EPA's Benefit Cost Analysis

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Texas Commission on Environmental Quality

Mission Statement:

The Texas Commission on Environmental Quality strives to protect our state's human and natural resources consistent with sustainable economic development. Our goal is clean air, clean water, and the safe management of waste.

The TCEQ regularly weighs matters that affect the environment and economy. Our goal is sensible regulation that addresses real environmental risks, while being based on sound science and compliance with state and federal statutes. In every case where Texas disagrees with EPA's action, it is because EPA's action is not consistent with these principles.

Background

- March 2011 – EPA published “Benefits and Costs of the Clean Air Act from 1990 to 2020 (Second Prospective Study)”
  - Benefits ($2T) outweigh costs ($65B) by 30 to 1
    - TCEQ staff examined this analysis, focusing on:
      - The studies used
      - The assumptions made
      - The methods employed

Regulatory Impact Analyses

- President requires RIAs (Regulatory Impact Analyses) from all agencies proposing significant regulations

- RIA should help determine if the benefits of an action are likely and justify the costs or discover which of various possible alternatives would be the most cost-effective
  - (OMB circular A4, 09/2003)

- RIAs are NOT subject to peer or public review

Key legislation – Executive Orders

- EO12291 – Reagan, 1981
  - "Regulatory action shall not be undertaken unless the potential benefits to society for the regulation outweigh the potential costs to society…the alternative involving the least net cost to society shall be chosen"
- EO12866 – Clinton, 1993
  - Key change: benefits must justify the costs
- EO13563 – Obama, 2011
  - Benefits must justify the costs
  - New: equity, human dignity, fairness and distributive impacts are required to be considered
  - "Our regulatory system must protect public health, welfare, safety, and our environment while promoting economic growth, innovation, competitiveness, and job creation"

Use of $PM_{2.5}$ in RIAs

- EPA uses estimates of benefits from reducing $PM_{2.5}$ in its RIAs for rulemakings under the Clean Air Act
  - This is called "co-benefits" because a $PM_{2.5}$ reduction is expected from efforts to reduce other air pollutants
- Trend towards using $PM_{2.5}$ as primary source of benefits in most RIAs since 1997
  - Even when regulation is not intended to protect public health from exposures to ambient $PM_{2.5}$

Table 2. Summary of Degree of Reliance on $PM_{2.5}$-Related Co-Benefits in RIAs Since 1997 for Major Non-$PM_{2.5}$ Rulemakings under the CAA
(RIAs with no quantified benefits at all are not in this table. Where ranges of benefit and/or cost estimates are provided, percentages are based on upper bound of both the benefits and cost estimates. Estimates using the 7% discount rates are used in all cases.)

Year	RIAs for Rules NOT Based on Legal Authority to Regulate Ambient $PM_{2.5}$	$PM_{2.5}$ Co-Benefits Are >50% of Total	$PM_{2.5}$ Co-Benefits Are Only Benefits Quantified
1997	Ozone NAAQS (.12 1hr=>.08 8hr)	×	
1997	Pulp&Paper NESHAP		
1998	NOx SIP Call & Section 126 Petitions		
1999	Regional Haze Rule	×	
1999	Final Section 126 Petition Rule	×	
2004	Stationary Reciprocating Internal Combustion Engine	×	
2004	Industrial Boilers & Process Heaters NESHAP	×	×
2005	Clean Air Mercury Rule	×	
2005	Clean Air Visibility Rule/BART Guidelines	×	
2006	Stationary Compression Ignition Internal Combustion		
2007	Control of HAP from mobile sources	×	×
2008	Ozone NAAQS (.08 8hr =>.075 8hr)	×	
2008	Lead (Pb) NAAQS	×	
2009	New Marine Compress'n-Ign Engines >30 L per	×	
2010	Reciprocating Internal Combustion Engines NESHAP	×	×
2010	EPA/NHTSA Joint Light-Duty GHG & CAFES		
2010	SO2 NAAQS (1-hr, 75 ppb)	×	> 99.9%
2010	Existing Stationary Compression Ignition Engines	×	×
2011	Industrial, Comm, and Institutional Boilers NESHAP	×	×
2011	Indus'l, Comm'l, and Institutional Boilers & Process	×	×
2011	Comm'l & Indus'l Solid Waste Incin. Units NSPS &	×	×
2011	Control of GHG from Medium & Heavy-Duty		
2011	Ozone Reconsideration NAAQS	×	
2011	Utility Boiler MACT NESHAP (Final Rule's RIA)	×	≥ 99%
2011	Mercury Cell Chlor Alkali Plant Mercury Emissions	×	
2011	Sewage Sludge Incineration Units NSPS & Emission	×	×
2011	Ferroalloys Production NESHAP Amendments	×	×

2009 Change in Methodology

From Smith, 2012 testimony

Key Changes in $PM_{2.5}$ Methodology

- The Benefits and Costs of the Clean Air Act from 1990 to 2020 (March 2011)

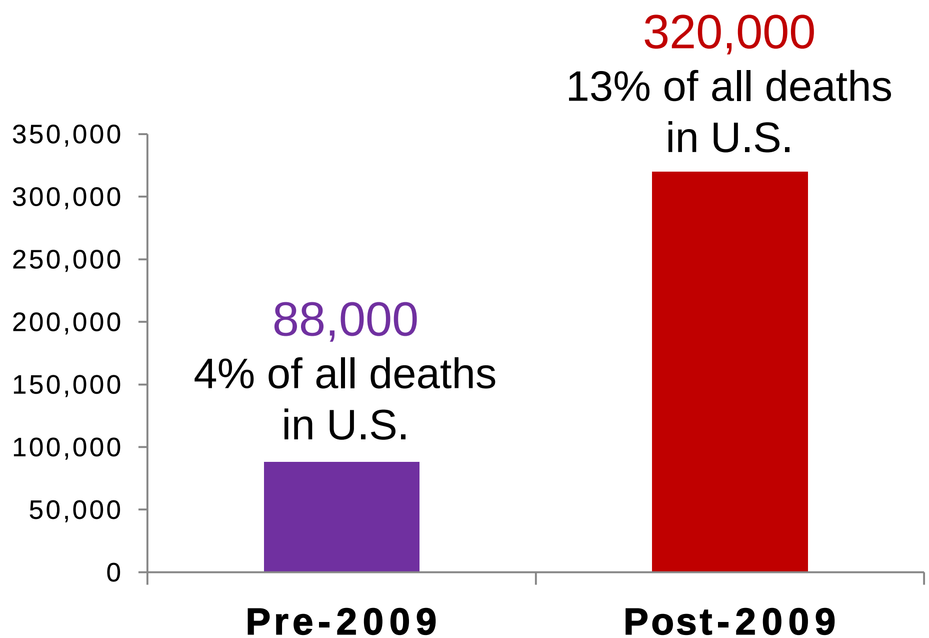
  1. A no-threshold model for $PM_{2.5}$ that calculates incremental benefits down to the lowest modeled air quality levels
  2. Risks attributed to very low (background) levels of ambient $PM_{2.5}$
  3. Assumption of causal relationship between $PM_{2.5}$ and mortality
  4. A Value of Statistical Life (VSL)

