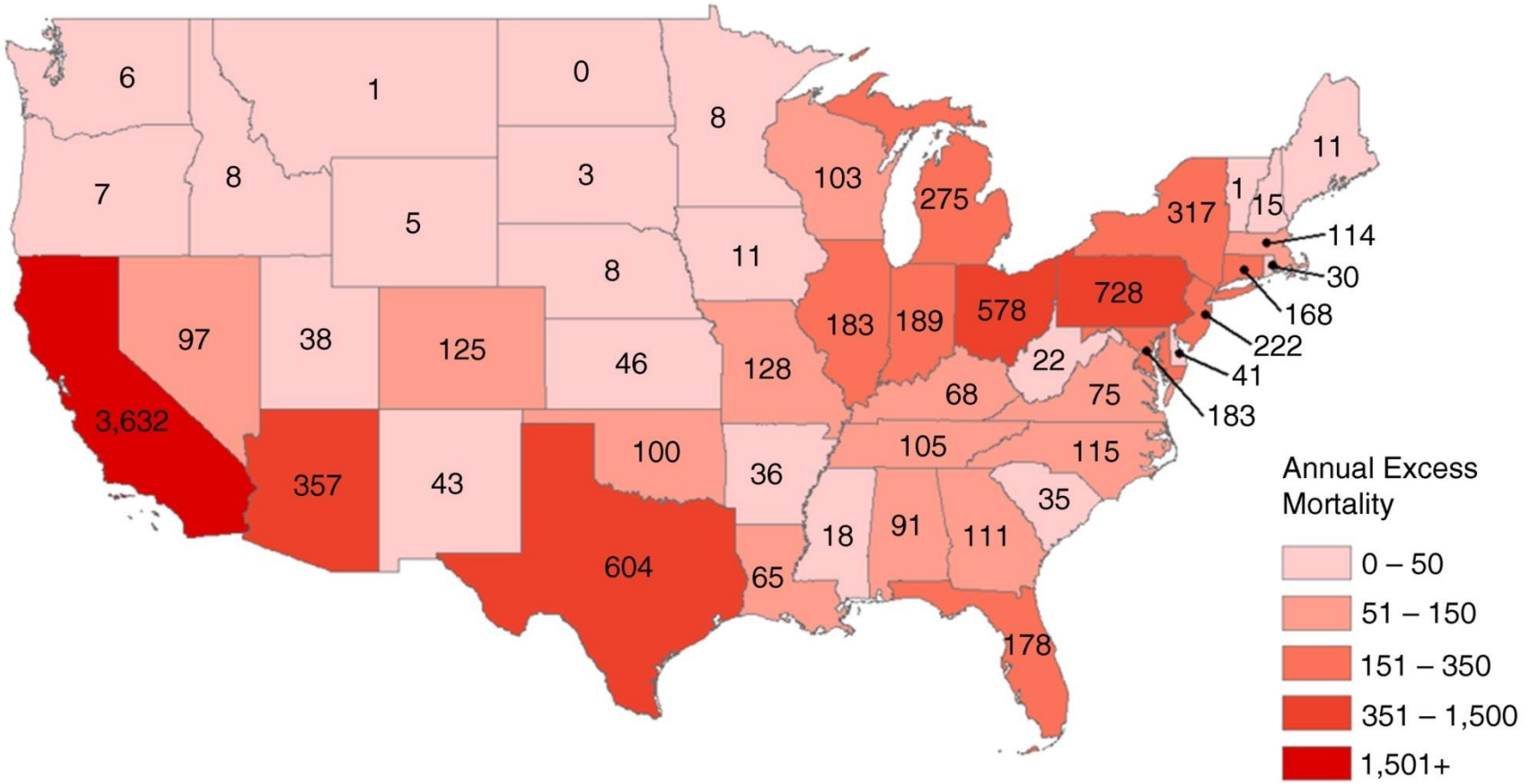
NYU | Marron Institute of Urban Management

PUBLIC HEALTH & AIR QUALITY

Kevin Cromar, PhD



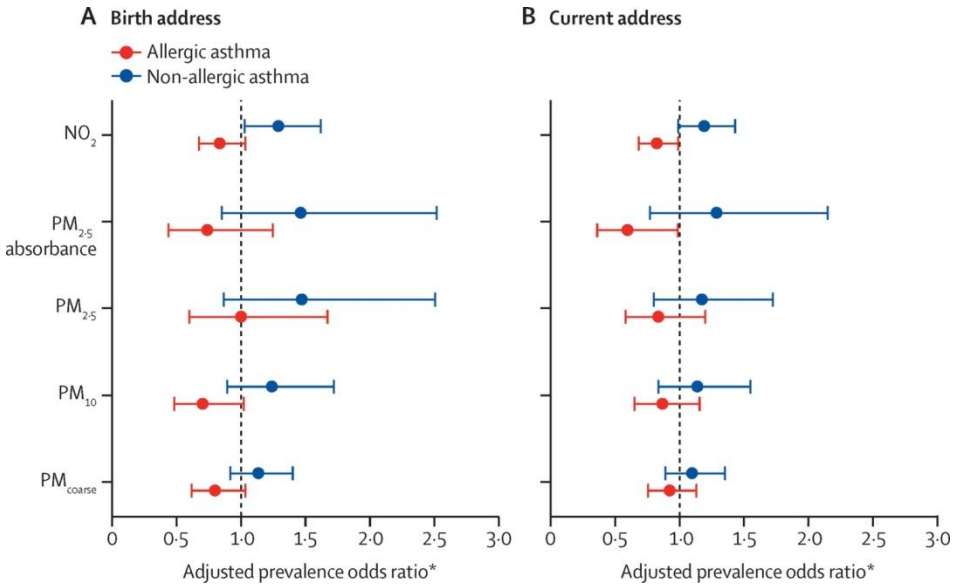
NATIONWIDE TOTALS

Ozone (O_3)			Fine Particulate Matter ($PM_{2.5}$)		
Health Category	*Estimate*	*95% CI*	*Health Category*	*Estimate*	*95% CI*
Mortality	6,408	(2,517 – 10,217)	Mortality	2,913	(1,980 – 3,858)
Morbidity	15,869	(–4,966 – 36,023)	Morbidity	5,543	(1,741 – 9,253)
Impacted Days	16,991,656	(4,651,415 – 28,781,244)	Impacted Days	2,348,094	(1,928,554 – 2,765,482)

