A Global Perspective on Air Pollution and Health

Aaron J Cohen
Health Effects Institute
• What factors determine the health impacts of air pollution on a global scale?

• How large is the burden of disease due to air pollution on a global scale?

• What are the key uncertainties?

• Does reducing air pollution improve health?
The Environmental Risk Transition

Smith and Ezzati 2005
Sources of fine particulate air pollution vary worldwide.
Biomass Burning and Respiratory Health in Kuala Lumpur 1997
(Data from M Brauer 1997)
Global exposure to air particulate pollution

Exposure = Population × Time × Pollution

Data from KR Smith personal communication 2002
In developing countries poor women and children are exposed to high levels of pollution from indoor burning of solid fuels.
Human exposure to traffic-related air pollution
The Epidemiologic Transition

Smith and Ezzati 2005
Number of people at high CV risk globally in 2000
(A Rogers 2005)

>175 million people at 25%+ risk of a major CV event in the next decade, by WHO subregion
Air Pollution and SARS Mortality in the PRC

Figure 1
The Correlation and Association between Short-term Exposure to Ambient Air Pollution and Case Fatality of SARS in People's Republic of China.

Yan Cui et al 2003
Health Effects of Outdoor Air Pollution in Developing Countries of Asia: A Literature Review

HEI International Scientific Oversight Committee of HEI Public Health and Air Pollution in Asia Program (a program of the Clean Air Initiative for Asian Cities)

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HEALTH EFFECTS INSTITUTE
Two epidemiologic methods to study air pollution and mortality: Time series and cohort studies

**Time Series studies**
- Exploit *temporal* differences in exposure
- Estimate the association between *daily mortality rates* and the level of air pollution *shortly* before death

**Cohort studies**
- Exploit *spatial* differences in exposure
- Estimate the association between *long-term average mortality rates* and *long-term* exposure to air pollution
- Estimate the association between *time-to-death* (e.g. YLL) and *long-term* exposure to air pollution
PAPA Meta Analysis Results:
Asian Risk Estimates Similar to West; Initial Support for Extrapolating from Western Studies

Percent Increase in Mortality per 10 micrograms of Exposure

0.46
0.62
0.49

US(90 Cities)*  Eur(21 Cities)*  Asia (4 Cities)

* Estimates Using Pre-GAM Results (without revision)
Long-term Exposure to Fine Particulate Air Pollution and Mortality from Chronic Cardiopulmonary Disease

Source: HEI Reanalysis of the American Cancer Society Study (Krewski 2000)
CRA project and WHR 2002
## Estimated Impacts of Urban Air Pollution Worldwide
*(95% confidence intervals)*

<table>
<thead>
<tr>
<th>Condition</th>
<th>AF (%)</th>
<th>Deaths (x 10^3)</th>
<th>DALYs (x 10^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPD</strong></td>
<td>3 (1, 6)</td>
<td>712 (245, 1107)</td>
<td>6360 (2140, 10129)</td>
</tr>
<tr>
<td><strong>Lung Cancer</strong></td>
<td>5 (1, 9)</td>
<td>62 (10, 114)</td>
<td>588 (104, 1089)</td>
</tr>
<tr>
<td><strong>ARI (0-5 yr.)</strong></td>
<td>1 (-1, 3)</td>
<td>26 (-24, 66)</td>
<td>913 (-846, 2358)</td>
</tr>
</tbody>
</table>

*Cohen et al. 2004*
Mortality attributable to leading risk factors

- High blood pressure
- Tobacco
- High cholesterol
- Underweight
- Unsafe sex
- Low fruit and vegetable intake
- Overweight and obesity
- Physical inactivity
- Alcohol
- Unsafe water, sanitation, and hygiene
- Indoor smoke from solid fuels
- Iron deficiency
- Urban air pollution
- Zinc deficiency
- Vitamin A deficiency
- Contaminated health care injections
- Occupational airborne particulates
- Occupational risk factors for injury
- Lead exposure
- Illicit drugs

Mortality in thousands (Total 55.86 million)