Result of Key Changes in $PM_{2.5}$ Methodology

Change in deaths attributable to $PM_{2.5}$

Increased estimates of benefits

Number of Deaths due to $PM_{2.5}$ in 2005

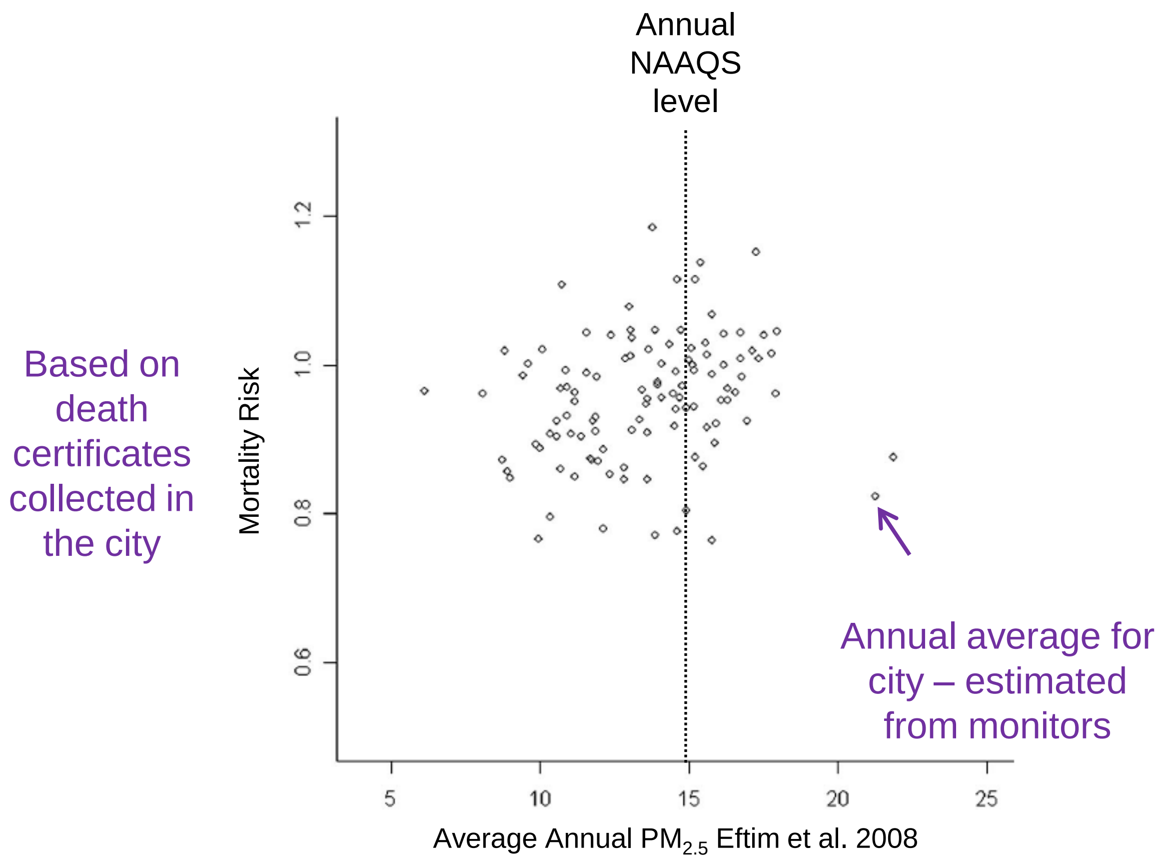


Source: EPA 2010 Quantitative Health Risk Assessment for $PM_{2.5}$ Table G-1

Despite improvement in air quality since the CAAA

1. No Threshold Model

- A no-threshold model for $PM_{2.5}$ that calculates incremental benefits down to the lowest modeled air quality levels



Adapted from Smith 2011

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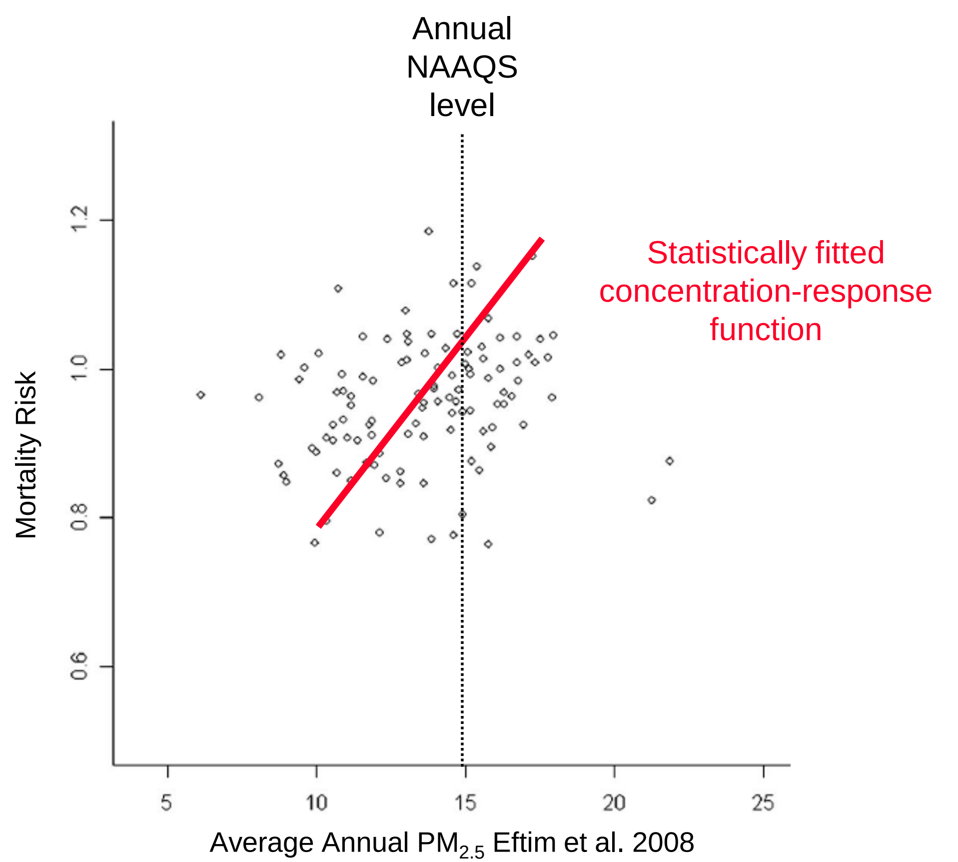

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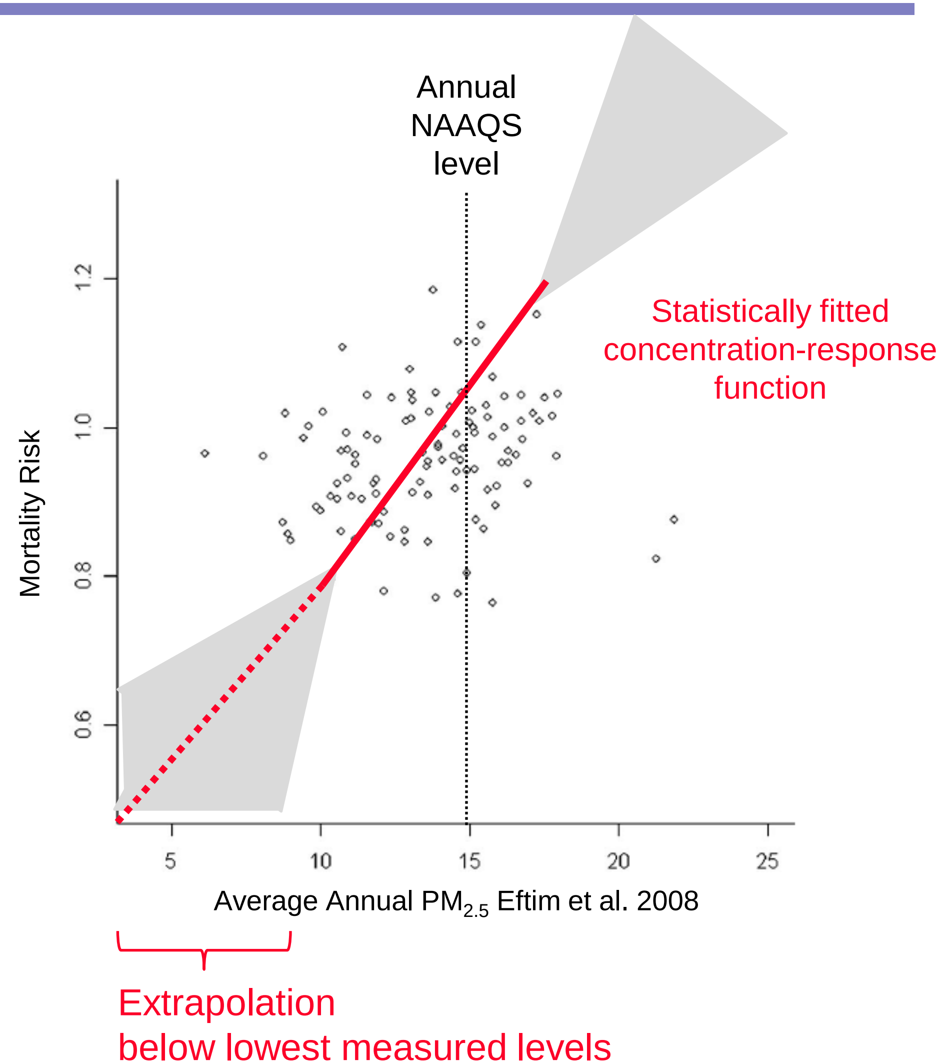