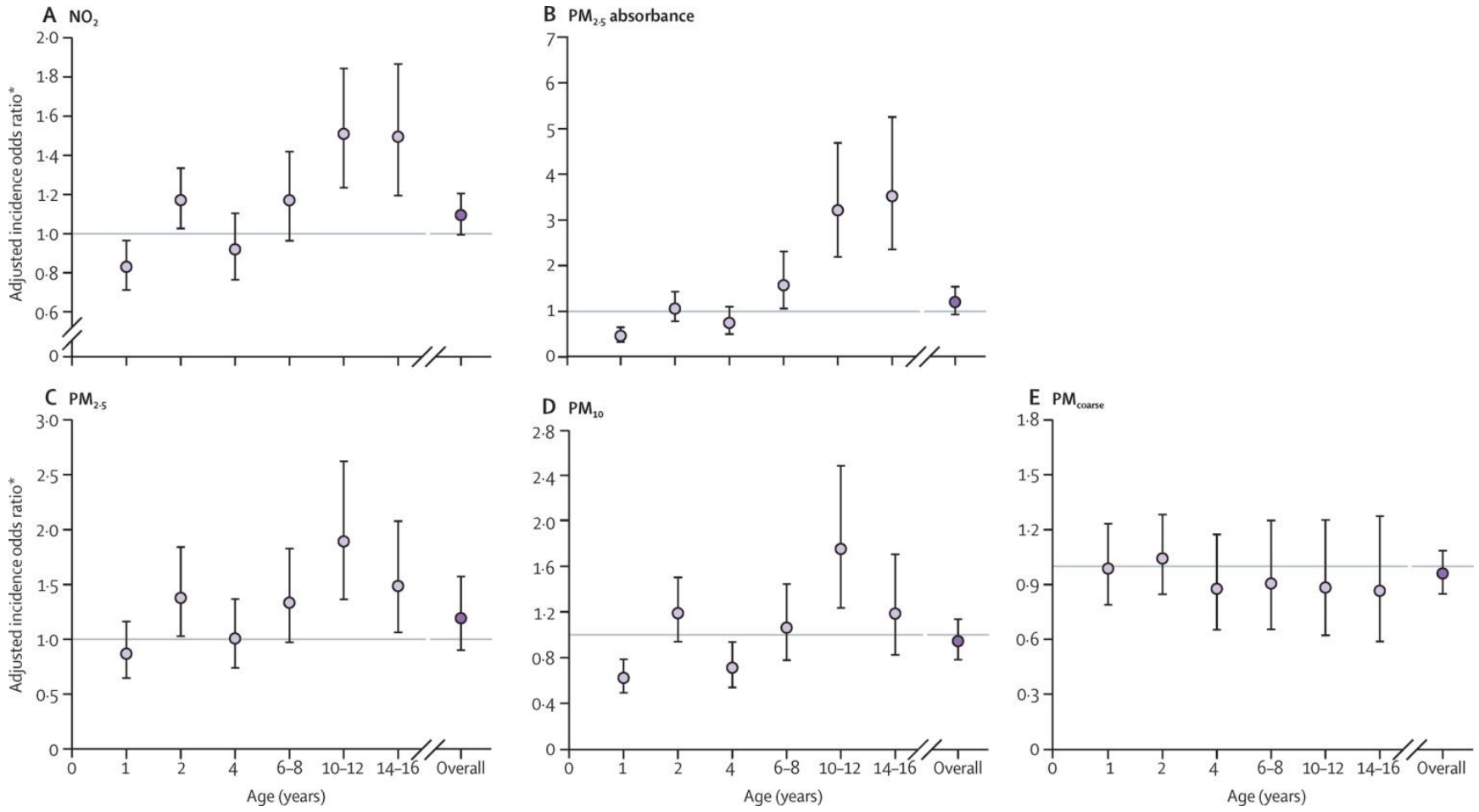
Update on Public Health Impacts

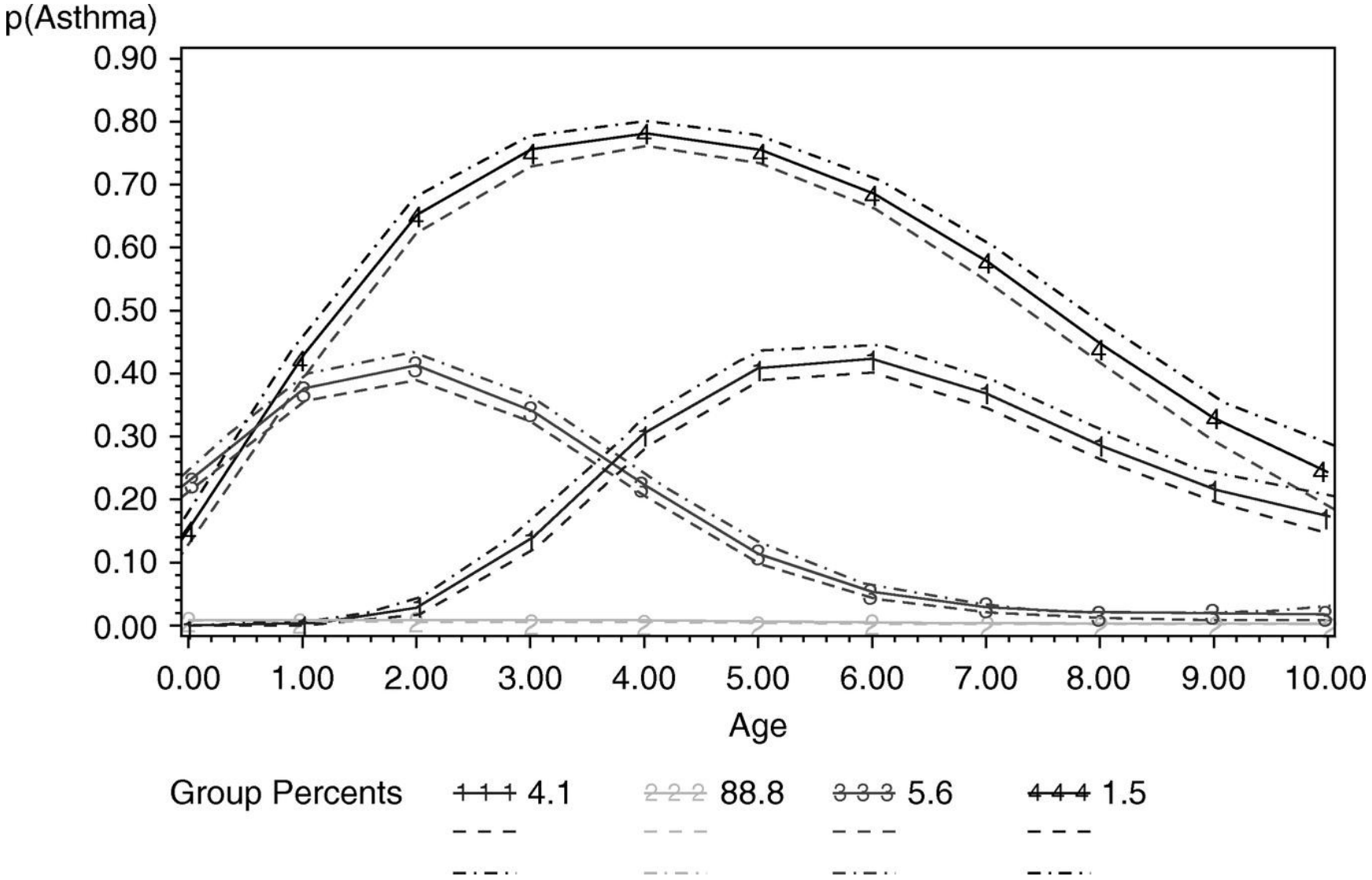
Development of asthma in children, lung cancer incidence, neurological health outcomes, and mortality risks at low ambient concentrations

1. DEVELOPMENT OF ASTHMA



- Growing evidence from prospective cohort studies indicate a causal role of ambient air pollution in the development of asthma in children
- These effects are most easily observed in school aged children (> 4 years)


A NO_2
B $PM_{2.5}$ absorbance
C $PM_{2.5}$
D PM_{10}
E PM_{coarse}
Adjusted incidence odds ratio*
Age (years)
0
1
2
4
6–8
10–12
14–16
Overall


p(Asthma)
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Age
Group Percents
1 1 1 4.1
2 2 2 88.8
3 3 3 5.6
4 4 4 1.5

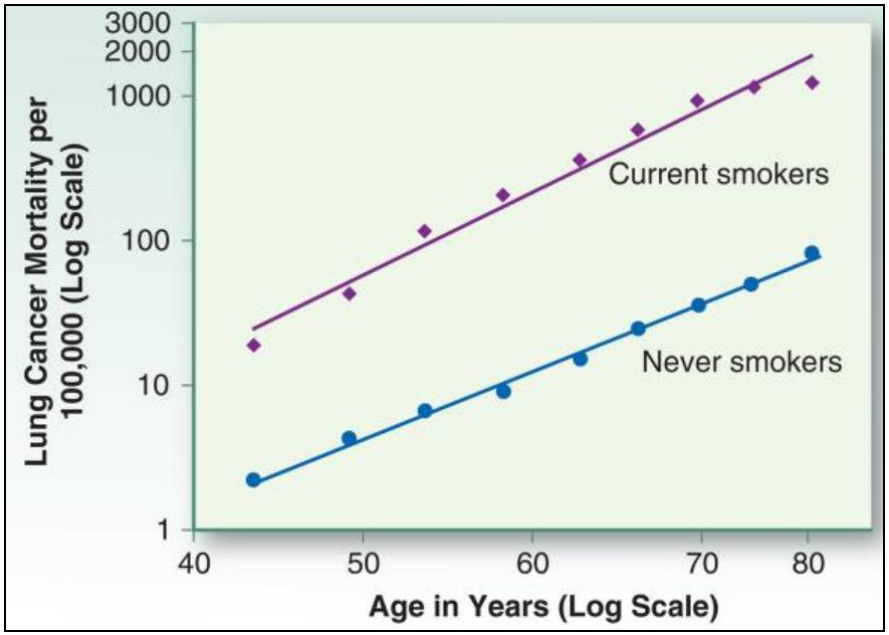
Exposure	Exposure Level†	Group	Unadjusted Models		Adjusted Models	
			RRR	95% CI	RRR	95% CI
NDVI	3 vs. 0	T	0.88	0.88–1	0.91	0.80–1.05
		LO CA	0.92	0.79–1.07	1.05	0.90–1.23
