

## International Variation in the Health Effects of Air Pollution: Implications for Health Impact Assessment

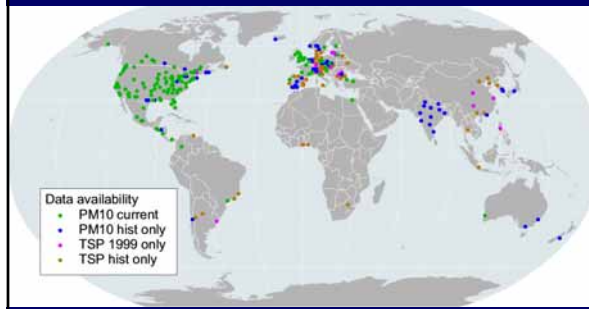
Aaron J Cohen  
Health Effects Institute

## Estimating Health Impacts

$$\text{Attributable Fraction} = \frac{P(RR-1)}{[P(RR-1)+1]}$$

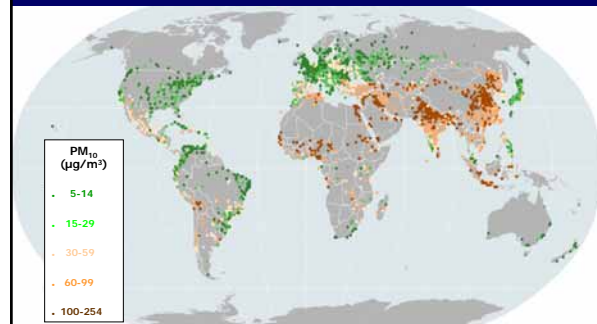
$$\text{Attributable Burden} = AF * B$$

## Availability of Exposure Data at Fixed Monitoring Sites in Residential Areas



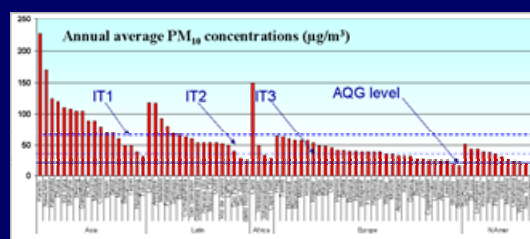
Cohen AJ et al. 2004

## Estimated PM<sub>10</sub> Concentration in World Cities (pop >= 100,000)



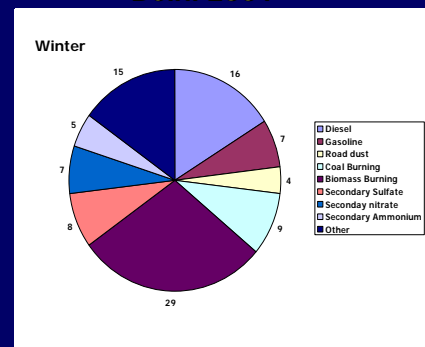
Cohen AJ et al. 2004

## International Variation in Ambient Concentrations



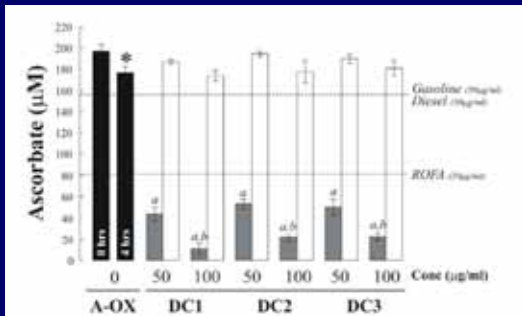
M Krzyzanowski 2006

## Sources of fine particulate air pollution Delhi 2001



Georgia Tech (USA) 2004

## Differential Toxicity of PM from Biomass and Fossil Fuels



Mudway et al. *Particle and Fibre Toxicology* 2005

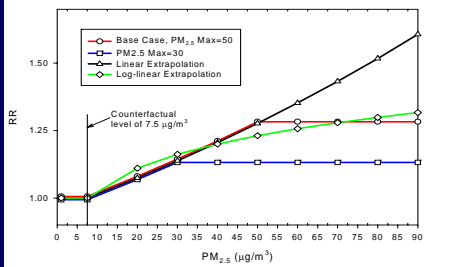
## Where should the risk coefficients for impact assessment come from?