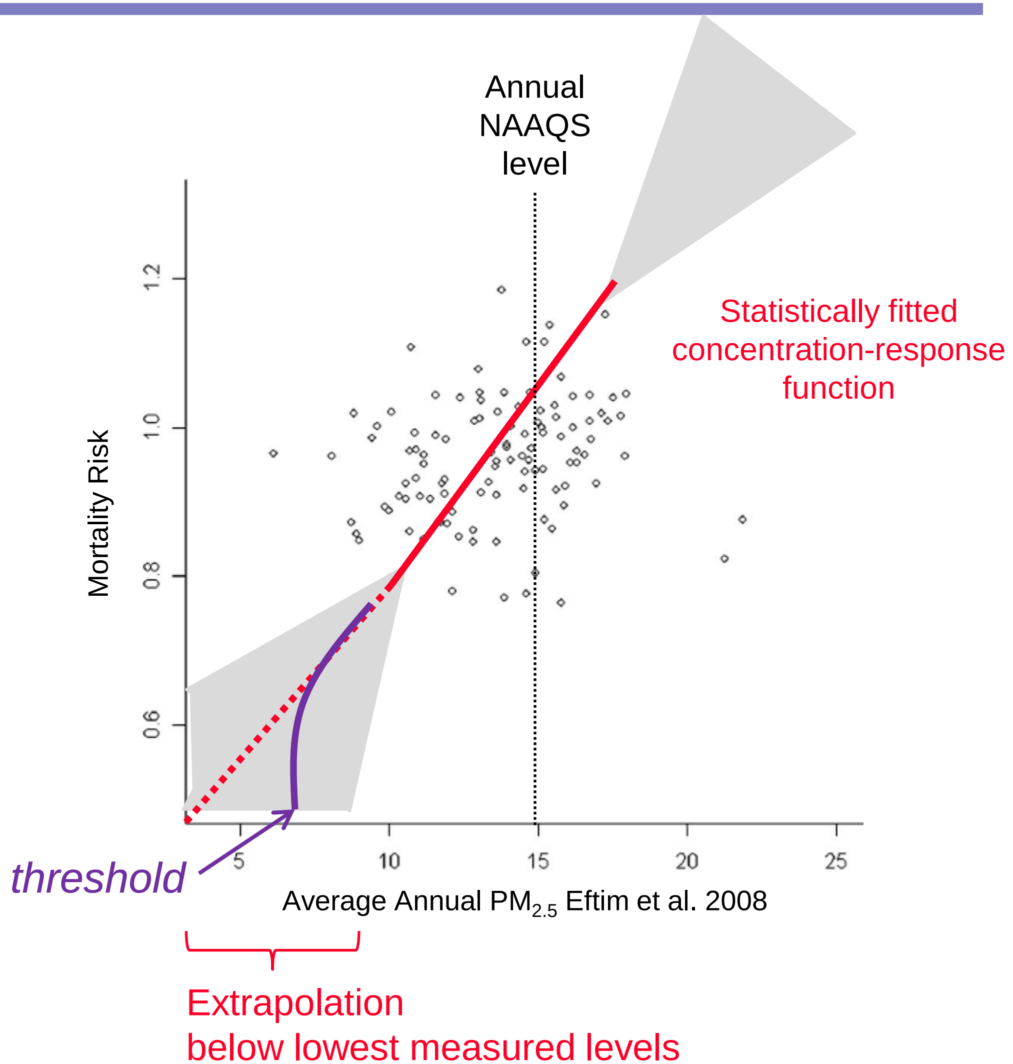
Adapted from
Smith 2011

1. No Threshold Model

- A no-threshold model for $PM_{2.5}$ that calculates incremental benefits down to the lowest modeled air quality levels

1. Question: what is the shape of the curve in the low-dose range?

2. Question: is there significant risk associated with ambient $PM_{2.5}$ levels?



Adapted from Smith 2011

Clinical Exposure Studies Conducted by EPA

January 2010 – June 2011

41 Volunteers

Dose:35 – 750 ug/m^3

Results:

1 individual: elevated heart rate
1 individual: irregular heart beat*
39 individuals: no clinical effects

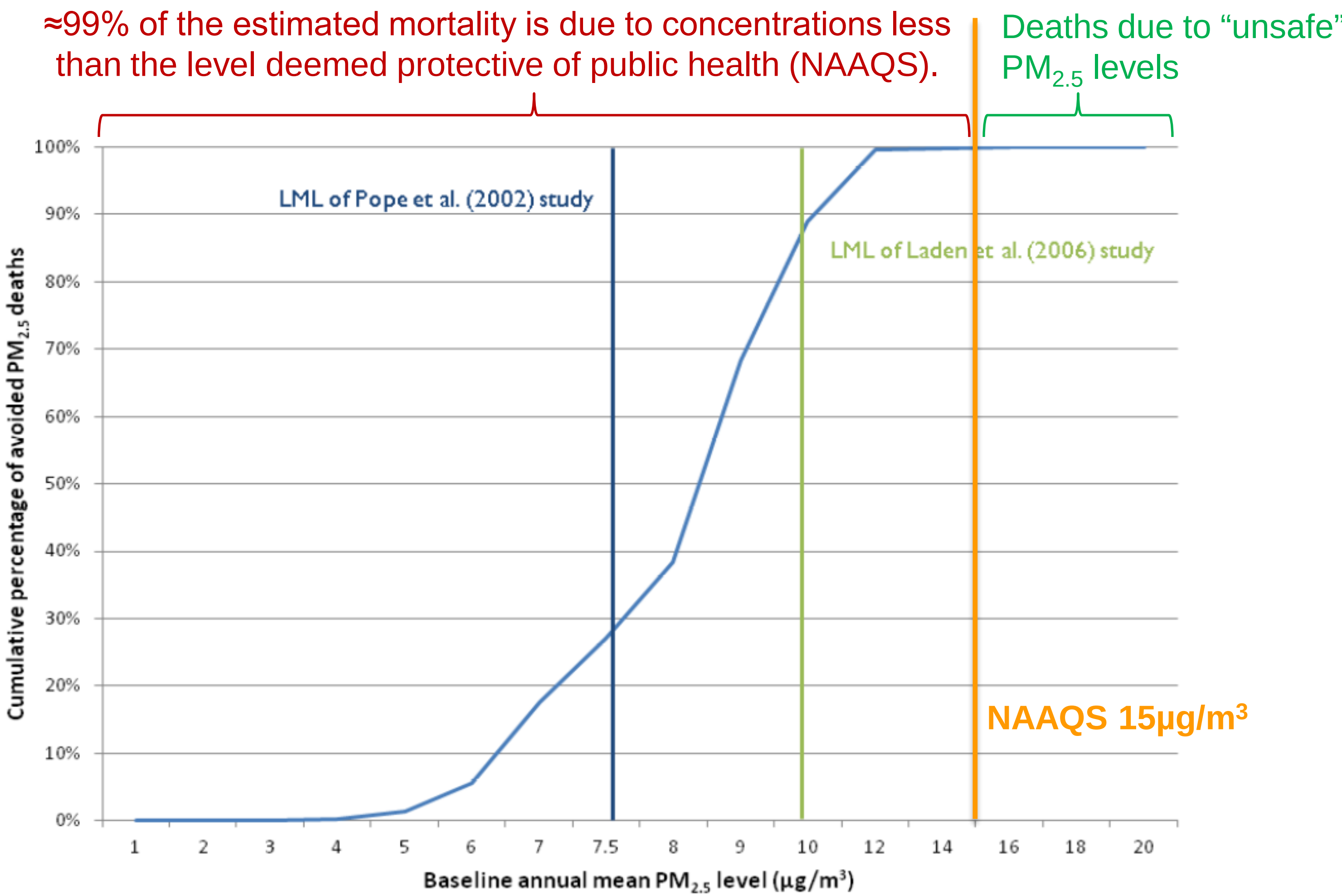
** Case Report: Supraventricular Arrhythmia after Exposure to Concentrated Ambient Air Pollution Particles. Ghio et al. EHP. Feb. 2012. 120:275-277*