		EO CA	0.88	0.72–1.09	1.01	0.81–1.25
	2 vs. 0	T	0.98	0.87–1.11	0.98	0.86–1.11
		LO CA	1.2	1.04–1.38	1.29	1.12–1.49
		EO CA	1.08	0.89–1.31	1.15	0.94–1.41
	1 vs. 0	T	1	0.88–1.13	0.98	0.86–1.12
		LO CA	1.06	0.92–1.23	1.09	0.94–1.26
		EO CA	0.96	0.78–1.18	0.98	0.80–1.20
NO_2	3 vs. 0	T	1.13	0.98–1.29	1.14	1.00–1.31
		LO CA	1.11	0.95–1.3	1.04	0.88–1.22
		EO CA	1.21	0.96–1.51	1.15	0.98–1.44
	2 vs. 0	T	1.08	0.94–1.23	1.06	0.93–1.22
		LO CA	1.39	1.19–1.62	1.30	1.11–1.52
		EO CA	1.27	1.02–1.59	1.20	1.00–1.51
	1 vs. 0	T	1.13	0.98–1.29	1.11	0.96–1.51
		LO CA	1.25	1.07–1.46	1.20	1.03–1.41
		EO CA	1.51	1.22–1.89	1.51	1.21–1.88
$PM_{2.5}$	3 vs. 0	T	1.10	0.96–1.27	1.06	0.93–1.22
		LO CA	1.03	0.88–1.21	0.95	0.81–1.12
		EO CA	0.94	0.76–1.16	0.85	0.69–1.07
	2 vs. 0	T	1.32	1.15–1.50	1.24	1.08–1.42
		LO CA	1.36	1.18–1.58	1.24	1.07–1.45
		EO CA	1.11	0.90–1.37	0.99	0.80–1.23
	1 vs. 0	T	1.22	1.06–1.39	1.16	1.00–1.32
		LO CA	1.21	1.04–1.40	1.13	0.97–1.32
		EO CA	1.28	1.04–1.56	1.17	0.95–1.43

