The Health Effects of Air Pollution Asian Science in a Global Context "PAPA Program"

Robert O'Keefe, Vice President
Health Effects Institute

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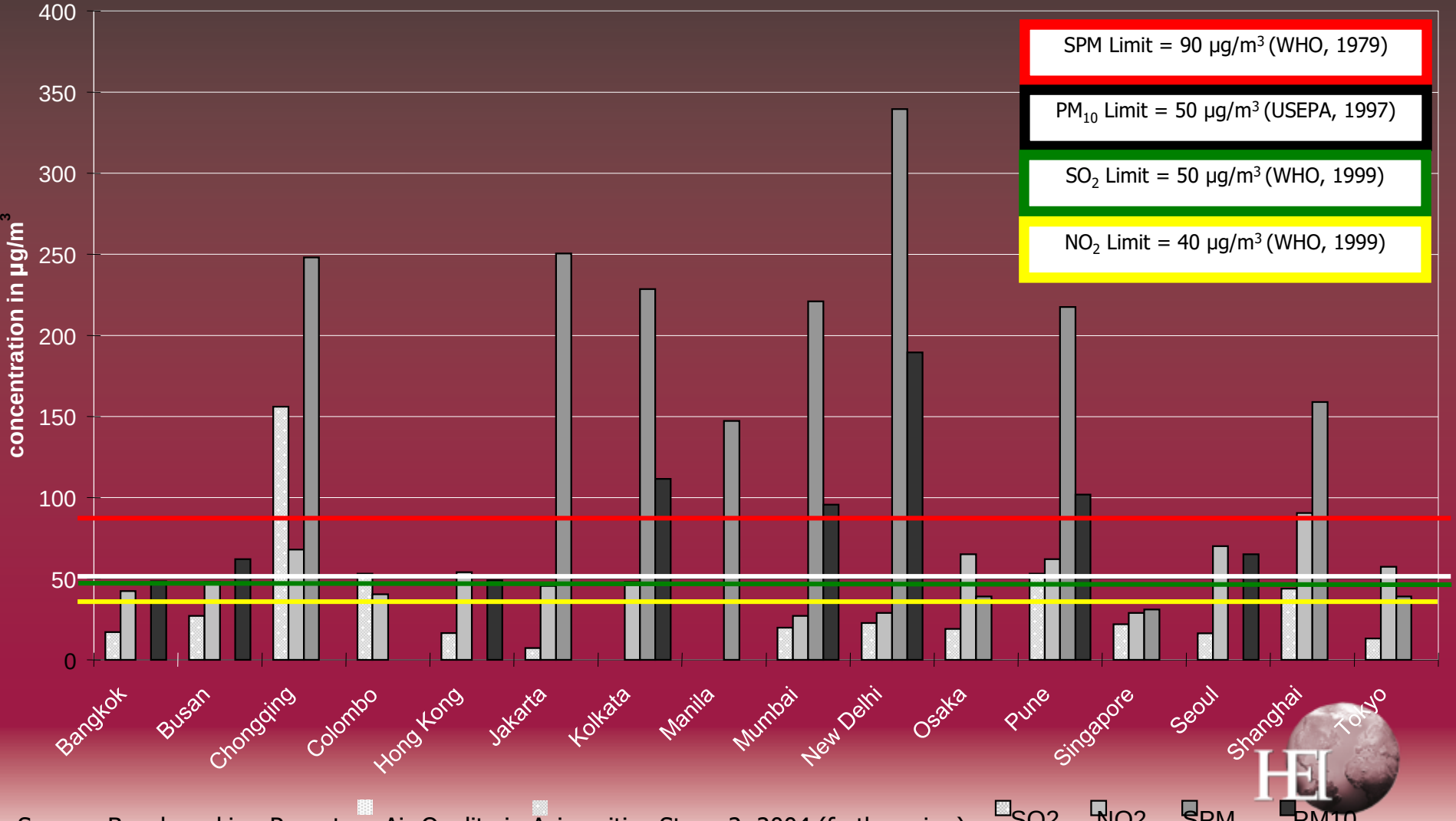
The Health Effects of Air Pollution: Asian Science in a Global Context

- Health Effects Institute
  - A brief introduction
- Health Burden of Air Pollution in Asia
- “PAPA” Program – Chinese Studies
- Key Pollutants and Health Effects
- Health Benefits of Interventions
- Priority Pollutants