"The most complete estimates of both attributable numbers of deaths and average reductions in lifespan associated with exposure to air pollution are those based on cohort studies. Until the risk estimates from the European studies are available, impact assessment will need to rely on the results of currently available United States' studies. Additional cohort studies, in Europe and elsewhere, and confirmation of the transferability of United States' results to European populations are critical research needs."

## Alternative Scenarios for Burden of Disease Estimation for Urban Air Pollution

Alternative concentration-response curves for cardiopulmonary deaths



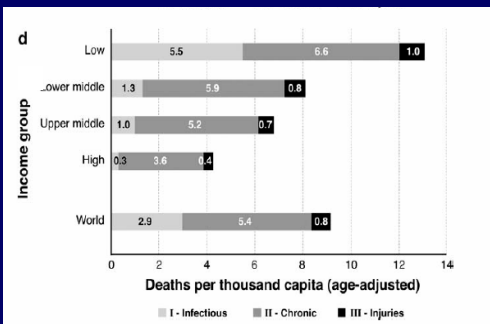
Cohen AJ et al. 2004

## International variation in attributable burden depends on C-R assumption

Subregion	Base-Case		Max 30		Linear		Log-linear	
	Deaths	YLL	Deaths	YLL	Deaths	YLL	Deaths	YLL
AFR-D	18	162	13	123	19	179	19	180
AFR-E	9	84	8	79	9	84	12	113
AMR-A	23	116	23	116	23	116	41	205
AMR-B	27	201	25	187	27	203	35	261
AMR-D	4	31	4	28	4	31	5	38
EMR-B	8	65	7	62	8	65	10	89
EMR-D	45	386	26	219	64	545	46	397
EUR-A	20	90	20	90	20	90	34	151
EUR-B	34	238	33	229	34	238	44	304
EUR-C	43	291	43	291	43	291	68	460
SEAR-B	30	240	17	132	36	287	28	226
SEAR-D	119	1006	79	667	136	1150	123	1037
WPR-A	15	65	15	65	15	65	23	99
WPR-B	317	1992	192	1209	344	2163	305	1915
World	712	4966	506	3498	783	5507	794	5476

Cohen AJ et al. 2004

## The Epidemiologic Transition



Smith and Ezzati 2005

## Number of people at high CV risk globally in 2000 (A Rogers 2005)



## Leading Causes of Mortality and Burden of Disease 2002

Mortality		DALYs	
	%		%
• Ischaemic heart disease	12.6	• Perinatal conditions	6.5
• Cerebrovascular disease	9.7	• Lower respiratory infections	6.1
• Lower respiratory infections	6.8	• HIV/AIDS	5.7
• HIV/AIDS	4.9	• Depression	4.5
• COPD	4.8	• Diarrhoeal diseases	4.2
• Perinatal conditions	4.3	• Ischaemic heart disease	3.9
• Diarrhoeal diseases	3.2	• Cerebrovascular disease	3.3
• Tuberculosis	2.7	• Malaria	3.1
• Lung cancer	2.2	• Road traffic accidents	2.6
• Malaria	2.2	• Tuberculosis	2.3
• Road traffic accidents	2.1	• COPD	1.9