Definition of abbreviations: CI = confidence interval; EO CA = early-onset chronic asthma; LO CA = late-onset chronic asthma; NDVI = Normalized Difference Vegetation Index; $PM_{2.5}$ = fine particulate matter with aerodynamic diameter 2.5 μm or less; RRR = relative risk ratios; T = transient.

*Models were adjusted for sex, parity, breastfeeding initiation, birth weight, delivery mode, maternal smoking and educational attainment, and household income.

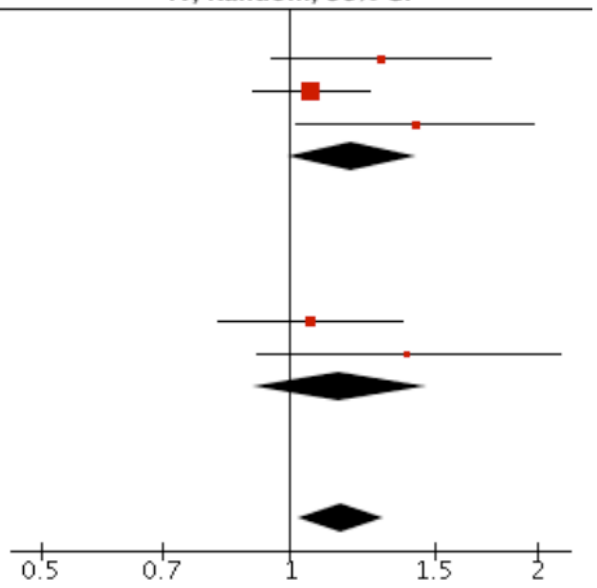
†Categories were defined as quartiles of exposure levels.

2. LUNG CANCER



- Approximately 10-15% of all lung cancer deaths are caused by factors other than active smoking
- Lung cancer in never smokers would be one of the leading causes of cancer-related mortality if considered as a separate category

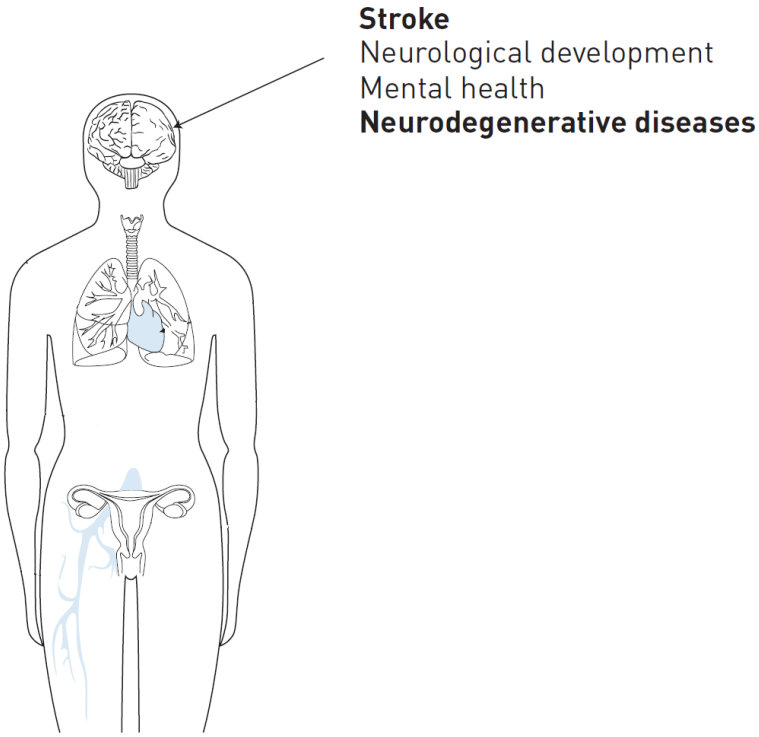
Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI	Year
1.1.1 North America					
Hystad 2013	0.2546	0.1561	14.4%	1.29 [0.95, 1.75]	2013
Puett 2014	0.0583	0.0835	45.6%	1.06 [0.90, 1.25]	2014
Gharibvand 2016	0.3507	0.1688	12.3%	1.42 [1.02, 1.98]	2016
Subtotal (95% CI)			**72.3%**	**1.19 [0.99, 1.43]**	
Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 3.05$, df = 2 (P = 0.22); $I^2 = 35\%$					
Test for overall effect: Z = 1.88 (P = 0.06)					
1.1.2 Europe					
Beelan 2008	0.0583	0.131	20.0%	1.06 [0.82, 1.37]	2008
Raaschou-Neilsen 2013	0.3293	0.2161	7.6%	1.39 [0.91, 2.12]	2013
Subtotal (95% CI)			**27.7%**	**1.15 [0.90, 1.47]**	
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 1.15$, df = 1 (P = 0.28); $I^2 = 13\%$					
Test for overall effect: Z = 1.12 (P = 0.26)					
Total (95% CI)			**100.0%**	**1.15 [1.03, 1.30]**	
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 4.21$, df = 4 (P = 0.38); $I^2 = 5\%$					
Test for overall effect: Z = 2.37 (P = 0.02)					
Test for subgroup differences: $Chi^2 = 0.05$, df = 1 (P = 0.82), $I^2 = 0\%$					



"There is *sufficient evidence* in humans for the carcinogenicity of outdoor air pollution. Outdoor air pollution causes cancer of the lung."