The Health Effects Institute

- Founded in 1980 to provide impartial, high-quality science on health effects of air pollution
- Joint and balanced core funding from
  - Government (U.S. EPA)
  - Industry (28 worldwide auto)
  - Also partnerships with CAI-Asia, WHO, CARB, Vietnam Government, Oil, Chemical industry, Hewlett foundation, others
- Independent Board and Expert Science Committees oversee and review all research
- High level international experts (China India Thailand)
- Over 250 studies, scientific reviews, reanalysis
  - Relevant to regulation
  - North & South America, Europe, Asia
  - CO, particulate matter, ozone, SO2, NO2, diesel exhaust, benzene, butadiene, manganese, metals, MTBE, others

The Problem: Air Pollution in Asia: High Levels in Many Cities (2000-2001)



Source: Benchmarking Report on Air Quality in Asian cities Stage 2, 2004 (forthcoming)

Excess Deaths from Selected Environmental Factors
(*WHO Global Burden of Disease)*

Environmental Risks	Global Estimate	Asian Estimate (S ,SE Asia + W Pacific)	Asia as a percent of Global
Unsafe Water	1,730,000	730,000	42%
Urban Outdoor Air	799,000	487,000	65%
Indoor Air	1,619,000	1,025,000	63%
Lead	234,000	88,000	37%

Particular Challenge: Many Sources of Air Pollution in Asia

- Combustion
  - Agricultural burning
  - Brick Kilns
  - Vehicles
  - Trash burning
  - Factories
  - Power generation
  - Cooking in slums
  - Other area sources
- Non-Combustion
  - Agricultural cultivation
  - Street sweeping
  - Windblown sand
  - Unpaved roads
  - Paved roads (asbestos, rubber etc)
  - *Construction*

Health Effects

- Different Pollutants have Different Effects

  - Carbon Monoxide - circulatory system, heart
  - Ozone - respiratory system, lung
  - Lead - nervous system, brain
  - PM - lung, potential effects on heart
  - Diesel Exhaust - PM contributor, respiratory, cancer
  - Sulfur Dioxide – impaired respiratory function, PM Contributor
  - Nitrogen Dioxide – lung irritant. ozone contributor
  - Air Toxics – cancer, reproductive, neurotoxic
  - ***There are potential effects of the mixture***

  - Carbon Dioxide and Carbon Particles - climate change

PAPA Program

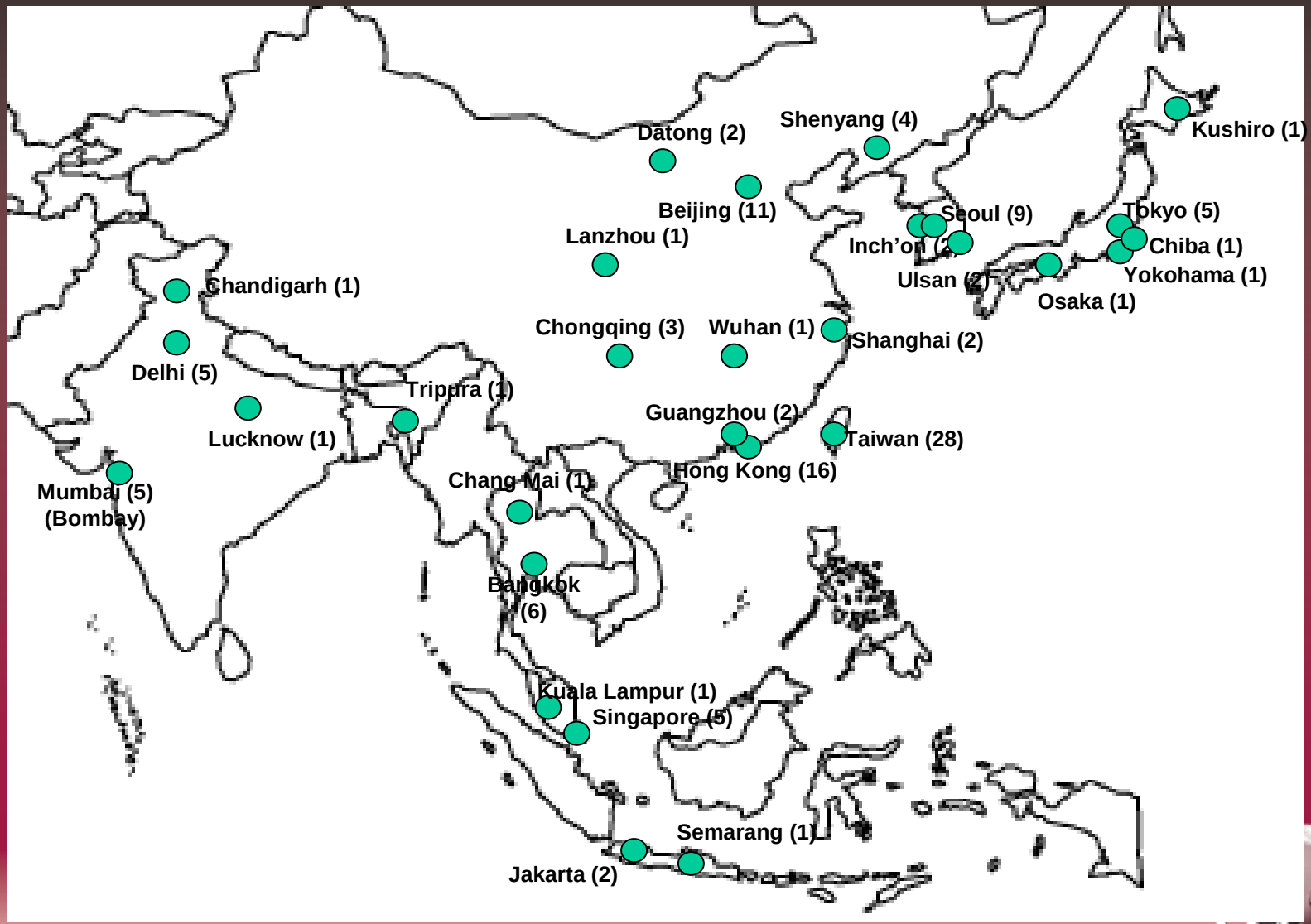
- ***Partnership with CAI-ASIA*** to understand & communicate the health effects of air pollution in Asia
  - Published ***Scientific Review*** and ***Meta Analysis*** of what is known today about health effects in Asian cities
  - New! Periodic ***updating compendium of Asian studies*** (140-+260)
  - ***Series of epidemiological studies*** in 8 Asian cities
    - Understand local impact
    - Combine to provide Asia-wide understanding
  - ***Regular Communication*** of results to policy makers
  - ***Build capacity*** of local scientists
  - Publish a C***omprehensive Assessment*** of the state of air pollution and health across Asian cities
  - Initiate new science to ***understand intersection of poverty air pollution and health***

