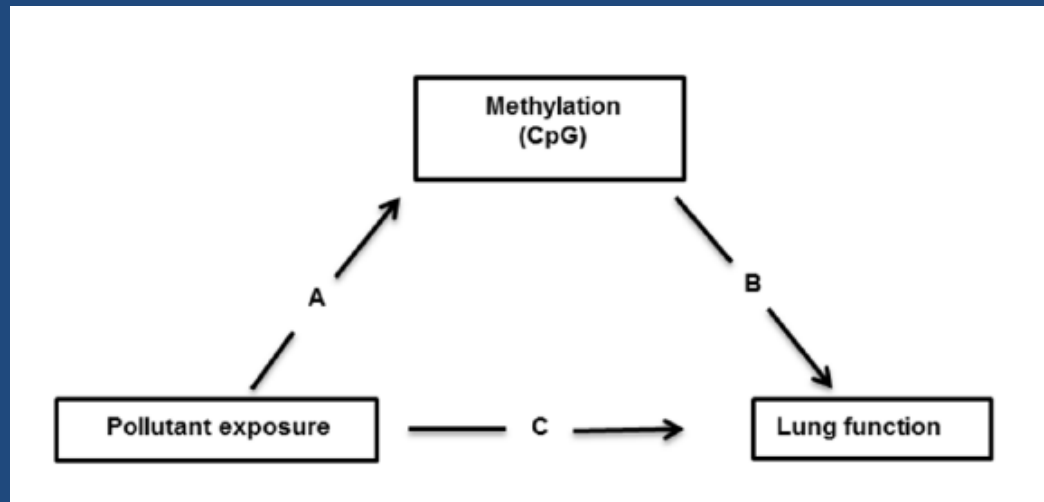
Fig. 3 Association between PM_{2.5} and NO_x and 2,713 expression-associated methylation sites. Red line demarcates statistical significance at a false discovery rate of 5%. Plot for NO_x does not have a red line because no sites were statistically significant

Long-term Air Pollution Exposure, Genome-wide DNA Methylation and Lung Function in the LifeLines Cohort Study

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Table 2. Genome-wide differential DNA methylation associated with NO₂ exposure (per 10 µg/m³) in the LifeLines Cohort Study (n = 1,017).