IARC MONOGRAPHS – 109, p. 443 (2016)

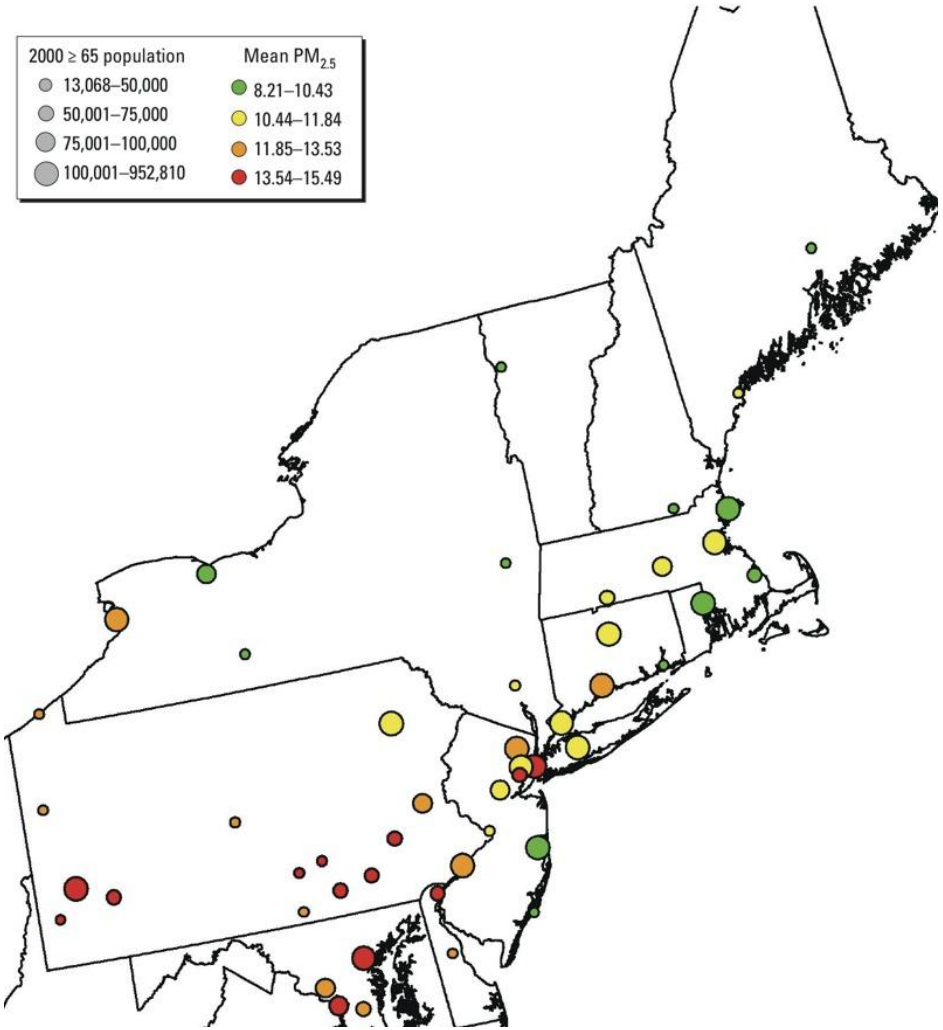
3. NEUROLOGICAL HEALTH



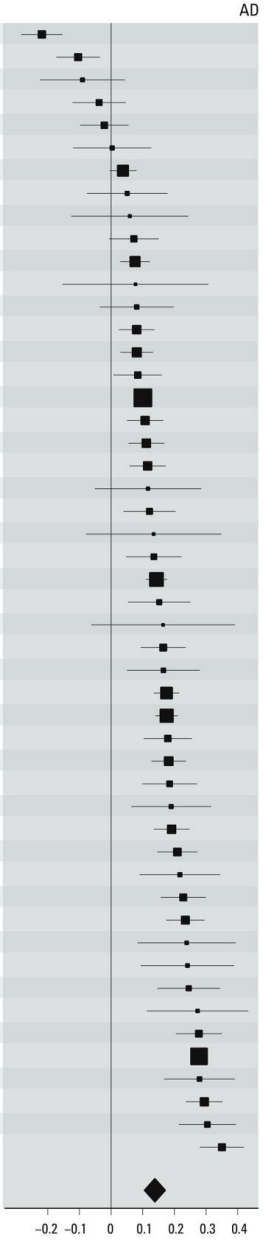
- Epidemiology studies are starting to find associations between outdoor air pollution and neurological health outcomes
- Many of the existing studies have focused on long-term exposures and traffic-related air pollutants

TABLE 7 Neurological and psychiatric conditions tentatively associated with air pollution and examples of markers of neurological effects

Conditions	Alzheimer's disease and other dementias
	Parkinson's disease
	Reduced cognitive function in adults
	Delayed neurodevelopment in children
	Depression
	Anxiety disorders
Markers	Structural brain damage at functional magnetic resonance imaging
	Neurobehavioral testing
	Cognitive function testing