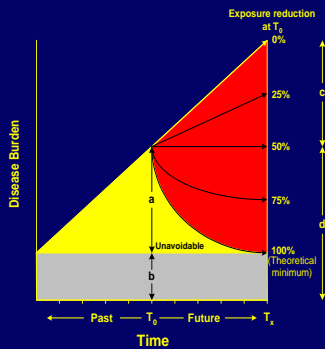
WHO 2002

## Combustion Source Air Pollution and TB

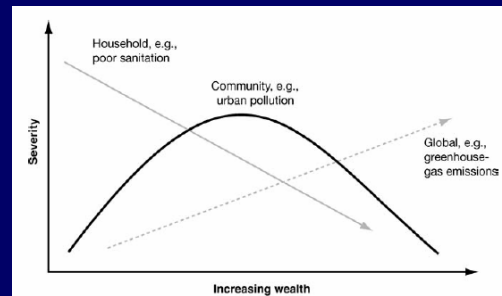
	Millions of Deaths (% in developing countries)	% Global Burden of Disease (% in developing countries)	Range of reported TB relative risk estimates
Tuberculosis	1.6 (>90%)	2.5 (>90%)	
Smoking	4.8 (50%)	4.1 (>50%)	1.03-5.92 (Yes/No) 5 mortality studies
Indoor Air Pollution	1.6 (>95%)	2.6 (>95%)	0.6-2.5 (solid fuel use) 5 studies of clinical disease risk
Urban Outdoor Air Pollution	0.8 (>70%)	0.4 (>70%)	Only one

Data from Baris and Ezzati 2004; Lin et al. 2007

## Attributable and avoidable burden



## The Environmental Risk Transition

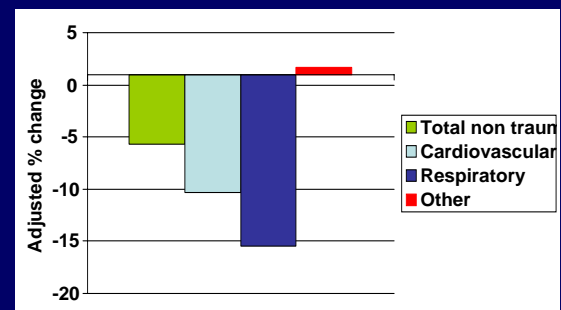


Smith and Ezzati 2005

## What determines the health effects of air pollution as economies grow?

- ✓ Number of people in cities
- ✓ Sources of air pollution
- ✓ Emissions
- ✓ Air quality
- ✓ Susceptibility

## Reductions in Mortality in Dublin 72 Months Pre- vs. Post-1990 Ban on Coal Sales



Clancy et al. Lancet 2002

## When can we expect to see the effects of pollution reduction?

Table 3 YLLs attributable to air pollution in Switzerland during one year (2000), using different values of time constant  $k$  in a dynamic exposure-response model

Time constant $k$	0.1	0.2	0.5	3	$\infty^a$
Time period considered (years)	30	20	10	10	1
Proportion of effect within first year	9.5%	18.1%	39.3%	95.0%	100.0%
Proportion effect within the first 2 years	18.1%	33.0%	63.2%	99.8%	100.0%
Proportion effect within the first 5 years	39.3%	63.2%	82%	100.0%	100.0%
Total number of years of life lost (YLLs)	46 200	44 300	42 400	40 700	40 600
95% CI for YLLs	24 500-68 000	23 500-65 100	22 600-63 600	21 900-59 300	21 800-59 100
Proportion of YLLs attributable to infant deaths	3.7%	3.9%	4.0%	4.2%	4.2%

Swiss population size: 7 209 000; infants (0-1 year): 77 800.

<sup>a</sup> Corresponds to steady state model.

Roosli et al. 2005

## Conclusions (1)

- ✓ **More research really *is* needed!!**
  - ✓ **Studies of exposure to emissions from all locally-important sources of air pollution**
  - ✓ **Studies of long-term exposure and chronic effects in developing countries**
  - ✓ **Studies of all major diseases of relevance to the global burden of disease**

## Conclusions (2)

- ✓ **But not *just* research, also increased infrastructure in the most affected regions**
  - ✓ **improved monitoring capacity**
  - ✓ **Expanded vital registration**
  - ✓ **Expanded scientific capacity**

## Thank You

[acohen@healtheffects.org](mailto:acohen@healtheffects.org)