- High-mortality developing
- Lower-mortality developing
- Developed

Ezzati et al. 2002; WHO 2002
<table>
<thead>
<tr>
<th>Environmental Risks</th>
<th>Global Estimate</th>
<th>Asian Estimate (S, SE Asia + W Pacific)</th>
<th>Asia as a percent of Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsafe Water</td>
<td>1,730,000</td>
<td>730,000</td>
<td>42%</td>
</tr>
<tr>
<td>Urban Outdoor Air</td>
<td>799,000</td>
<td>487,000</td>
<td>65%</td>
</tr>
<tr>
<td>Indoor Air</td>
<td>1,619,000</td>
<td>1,025,000</td>
<td>63%</td>
</tr>
<tr>
<td>Lead</td>
<td>234,000</td>
<td>88,000</td>
<td>37%</td>
</tr>
</tbody>
</table>
The PAPA Studies
PAPA - Public Health and Air Pollution in Asia

*New Research in Asian Cities*

- 9 new studies of air pollution and health in Asian Cities

- **Acute Effects:**
  - Bangkok, Hong Kong, Shanghai, Wuhan, Chennai, Delhi, Ludhiana

- **Effects of Long Term Exposure**
  - Guangzhou, China pilot study in elderly cohort

- **Air Pollution, Poverty, and Health**
  - Ho Chi Minh City
The poor may suffer more health effects from air pollution

- Higher exposures
  - Living close to traffic
  - Roadside occupations
  - Small and medium scale industries
  - Use of solid fuels for cooking

- More susceptible
  - Poor nutrition / immunosuppression
  - Higher incidence of ‘diseases of poverty’
  - Lack of timely access to health care
Studying Air Pollution, Poverty, and Health in HCMC

Overall Objectives:

1. Develop feasible approaches to studying air pollution, poverty, and health
   • Methods appropriate for HCMC context
   • Methods suitable for use in other cities - promote building an evidence base across Asian cities

2. Develop infrastructure for future studies of the health effects of air pollution in HCMC
   • Technical capacity (epidemiologic methods, exposure assessment, analysis)
   • Resources (data integration, equipment)
Ho Chi Minh City Study of Air Pollution, Poverty, and Health

Hospital-based study
- Estimate the effect of short-term exposure to air pollution on hospital admissions for ALRI in young children (<5 years) in HCMC
- Compare the magnitude of the effect of air pollution on poor children vs. other children

Household-based study
- Estimate personal exposures to air pollution among the poor and the non-poor
  - ambient air pollution
  - other sources (cooking with solid fuels, cottage industries)
- Estimate prevalence of respiratory symptoms in HCMC
- Survey of perceptions and economic costs
Does reducing air pollution improve health??

Is it worth the cost??
UK $\text{SO}_2$ Emissions and Electricity Generation 1970-1995

Fig. 6.1  (a) UK power station emissions of sulfur dioxide and electricity generated, (b) Index of UK power station $\text{SO}_2$ emissions per electricity generated (1970 = 100).
The Hong Kong Air Quality Intervention 1990

Before

After

July 1st 1990: Environmental Protection Department restricted sulphur content of fuel to 0.5% by weight

Courtesy AJ Hedley
Assessing Benefits of Fuel Sulfur Reduction in Asia: Hong Kong

AIR POLLUTANT CONCENTRATIONS 1988 - 95 IN HONG KONG
HALF YEARLY MEAN LEVELS

Fuel restriction on sulphur

50% reduction in SO2 after the intervention

No change in other pollutants

REDUCTIONS IN DEATHS AFTER SULPHUR RESTRICTION

% Reduction in annual trend

-1.8%  -1.6%  -2.4%  -4.2%

15-64 15-64 15-64 15-64
All causes  Cardiovascular  Respiratory
Estimates of Benefits US Highway Diesel Rule

Mortality
Hospital Admissions
Emergency Room Visits
New cases of chronic bronchitis
New cases of bronchitis in children
Acute asthma attacks
Acute respiratory symptoms e.g.: new cases of croup, pneumonia
Restricted activity days

Number of Annual Cases for All of US 2030

- Mortality: 8,300
- Hospital Admissions: 5,600
- Emergency Room Visits: 2,100
- Acute respiratory symptoms: 5,500
- New cases of bronchitis in children: 17,600
- Acute asthma attacks: 361,400
- New cases of chronic bronchitis: 386,000
- Restricted activity days: 9.5 million

US EPA RIA, 2000
Comparing Costs and Benefits
US Highway Diesel Rule
(Source: US EPA RIA 2000)

- 2030 Implementation Costs
- Monetized Annual 2030 Benefits (avoided deaths and other effects)
Thank You

acohen@healtheffects.org