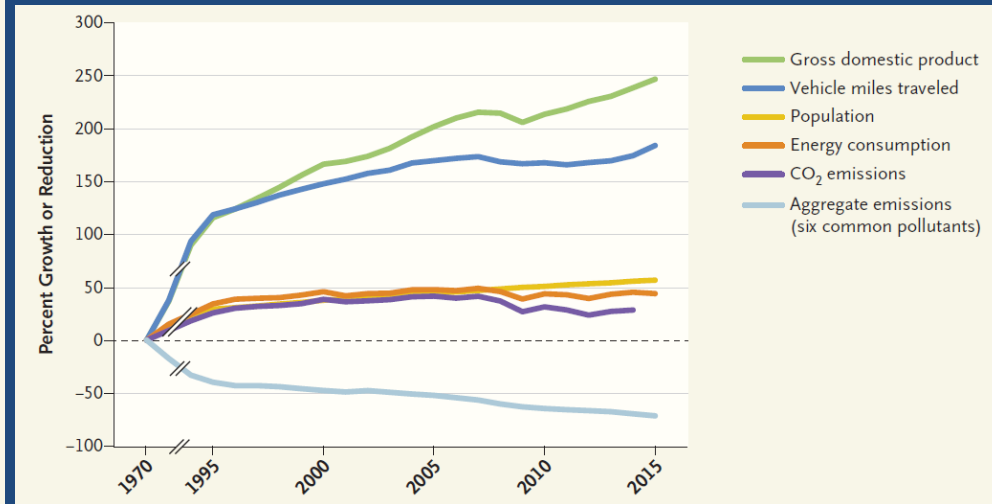
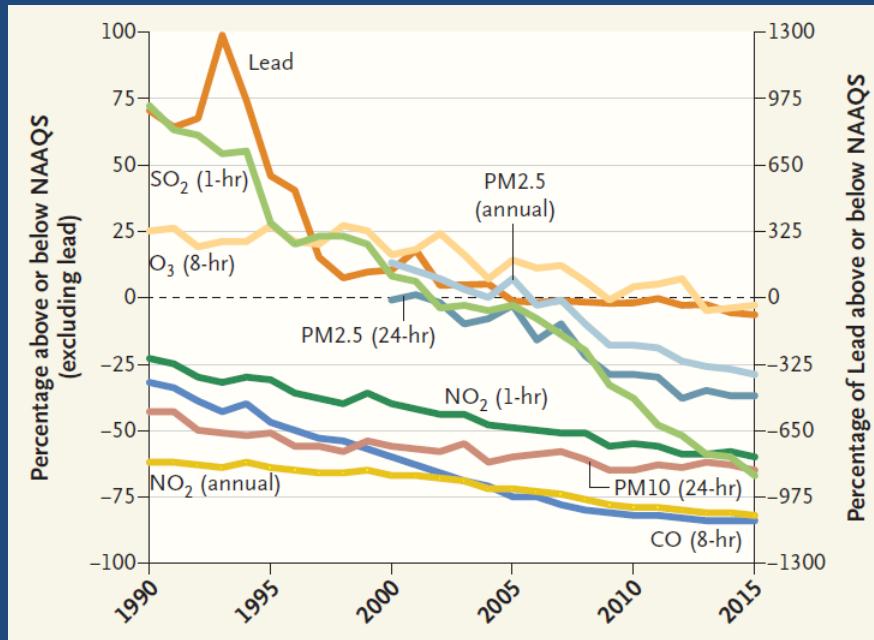
CpG site	B ± SE ^a	p-Value ^b	Chr	Bp position	Gene	Location in gene	Relation to island
cg04908668	-0.012 ± 0.002	7.94 × 10 ⁻⁹	6	32823941	PSMB9	Body	S_Shore
cg14938677	0.023 ± 0.004	1.05 × 10 ⁻⁸	7	127231698	ARF5	3'UTR	S_Shelf
cg00344801	-0.028 ± 0.005	2.38 × 10 ⁻⁸	22	46685728	TTC38	Body	Island
cg18379295	0.020 ± 0.004	3.50 × 10 ⁻⁸	14	52326155	GNG2	TSS1500	OpenSea
cg25769469	0.035 ± 0.006	3.69 × 10 ⁻⁸	5	71643841	PTCD2	Body	OpenSea
cg02234653	-0.017 ± 0.003	4.07 × 10 ⁻⁸	2	224625080	AP1S3	Body	OpenSea
cg08500171	0.023 ± 0.004	9.81 × 10 ⁻⁸	6	31590674	BAT2	Body	S_Shore



The Trump Administration and the Environment — Heed the Science

Jonathan M. Samet, M.D., Thomas A. Burke, Ph.D., M.P.H., and Bernard D. Goldstein, M.D.

- Scientific evidence
— > environmental regulation



정책적 제안, 국민 합의

국가별 미세먼지 대기 환경 기준

항목	기준	한국	미국	일본	E.C.	캐나다	호주
PM10 ($\mu\text{g}/\text{m}^3$)	1시간			200			
	24시간	100	150	100	50	50	
	년	50			40		50
PM2.5 ($\mu\text{g}/\text{m}^3$)	24시간	50	35	35		30	25
	년	25	12/15	15	25		8

- 2018년 3월 20일 시행령이 의결됨으로써, 우리나라도 기준이 대폭 강화됨.
- PM2.5 일평균 기준 = $35 \mu\text{g}/\text{m}^3$, 연평균 기준 = $15 \mu\text{g}/\text{m}^3$
- 미국의 경우 연평균 기준이 primary standard ($12 \mu\text{g}/\text{m}^3$)와 secondary standard ($15 \mu\text{g}/\text{m}^3$)로 구분되어 있는데, primary standard는 vulnerable group에 대한 고려.