Cities	HR (95%CI)
Upper Marlboro (MD)	0.80 (0.75–0.86)
Rockville (MD)	0.90 (0.84–0.97)
Erie (PA)	0.91 (0.80–1.04)
Buffalo (NY)	0.96 (0.89–1.05)
Essex (MA)	0.98 (0.91–1.06)
Washington (PA)	1.00 (0.89–1.14)
York (PA)	1.04 (1.00–1.08)
Nashua (NH)	1.05 (0.93–1.19)
Bangor (ME)	1.06 (0.88–1.28)
Rochester (NY)	1.07 (0.99–1.16)
Portland (ME)	1.08 (1.03–1.13)
Mercer (PA)	1.08 (0.86–1.36)
Greensburg (PA)	1.08 (0.97–1.22)
Jersey City (NJ)	1.08 (1.03–1.15)
Lancaster (PA)	1.08 (1.03–1.14)
Plymouth (MA)	1.09 (1.01–1.17)
Paterson (NJ)	1.11 (1.08–1.13)
Baltimore (MD)	1.11 (1.05–1.18)
Toms River (NJ)	1.12 (1.06–1.18)
Reading (PA)	1.12 (1.06–1.19)
Burlington (VT)	1.12 (0.95–1.33)
Atlantic City (NJ)	1.13 (1.04–1.23)
Bath (NY)	1.14 (0.92–1.42)
Albany (NY)	1.14 (1.05–1.25)
Philadelphia (PA)	1.15 (1.12–1.19)
Scranton (PA)	1.16 (1.06–1.28)
Gettysburg (PA)	1.18 (0.94–1.48)
Elizabeth (NJ)	1.18 (1.10–1.27)
Newburgh (NY)	1.18 (1.05–1.32)
Middlesex (NJ)	1.19 (1.15–1.24)
Boston (MA)	1.19 (1.15–1.23)
Washington (DC)	1.20 (1.11–1.29)
Newark (NJ)	1.20 (1.14–1.27)
Trenton (NJ)	1.20 (1.10–1.31)
Dover (DE)	1.21 (1.07–1.37)
Stamford (CT)	1.21 (1.14–1.28)
Pittsburgh (PA)	1.23 (1.16–1.31)
Worcester (MA)	1.24 (1.09–1.41)
Wilmington (DE)	1.26 (1.17–1.35)
Allentown (PA)	1.26 (1.19–1.34)
Providence (RI)	1.27 (1.09–1.48)
Springfield (MA)	1.27 (1.10–1.47)
Harrisburg (PA)	1.28 (1.16–1.41)
State College (PA)	1.31 (1.12–1.54)
New Haven (CT)	1.32 (1.23–1.42)
New York (NY)	1.32 (1.28–1.36)
New London (CT)	1.32 (1.18–1.48)
Melville (NY)	1.34 (1.27–1.42)
Carlisle (PA)	1.36 (1.24–1.48)
Hartford (CT)	1.42 (1.32–1.52)
Summary	**1.15 (1.11–1.19)**



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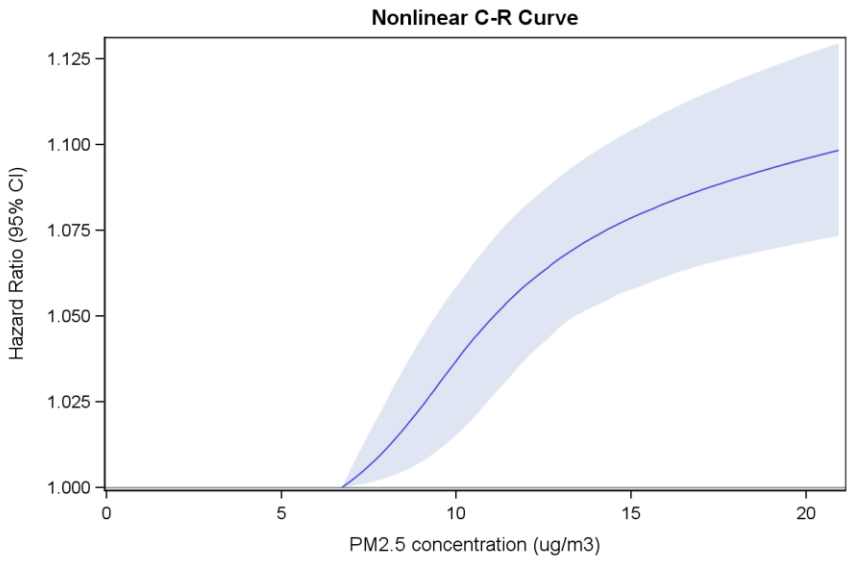
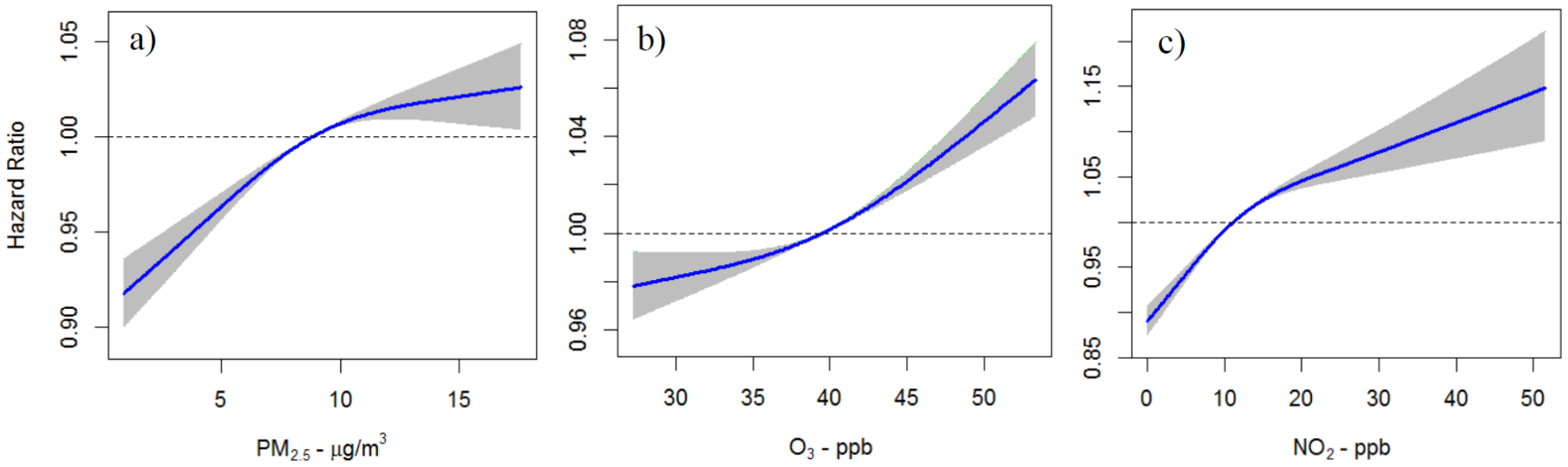
4. MORTALITY RISK AT LOW AMBIENT CONCENTRATIONS



- Mortality risk is associated with outdoor air pollution
- Ambient air pollution concentrations in the US are generally lower than the average exposures levels from US-based prospective cohort studies ($PM_{2.5}$ = 14.4 µg/m³)



Mean $PM_{2.5}$ = 8.9 µg/m3

Mean O_3 = 39.6 ppb

Mean NO_2 = 11.6 ppb

"a relative risk in ischemic heart disease mortality of 1.20 associated with a change in $PM_{2.5}$ exposure from 5 µg/m^3 to 10 µg/m^3."