FOIA # HQ-FOI-02235-11

Exposure Date	SUBJECT	Entered Chamber	Exited Chamber	Filter Conc (ug/m3)	Clinical Effects*
1/5/2010	OMC019	11:02	13:02	205.27	No clinical effects requiring follow-up observed
1/6/2010	KCN112	9:34	11:34	153.58	No clinical effects requiring follow-up observed
2/9/2010	OMC021	10:52	12:52	442.49	No clinical effects requiring follow-up observed
3/9/2010	OMC023	10:45	11:08	750.83	No clinical effects requiring follow-up observed
3/23/2010	OMC024	10:49	12:49	147.42	No clinical effects requiring follow-up observed
4/13/2010	OMC025	10:43	12:43	431.06	No clinical effects requiring follow-up observed
4/20/2010	OMC026	11:19	13:19	336.56	No clinical effects requiring follow-up observed
4/27/2010	OMC027	11:00	13:00	257.18	No clinical effects requiring follow-up observed
4/28/2010	KCN111	9:13	11:13	154.36	No clinical effects requiring follow-up observed
5/4/2010	OMC028	10:54	12:54	326.78	No clinical effects requiring follow-up observed
5/5/2010	KCN113	9:26	11:26	578.95	No clinical effects requiring follow-up observed
5/11/2010	OMC022	10:51	12:51	247.77	No clinical effects requiring follow-up observed
6/8/2010	OMC030	10:48	12:48	257.12	No clinical effects requiring follow-up observed
6/15/2010	OMC031	11:28	13:28	468.96	No clinical effects requiring follow-up observed
6/29/2010	OMC033	11:04	13:04	321.36	No clinical effects requiring follow-up observed
7/13/2010	OMC034	10:49	12:49	177.02	No clinical effects requiring follow-up observed
7/15/2010	XCE224	11:10	13:10	137.19	No clinical effects requiring follow-up observed
8/10/2010	OMC035	11:00	13:00	411.98	No clinical effects requiring follow-up observed
8/12/2010	XCE225	10:59	12:59	157.63	No clinical effects requiring follow-up observed
8/25/2010	KCN114	9:55	11:55	232.91	No clinical effects requiring follow-up observed
9/9/2010	XCE226	10:55	12:55	87.36	No clinical effects requiring follow-up observed
9/23/2010	XCE228	11:05	13:05	174.61	No clinical effects requiring follow-up observed
10/6/2010	KCN115	9:31	11:31	131.50	No clinical effects requiring follow-up observed
10/7/2010	XCE227	11:21	12:10	111.68	Removed from chamber due to new onset of atrial fibrillation. Individual reverted to normal sinus rhythm approximately two hours later. Individual was admitted to the hospital overnight for observation and telemetry. Detailed in Ghio et al., 2011 Case Report, Environ Health Perspect doi:10.1289/ehp.1103877
11/18/2010	XCE229	11:14	13:14	59.09	No clinical effects requiring follow-up observed
12/2/2010	XCE231	10:55	12:55	35.60	No clinical effects requiring follow-up observed
1/6/2011	XCE233	11:05	13:05	43.65	No clinical effects requiring follow-up observed
1/24/2011	XCE232	10:47	12:47	150.63	No clinical effects requiring follow-up observed
1/31/2011	XCE234	11:03	13:03	90.95	No clinical effects requiring follow-up observed
2/3/2011	XCE236	11:12	13:12	57.91	No clinical effects requiring follow-up observed
2/10/2011	XCE235	11:12	11:35	66.26	Removed from chamber due to a short episode of an elevated heart rate during exposure. The individual denied any symptoms. This individual was provided with copies of the EKG and holter recording and referred to MD.
2/24/2011	XCE238	10:57	12:57	103.51	No clinical effects requiring follow-up observed
3/28/2011	XCE239	10:52	12:52	80.06	No clinical effects requiring follow-up observed
4/14/2011	XCE237	10:48	12:48	93.24	No clinical effects requiring follow-up observed
4/18/2011	XCE242	11:09	13:09	72.89	No clinical effects requiring follow-up observed
4/25/2011	XCE240	11:05	13:05	41.54	No clinical effects requiring follow-up observed
5/2/2011	XCE244	11:13	13:13	85.31	No clinical effects requiring follow-up observed
5/16/2011	XCE243	11:00	13:00	142.50	No clinical effects requiring follow-up observed
5/23/2011	XCE245	10:57	12:57	266.92	No clinical effects requiring follow-up observed
6/2/2011	XCE247	11:00	13:00	179.58	No clinical effects requiring follow-up observed
6/9/2011	XCE246	10:55	12:55	359.52	No clinical effects requiring follow-up observed

* Note : Clinical Effects is defined as requiring medical follow-up or referral to physician

2. Risk Attributed to Ambient PM2.5

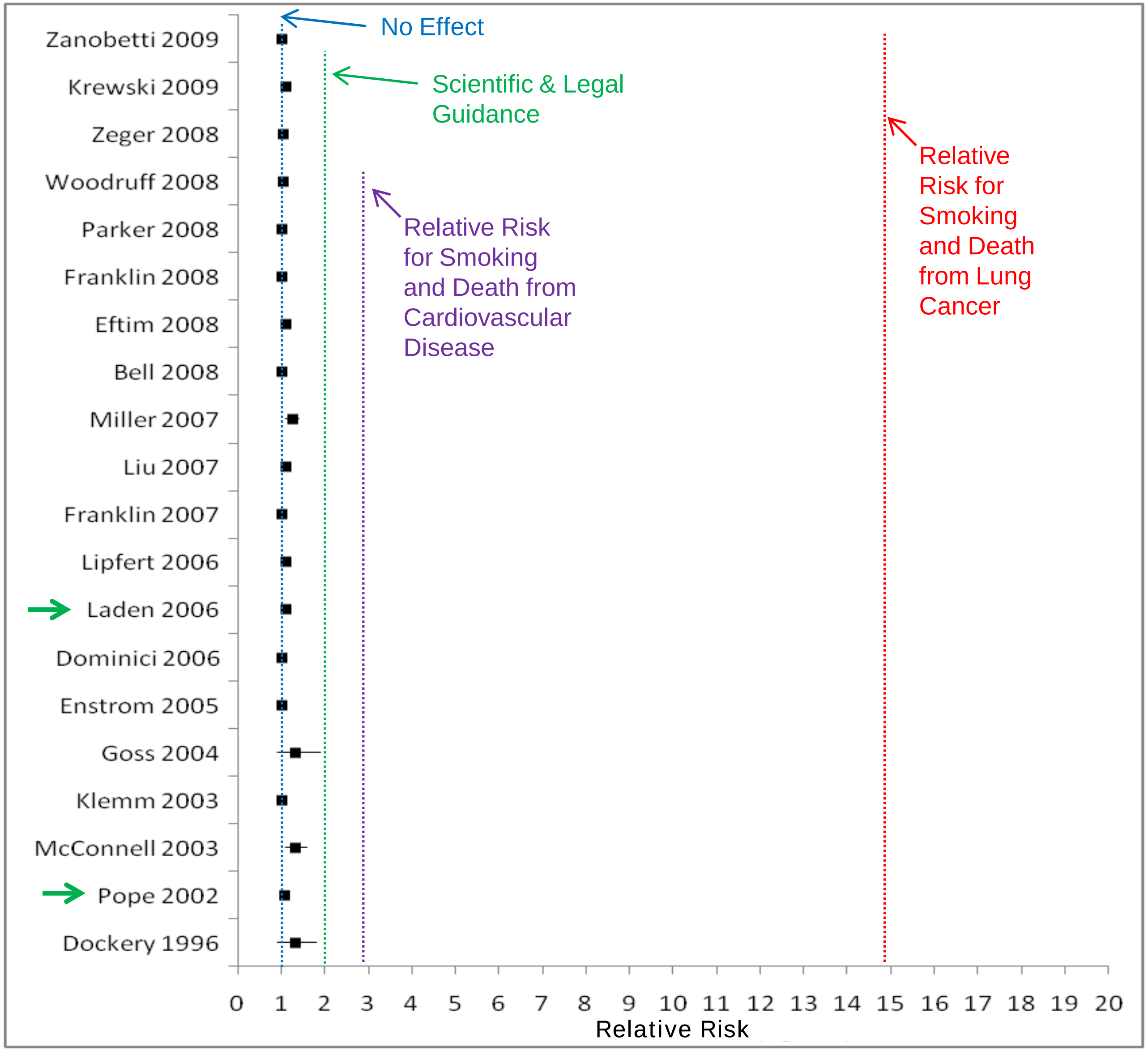


Of the total PM-related deaths avoided:

73% occur among population exposed to PM levels at or above the LML of the **Pope et al.** study.