배출원

- 배출원 목록 자료에 의하면,
수도권 : 도로이동오염원(특히 경유차)이 가장 큼.
전국: 사업장(제조업 연소)이 가장 큼.
- 미세먼지는 2차 생성(배출원에서 직접 배출되는 것이 아니라 대기중에서 새로 생성되는 먼지)이 전체 mass의 70% 이상을 차지함. → 농도 저감이 어려움. & 미세먼지에 대한 배출원 추정이 까다로움.
- 2차 생성의 전구물질 : SO_x, NO_x, & organic vapor
- 국내 vs 국외 기여도: 시기에 따라 다르며 연구마다 다름.
- 국외 영향 : 연평균 30~50%, 고농도 시에는 ~80%까지도 추정.
- 최근 중국의 미세먼지 농도는 상당부분 개선되었음.
그러나 우리나라는 변화 없음.

미세먼지/황사 건강피해 예방 및 권고지침: 호흡기질환

경 선 영^{1,2} · 김 영 삼^{1,3} · 김 우 진^{1,4} · 박 무 석^{1,3} · 송 진 우^{1,5} · 염 호 기^{1,6} · 윤 형 규^{1,7} · 이 진 국^{1,8} · 정 성 환^{1,2} | ¹미세먼지/황사 호흡기질환 권고지침 개발위원회, ²가천의과학대학교 길병원, ³연세대학교 의과대학 세브란스병원, ⁴강원대학교 의과대학, ⁵울산대학교 의과대학 서울아산병원, ⁶인제대학교 의과대학 서울백병원, ⁷가톨릭대학교 의과대학 여의도성모병원, ⁸가톨릭대학교 의과대학 서울성모병원 내과

실외에서는

- 미세먼지 예보등급이 '나쁨' 또는 '매우 나쁨'이면 외출이나 실외 운동을 삼가 하세요.
- 도로나 공장 등 미세먼지 농도가 높은 장소나 출퇴근 시간 등 농도가 높은 시간에는 가급적 외부활동을 줄이세요.
- 외부활동을 피할 수 없다면 덜 힘든 방법을 선택하세요(달리기→걷기).
- 교통량이 많은 지역에서의 이동을 자제하세요.
- 불필요한 차량이동을 자제하세요. 꼭 해야 하는 경우에는 최적의 차량 여과시스템을 유지하고 창문을 닫고 차량 내 공기를 환기시켜 줍니다.