Canadian Census Health and Environment Cohort Study

Maintaining a Focus on Health

Risk communication, regulatory review, and program development

HEALTH EFFECTS OF AIR POLLUTION

Air Quality Index (AQI) - A Guide to Air Quality and Your Health
U.S. Environmental Protection Agency
The AQI is an index for reporting daily air quality so citizens can reduce their exposure to poor air quality and learn about the associated health effects that may be concern to them.

1. What Is the AQI?

The AQI is a tool that simplifies reporting air quality to the general public. The AQI incorporates into a single index concentrations of 5 criteria pollutants: ozone (O^3), particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO^2), and nitrogen dioxide (NO^2). The scale of the index is divided into general categories that are associated with health messages.

2. Why Report the AQI?

The AQI offers various advantages:

a. It is simple to create and understand.

b. It conveys the health implications of air quality.

c. It promotes uniform use throughout the country.

3. Must I Report the AQI?

You must report the AQI daily if yours is a metropolitan statistical area (MSA) with a population over 350,000.

4. What Goes Into My AQI Report?

i. Your AQI report must contain the following:

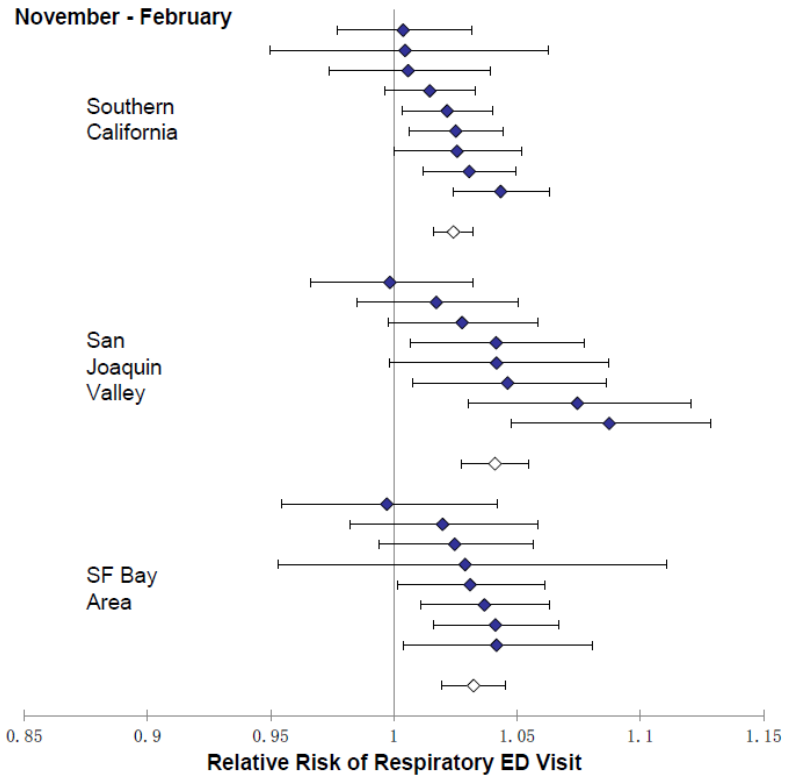
a. The reporting area(s) (the MSA or subdivision of the MSA).

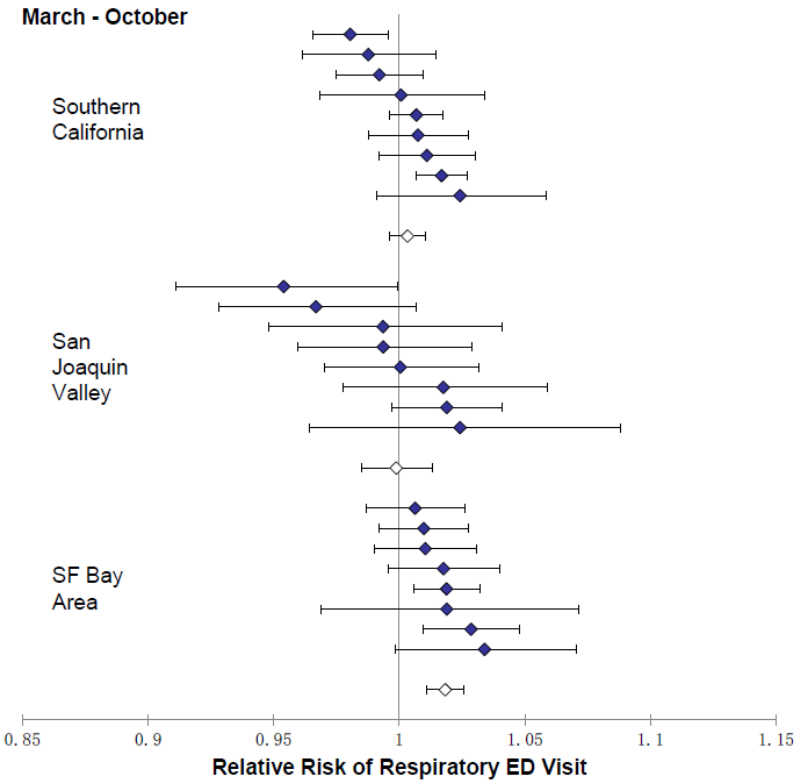
b. The reporting period (the day for which the AQI is reported).

c. The critical pollutant (the pollutant with the highest index value).