11% occur among population exposed to PM levels at or above the LML of the **Laden et al.** study.

3. Assumption of Causality



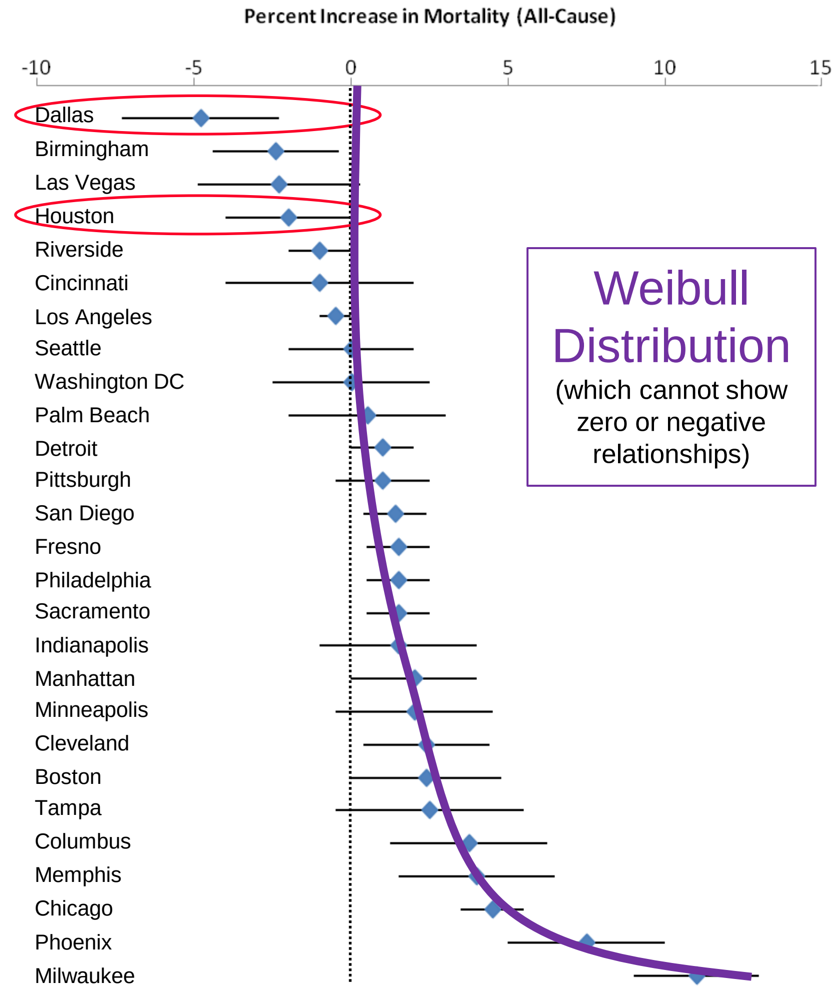
3. Assumption of Causality

- The epidemiology studies cannot show causality

- The analysis "assumes a causal relationship between $PM_{2.5}$ exposure and premature mortality…if the $PM_{2.5}$/mortality relationship is not causal, it would lead to a significant overestimation of net benefits"

-*EPA, The Benefits and Costs of the Clean Air Act from 1990 to 2020, March 2011*

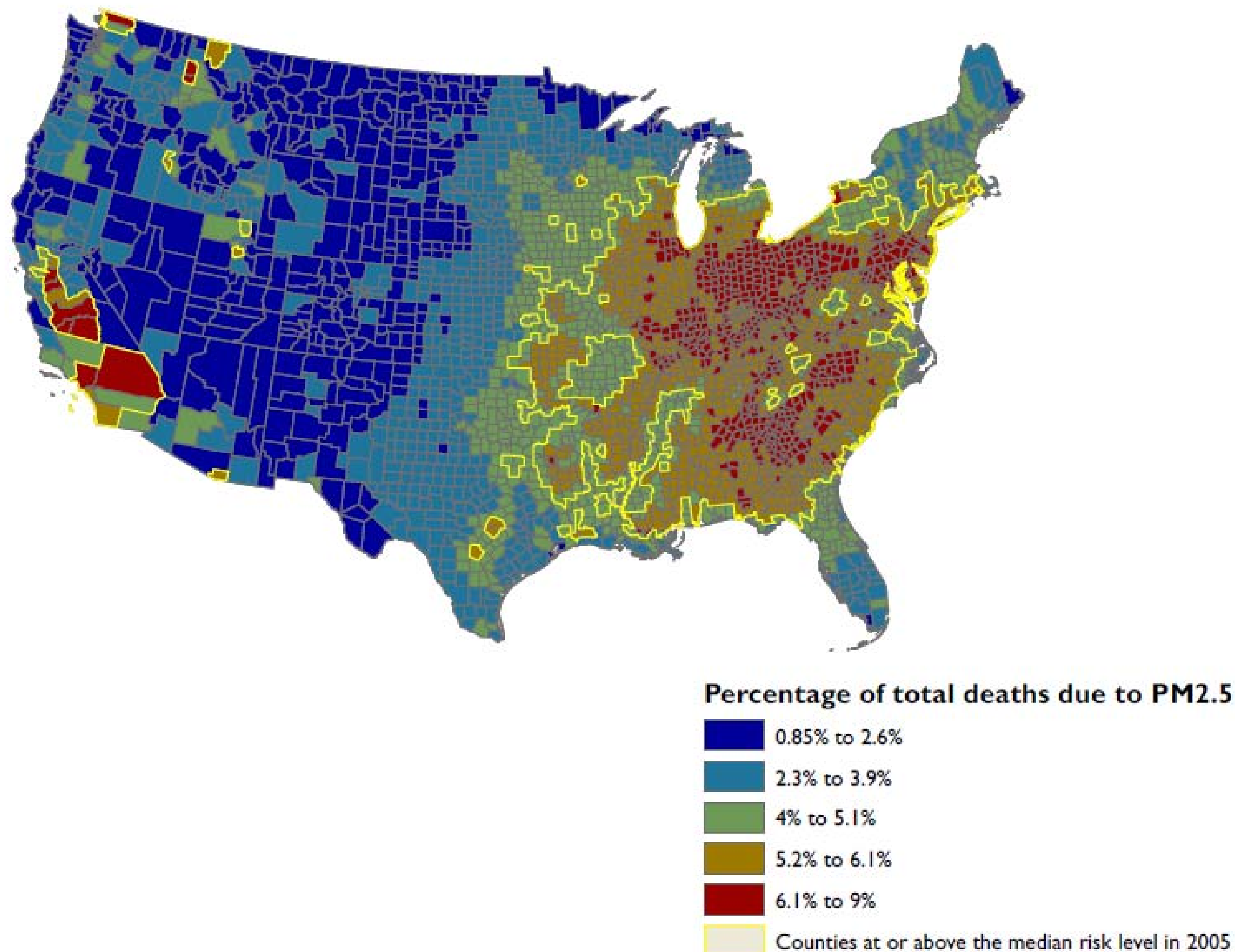
$PM_{2.5}$ -Mortality Coefficient Estimates and 95% CI
Adapted from Franklin et al. 2007



Estimates of the percent Increase in all-cause mortality with a 10 µg/m³ increase in previous day's concentration $PM_{2.5}$