실내에서는

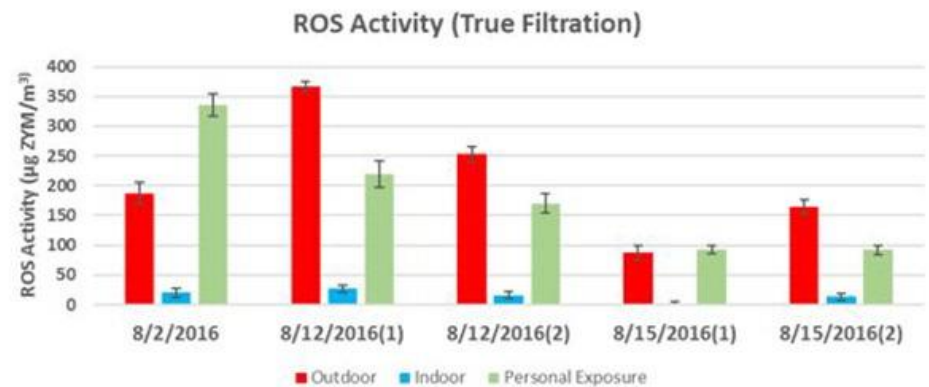
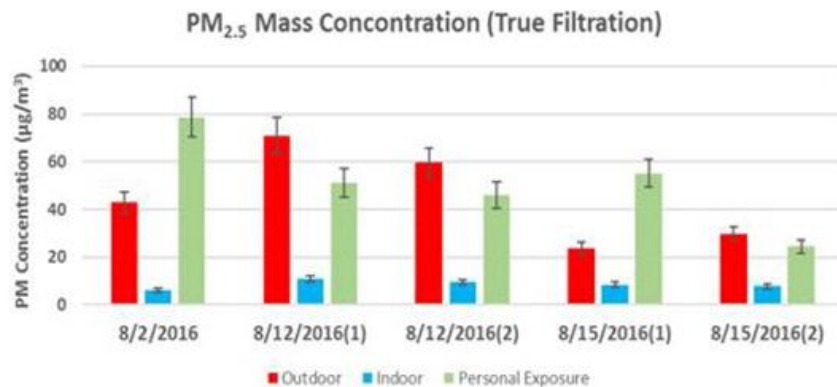
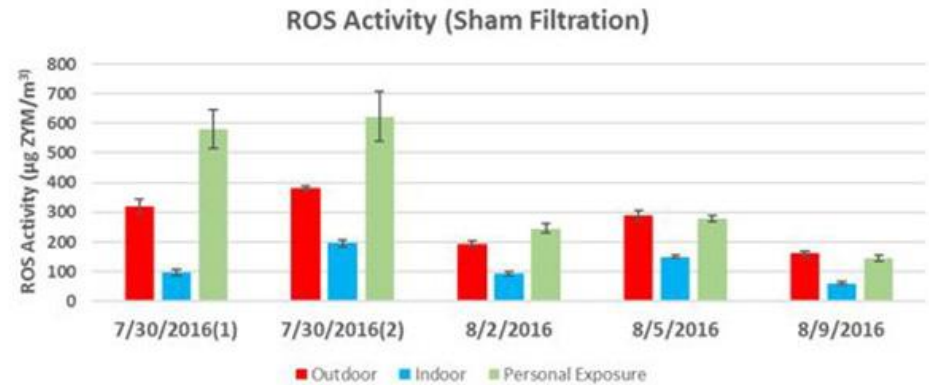
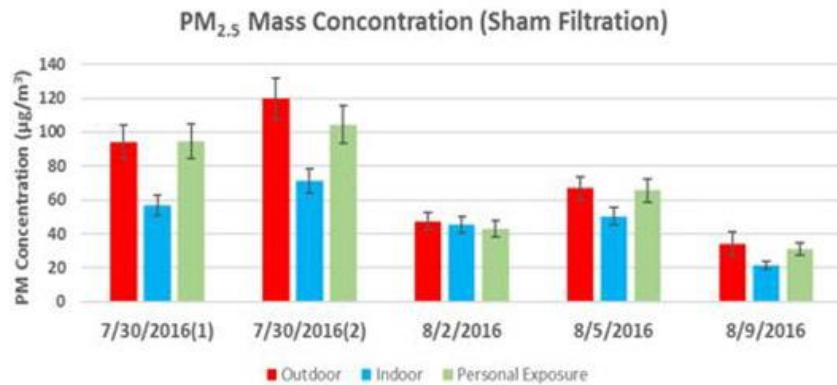
- 외출 후 실내에 들어오면 손, 발, 얼굴 등을 깨끗이 씻으세요.
- 미세먼지 농도가 높지 않을 때는 가급적 자주 환기를 하세요.
- 미세먼지를 증가시키는 흡연을 삼가하고 간접흡연도 피하세요.
- 음식을 조리할 때에는 초미세먼지가 급증하므로, 환풍기를 작동시키거나 환기를 더 자주 하세요.

구제약물(속효성 기관지 확장제)을 반드시 소지하고 필요한 경우 사용하도록 권고

기존의 호흡기질환 치료제를 성실히 복용

미세먼지 노출 후 호흡곤란, 가래, 기침, 발열 등 호흡기증상이 악화되는 경우는 바로 병원에

The influence of air cleaners on indoor particulate matter components and oxidative potential in residential households in Beijing



Air cleaner and COPD

- Clinical trial in Johns Hopkins University
- Hypothesis: An intervention using high-efficiency particulate **air** (HEPA) and carbon filter **air cleaners** in homes of former smokers with COPD will improve respiratory symptoms, quality of life, and lung function and reduce risk of COPD exacerbations compared with placebo (sham **air cleaners**).
- Hypothesis 2: An intervention using HEPA and carbon filter **air cleaners** in homes of former smokers with COPD will be associated with lower levels of markers of inflammation and oxidative stress known to be associated with adverse outcomes in patients with COPD.

결론

- PM은 일관되게 호흡기 사망률과 병원 방문 증가에 영향을 미침
- 대기오염 상황이 변하므로 지속적인 연구 필요
- PM의 성분/기전에 대한 연구 필요
- 과학적 근거에 따라 정책 마련 필요
- 예방관리 지침