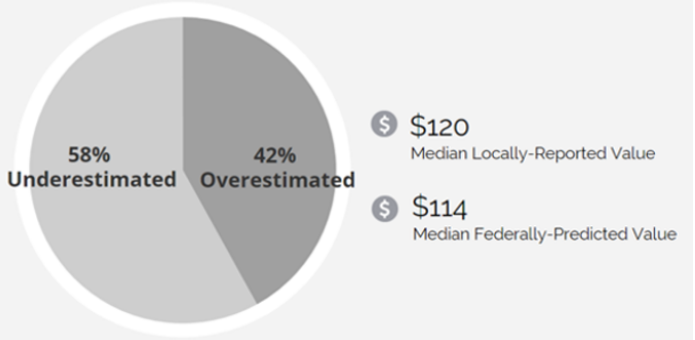
d. The AQI (the highest index value).

e. The category descriptor and index value associated with the AQI and, if you choose to report in a color format, the associated color. Use only the following descriptors and colors for the six AQI categories:


November - February
Southern California
San Joaquin Valley
SF Bay Area
0.85
0.9
0.95
1
1.05
1.1
1.15
Relative Risk of Respiratory ED Visit

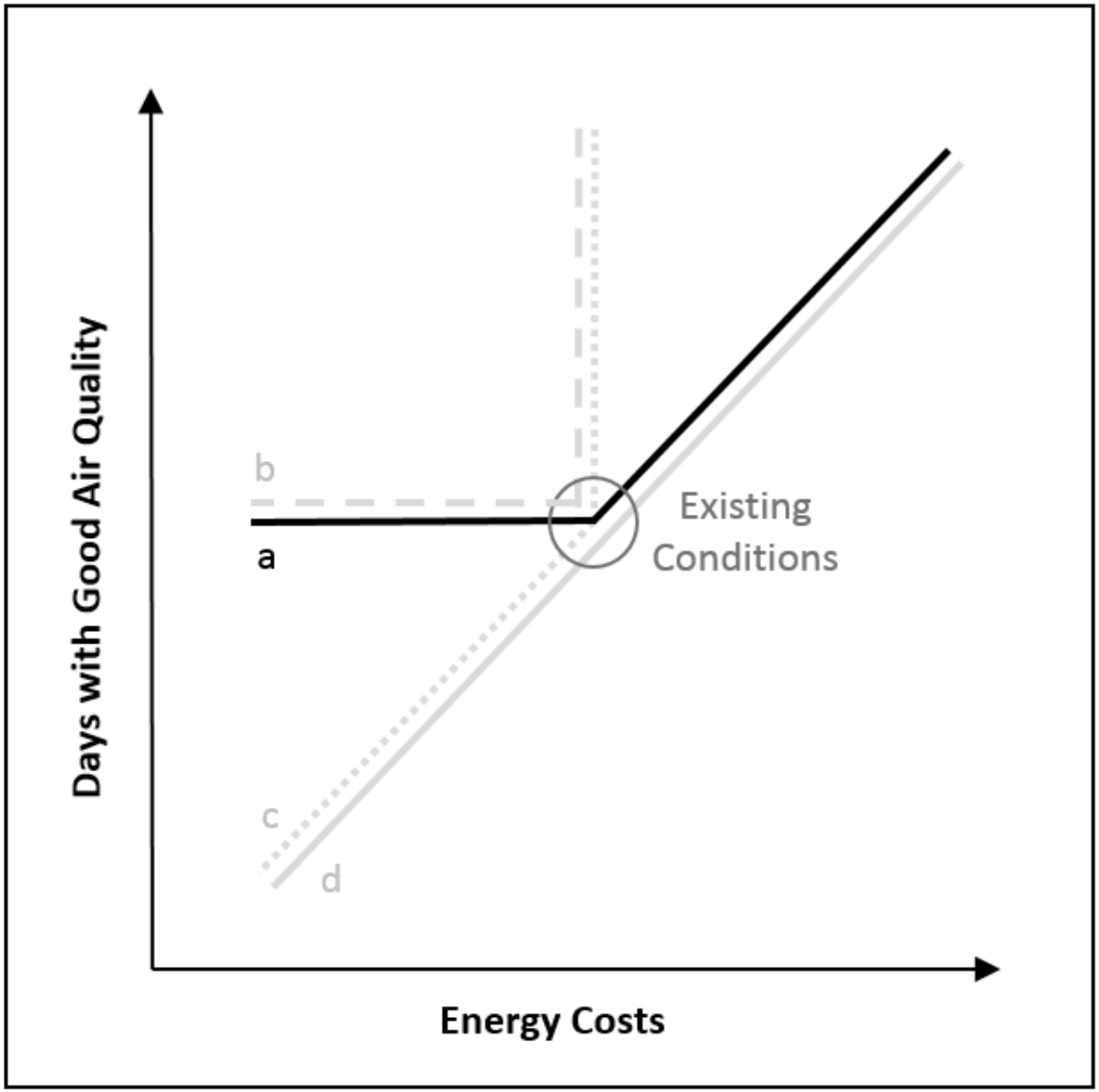

March - October
Southern California
San Joaquin Valley
SF Bay Area
0.85
0.9
0.95
1
1.05
1.1
1.15
Relative Risk of Respiratory ED Visit

Use of Federal Methods for Regulatory Review at the State Level



Air Pollution Impact	Selected Most Important
Personal Mortality Risk	35%
Mortality Risk for Others	23%
Personal Respiratory Events	18%
Crop/Vegetation Damage	12%
Respiratory Events for Others	8%
Reduced Visibility	4%

- Consideration of the health impacts of air pollution is an institutionalized aspect of federal rulemaking
- Some states may not consistently perform quantitative analysis for air quality regulations prior to implementation


Days with Good Air Quality
Energy Costs
b
a
Existing
Conditions
c
d