Extrapolation of Mortality Estimates

Figure C-2. Distribution of $PM_{2.5}$ Mortality Risk in 2005



From EPA – Regulatory Impact Analysis of the Proposed Toxics Rule: Final Report – March 2011

4. Value of Statistical Life Definition

- A Value of Statistical Life (VSL) = value of risk reduction
  - A “statistical life” has traditionally referred to the aggregation of small risk reductions across many individuals until that aggregate reflects a total of one statistical life
  - The VSL has been a shorthand way of referring to the monetary value or tradeoff between income and mortality risk reduction, i.e. the willingness to pay for small risk reductions across large numbers of people
  - It has led to confusion because it has been interpreted as referring to the loss of identified lives

If risk was reduced
by 1 in 1,000,000
for 1 year
in a population of 200 million

savings of 200 **statistical** lives = value of risk reduction

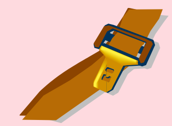
≠

savings of 200 **actual** lives

Deriving Value of Statistical Life

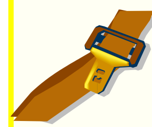
Willingness to Pay – Road Hazard Studies

- Example:
  - Cars with seatbelts cost $300 more than cars without seatbelts



$300

  - Buying a car with that option reduces the probability of death by 1 in 100,000



Probability of death by **1 in 100,000**

  - If people are willing to pay for this option, we can infer that the person is placing a valuation on his/her life of at least $300 x 100,000 = 30,000,000 ($30 million)

$300
x 100,000
= $30 million

Deriving Value of Statistical Life

Income vs. Risk – Occupational Studies

- Example:
  - A job carries a higher risk of injury, but pays $ 500 more per year

VS

$ 500

  - The more dangerous job carries an increased risk of injury by 1 in 10,000

Probability of injury by **1 in 10,000**

  - If people are willing to pay for this option, we can infer that the individuals are placing a valuation on their lives of at least $500 x 10,000 = 5,000,000 ($5 million)

$ 500
x 10,000
= $5 million

Interpreting VSL in the Media

"When these new [EGU MACT] standards are finalized, they **will assist in preventing** 11,000 heart attacks, **17,000 premature deaths**, 120,000 cases of childhood asthma symptoms and approximately 11,000 fewer cases of acute bronchitis among children each year. Hospital visits will be reduced and nearly 850,000 fewer days of work will be missed due to illness."

- Lisa Jackson, EPA Administrator, 2011

This was interpreted as:

"EPA's proposed mercury and air toxics standards … **are projected to save as many as 17,000 American lives** …

- John D. Walke, Natural Resources Defense Council, 2011

"These new standards mark a huge step forward in clean air protections and **will be responsible for saving thousands of lives** each year."

- Albert A. Rizzo, MD, National Volunteer Chair of the American Lung Association

"The new EPA mercury standards **will save countless lives** and improve the quality of life for millions."

- New York Mayor Michael Bloomberg

Appropriate Use of Value of Statistical Life

The Benefits and Costs of the Clean Air Act fron 1990 to 2020

TABLE 5-8. LIFE YEARS GAINED AND LIFE EXPECTANCY GAIN ESTIMATES FROM THE POPULATION SIMULATION MODEL

AGE COHORT		LIFE-YEARS GAINED IN SPECIFIC YEARS (ANNUAL)		CUMULATIVE LIFE YEARS GAINED THROUGH TARGET YEAR		LIFE EXPECTANCY GAINS (YEARS)		
START AGE	END AGE	2020	2040	2020	2040	2010	2020	2040
30	39	17,000	18,000	260,000	620,000	0.65	0.87	0.91
40	49	60,000	71,000	910,000	2,300,000	0.63	0.84	0.88
50	59	150,000	180,000	2,000,000	5,400,000	0.59	0.79	0.84
60	69	330,000	380,000	3,500,000	11,000,000	0.53	0.71	0.76
70	79	470,000	840,000	5,000,000	20,000,000	0.44	0.59	0.64
80	89	470,000	1,200,000	6,000,000	23,000,000	0.32	0.43	0.48
90	99	320,000	800,000	3,600,000	14,000,000	0.19	0.25	0.27
100+		60,000	200,000	490,000	3,100,000	0	0	0
	Total	1,900,000	3,800,000	22,000,000	80,000,000			

Note: Column entries to not add to totals due to rounding. Life expectancy results are incremental period conditional life expectancy gains at the start age of the cohort.

EPA VSL:$8,900,000

- Lives Saved vs. Life-Years Added
  - Deaths "prevented or avoided"
  - Gains in life expectancy

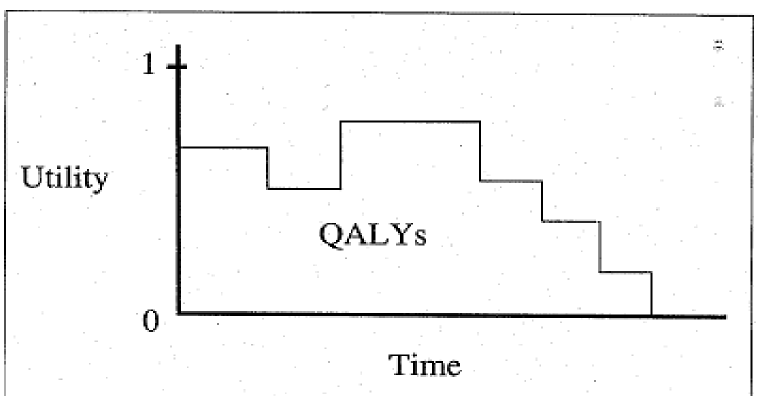


Figure: Determining Quality-Adjusted Survival—Length of life (time) is plotted against quality of life (utility). The area under the curve represents quality-adjusted survival measured in quality-adjusted life years (QALYs).

From Weeks 1995

- The median age of people who gain extra months of life from cleaner air is close to 80 years
- Adjustment of VSL for quality of life:
  - EPA VSL of $8,900,000 appropriate for healthy young adult (≈25)
  - 6:1 ratio for 25 vs. 80 year old

Clean Air Act - Benefits and Costs

reduced number of deaths in 2020 * value per statistical life saved
= 230,000 fewer deaths * $8,900,000 per life saved
≈ $2 trillion
Benefit/Cost = $2 trillion/$0.065 trillion* ≈ 30

life-years gained in 2020 * value per statistical life-year gained
=1,900,000 life-years gained * $150,000/life-year gained
≈ $0.3 trillion
Benefit/Cost = $0.3 trillion/$0.065 trillion* ≈ 5

Adjusted estimate of benefit:
$19 billion

Benefit/Cost = $0.019 trillion/$0.065 trillion* ≈ 0.3

Mercury & Air Toxics Standard

	Benefits from HAPs (billions)	"Co-Benefits" from non-HAPs (billions)
Mercury	$ 0.004-0.006	$ 1-2
Acid Gasses	$ 0	$ 32-87
Non-Hg Metals	$ 0	$ 1-2
Total	**≤$ 0.006**	**$ 33-90**

- MATS is estimated to prevent 0.00209 IQ point loss per child (starting immediately)
- Each child will gain 0.0956 school days over their lifetime
- 0.00209 IQ points x 244,468 children = 511 IQ points per year
- Assuming a net monetary loss per decrease in one IQ point of between ~$8,000 and ~$12,000 (in terms of foregone future earnings)
- Benefit = $4.2M to $6.2M

Table adapted from testimony by Anne E. Smith 2/2010 to Subcommittee on Energy and Power

Oil & Gas NSPS and NESHAPS

	Oil and Natural Gas NSPS (millions)	Oil and Natural Gas NESHAP Amendments (millions)
Benefits	NA	NA
Costs	- $15	$3.5
Non-monetized benefits	11,000 tons of HAP5 190,000 tons of VOC 1.0 million tons of methane Health effects of HAP exposure Health effects of $PM_{2.5}$ and ozone exposure Visibility impairment Vegetation effects Climate effects	670 tons of HAP 1,200 tons of VOC 420 tons of methane Health effects of HAP exposure Health effects of $PM_{2.5}$ and ozone exposure Visibility impairment Vegetation effects Climate effects

*"…**quantification of those benefits cannot be accomplished for this rule.** This is not to imply that there are no benefits of the rules; rather, it is a reflection of the difficulties in modeling the direct and indirect impacts of the reductions in emissions for this industrial sector with the data currently available."*

April 2012 RIA

PM Co-Benefits in RIAs

	$PM_{2.5}$ NAAQS	Utility Boiler MACT	Mercury Air Toxics Standard	Sewage Sludge Incineration Units	Ferroalloy NESHAP	Total Costs millions ($2006)
Estimated Statistical Deaths	15,000	11,900	2,650	25	14	
Cost	6,400	10,600	9,329	17	4	26,350

- Double counting benefits: same statistical lives counted in multiple rules
- Different costs: unique to each rule

Contact Information

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Health Effects of Poverty and Unemployment

- Poverty and unemployment have been recognized as risk factors for morbidity and mortality since the 1800's (Virchow, 1848)
  - As of March 2012, there are 4,850 publications on this topic

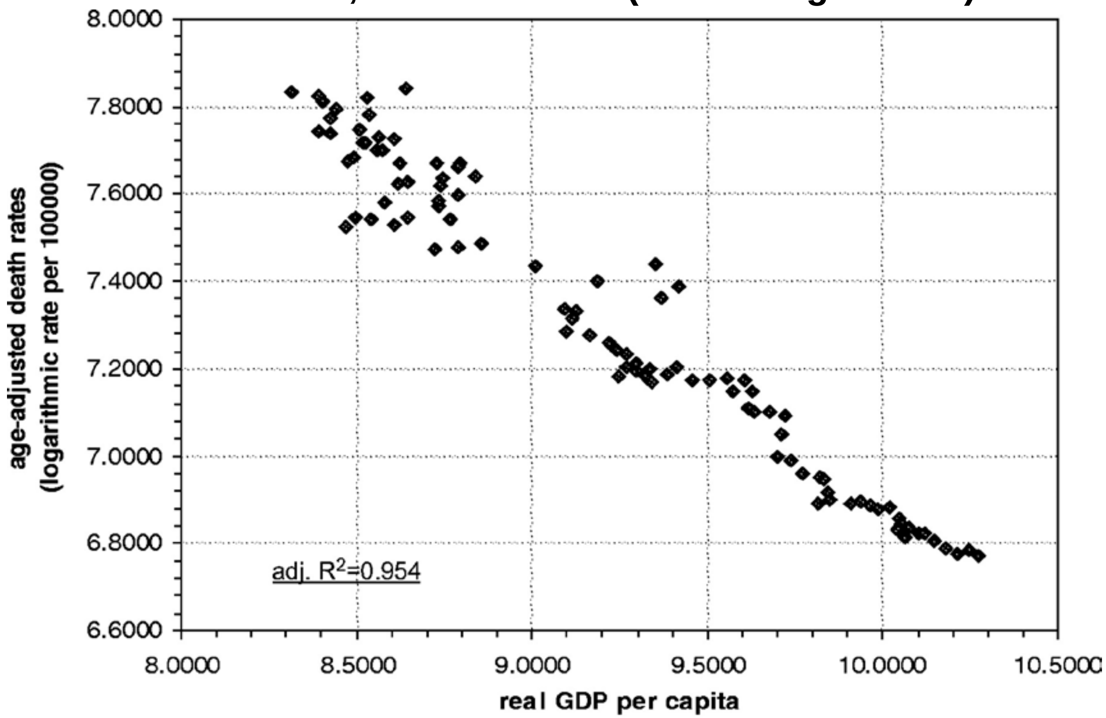
Unemployment and All-Cause Mortality

Meta-analyses stratified by gender and age [a]

Gender	Mean Age	HR (95% CI)
Women	Less than 40	1.73[b] (1.41, 2.11)
	40 to 49.9	1.34[b] (1.15, 1.56)
	50 to 65	0.94 (0.80, 1.11)
Men	Less than 40	1.95[b] (1.69, 2.26)
	40 to 49.9	1.86[b] (1.63, 2.12)
	50 to 65	1.17[c] (1.00, 1.36)

Roelfs et al. Soc Sci Med 2011; 72:840-54

Relation of real GDP per capita to age-adjusted death rates, US 1900–2000 (natural logarithms).

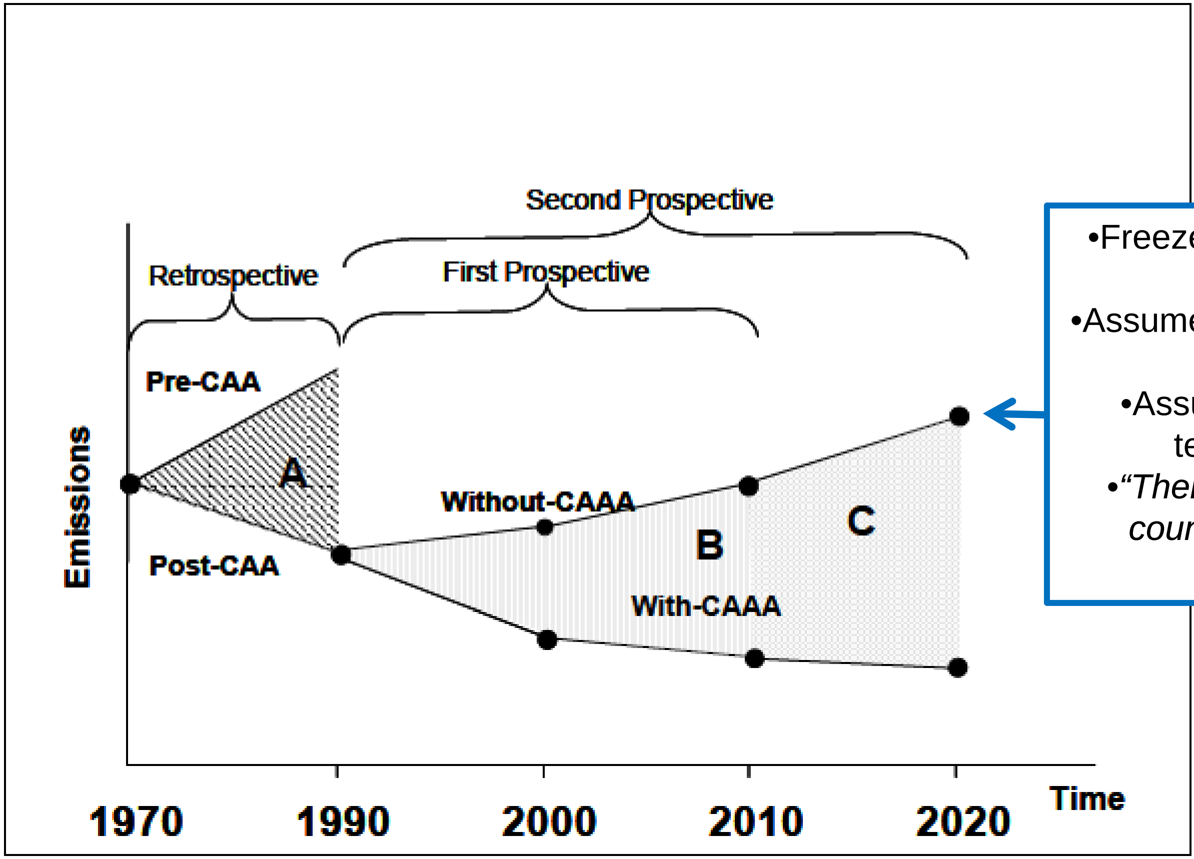


Brenner M H Int. J. Epidemiol. 2005;34:1214-1221

With CAAA vs. Without CAAA

The Benefits and Costs of the Clean Air Act fron 1990 to 2020

FIGURE 1-1. CLEAN AIR ACT SECTION 812 SCENARIOS: CONCEPTUAL SCHEMATIC



- •Freezes pollution controls at 1990 levels
- •Assumes no additional state or local regulation after 1990
- •Assumes no improvements in technology or efficiency
- •*"There is no way to validate the counterfactual, without-CAAA scenario estimates"*

Oil & Gas NESHAPS

Table 4-7 Climate Methane Benefits Using 'GWP' Approach

SCC Value for 2015 emission reductions ($/ton CO_2 in 2008 dollars)[1]	Total Benefits based on 100 year GWP adjustment[2] (millions 2008$) Final NSPS	Final NESHAP Amendments
$6 (mean 5% discount rate)	$100	$0.05
$25 (mean 3% discount rate)	$440	$0.20
$40 (mean 2.5% discount rate)	$700	$0.32
$76 (95th percentile at 3% discount rate)	$1,300	$0.60
Methane Emission Reductions[3] (MMT CO_2-e)	**17.6**	**0.008**

April 18, 2012 Press Conference

"Today's rules would yield significant reductions in methane, a potent greenhouse gas. EPA's Regulatory Impact Analysis for the rule estimates the value of the climate co-benefits that would result from this reduction at $440 million annually by 2015."
-Gina McCarthy

Reported monetized benefit: $0

Note: benefits calculated at 3%, but costs at 7%

Costs of the Clean Air Act and Amendments

Year	RIAs for Rules Not Targeting Ambient PM 2.5	PM Co-Benefits are >50% of Total	PM Co-Benefits Are Only Benefits Quantified	Cost ($ Billion)*
1997	Ozone NAAQS (.12 1hr=>.08 8hr)	x		9.60
1997	Pulp&Paper NESHAP			6.48
1998	NOx SIP Call & Section 126 Petitions			1.66
1999	Regional Haze Rule	x		1.74
1999	Final Section 126 Petition Rule	x		1.15
2004	Stationary Reciprocating Internal Combustion Engin NESHAP	x		0.25
2004	Industrial Boilers & Process Heaters NESHAP	x	x	0.86
2005	Clean Air Mercury Rule	x		0.90
2005	Clean Air Visibility Rule/BART Guidelines	x		1.50
2006	Stationary Compression Ignition Internal Combustion Engine NSPS			0.06
2007	Control of HAP from mobile sources	x	x	0.36
2008	Ozone NAAQS (.08 8hr =>.075 8hr)	x		8.20[#]
2008	Lead (Pb) NAAQS	x		3.20
2009	New Marine Compress'n-Ign Engines >30 L per Cylinder	x		1.90
2010	Reciprocating Internal Combustion Engines NESHAP - Comp. Ignit.	x	x	0.37
2010	EPA/NHTSA Joint Light-Duty GHG & CAFES			15.60
2010	SO2 NAAQS (1-hr, 75 ppb)	x	>99.9%	1.50
2010	Existing Stationary Compression Ignition Engines NESHAP	x	x	0.25
2011	Industrial, Comm, and Institutional Boilers NESHAP	x	x	0.49
2011	Indus'l, Comm'l, and Institutional Boilers & Process Heaters NESHAP	x	x	2.90
2011	Comm'l & Indus'l Solid Waste Incin. Units NSPS & Emission G'lines	x	x	0.28
2011	Control of GHG from Medium & Heavy-Duty Vehicles			2.00[&]
2011	Ozone Reconsideration NAAQS	x		8.20[#]
2011	Utility Boiler MACT NESHAP (Final Rule's RIA)	x	≥99%	9.60
2011	Mercury Cell Chlor Alkali Plant Mercury Emissions NESHAP	x		0.00
2011	Sewage Sludge Incineration Units NSPS & Emission Guidelines	x	x	0.02
2011	Ferroalloys Production NESHAP Ammendments	x	x	0.004
		Total:		**60.67**

+ MATS – 9.3

Partial Total: 69.97

- Cross State Air Pollution Rule
  - EPA estimated cost:$800 million annually
  - Independent analysis: $120 billion by 2015
- Boiler MACT
  - EPA estimated cost:$2.6 billion annually
  - Independent analysis:$14.5 billion

* ($2006)

Business Impact

The Benefits and Costs of the Clean Air Act from 1990 to 2020

TABLE 8-8.

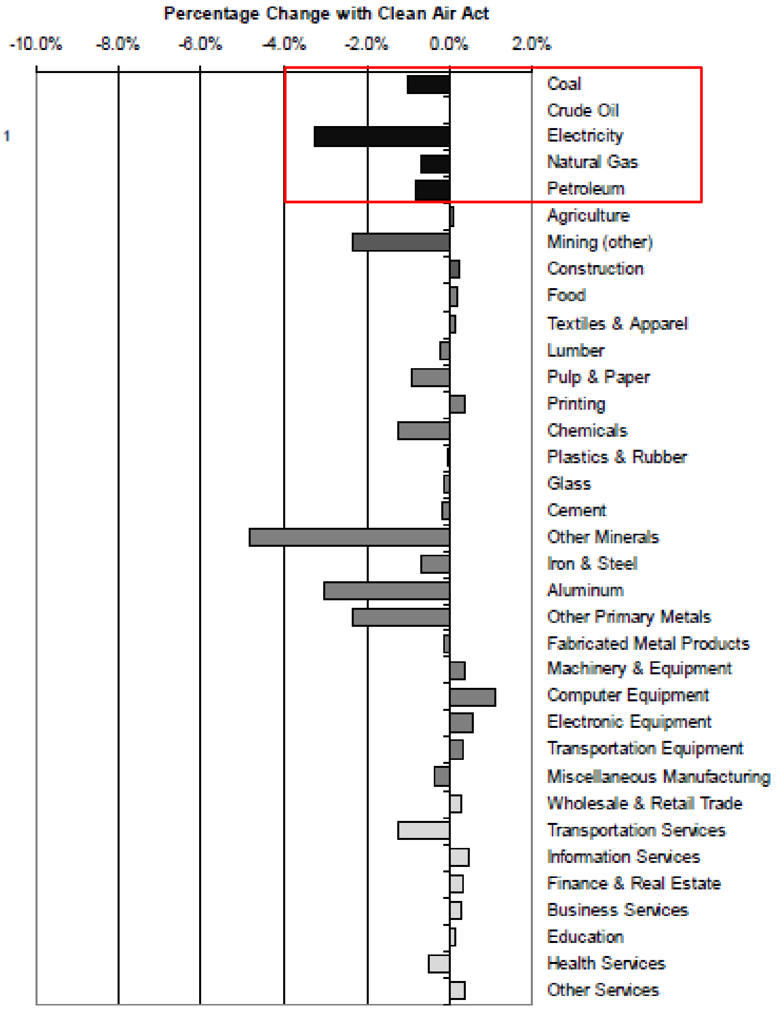
SUMMARY OF ANNUAL MACROECONOMIC IMPACTS: LABOR FORCE-ADJUSTED CASE[1]

VARIABLE	MODEL RUN	2010	2015	2020
GDP	With Clean Air Act ($ billion)	$15,027	$17,338	$20,202
	Without Clean Air Act ($ billion)	$15,059	$17,350	$20,197
	Change ($ billion)	-$32	-$12	$5
	% change	-0.21%	-0.07%	0.02%
Consumption	With Clean Air Act ($ billion)	$10,969	$12,699	$14,881
	Without Clean Air Act ($ billion)	$10,972	$12,696	$14,876
	Change ($ billion)	-$3	$3	$5
	% change	-0.03%	0.02%	0.03%
Hicksian EV (annual)	Change ($ billion)	$11	$22	$29
	% change	0.08%	0.13%	0.15%

Notes:

1. Results are expressed in year 2006 dollars.

FIGURE 8-6. PERCENT CHANGE IN INDUSTRY OUTPUT IN 2020: LABOR FORCE-ADJUSTED CASE



Adjusted Benefits Estimate

Tony Cox, 2011:

($1.8 trillion initial estimate)

x (1/6 reduction factor for VSL if age or VSLY is considered)

x (0.5 probability that a true association exists)

x (0.5 probability that a true association is causal, given that one exists)

x (0.5 probability that ambient concentrations are above any thresholds or nadirs in the C-R function, given that a true causal C-R relation exists)

x (0.5 expected reduction factor in C-R coefficient by 2020 due to improved medication and prevention of disease-related mortalities)

= (1.8 trillion)*(1/6)*(0.5)*(0.5)*(0.5)*(0.5) = $19 billion