- ***Overall Goal:***
  - **Quality science to inform key Asian regulatory & policy decisions**

PAPA Literature Review: *Health Effects of Outdoor Air Pollution in Developing Countries of Asia*

- **Systematic identification of 140 peer-reviewed Asian studies 1980-2003 (over 60 from China)**
- **Special focus on studies of daily changes in air pollution and health**
- **Conduct first ever Asian meta analysis" 28 "time series" studies evaluated in depth effects in Asia and to assess relative to West**
- **Identify knowledge gaps to guide future research**
- *Now being updated with many recent studies, made web accessible,*

Epidemiologic Studies of Air Pollution in Asia 1980–2003



PAPA Studies in China

-Literature Review

-Current Analyses in Chinese Cities

Literature Review: China Studies

- Seventy-eight studies in mainland, Hong Kong, and Taipei, China- range of pollutants \ effects
  - 26 cross-sectional
    - 34-4000 subjects: infants, children, adults
    - TSP, PM_{10}, SO_2, NOx, CO
    - Acute and chronic respiratory illness, lung function
  - 20 time series
    - 1,000-millions of subjects
    - Total and cause-specific mortality, unscheduled hospital visits, hospital admission, sudden infant death
    - TSP, SO_2, PM_{10} /$PM_{2.5}$
  - 11 cohort / 3 panel
    - 20- thousands of subjects
    - Birth outcomes, serum CO, lung function, respiratory symptoms, illness-related school absence
  - 7 case-control
    - Urban, occupational smoke, industrial pollution
    - Birth outcomes, lung cancer

NEW: PAPA Review Updated, Extended

- PAPA Review extended to include 2003-2005 and additional early studies
- Refined search methods yield ***double*** number of Asian studies (130-260)
- Chinese studies increase from 36 to 74
- HEI web-based comprehensive study summary, statistics and citation underway
- *New analyses of data planned*
- *New resource for policy makers in early 2006*

New PAPA Studies: China

Daily Mortality

- Hong Kong SAR
  - 1996-2002)
- Shanghai
  - 2002-2005
- Wuhan
  - 7/2000-6/2004

Pilot Cohort

- Guangzhou
  - 2004

Combined analysis to provide Asia profile

Hong Kong Time-Series Study

- Team: Dr. CM Wong, Hong Kong University
- Population size
  - 6.8 million
- Major Pollutants & Sources
  - PM, SO_2, NOx
  - Traffic (vehicle, marine vessel, aircraft), industry, power generation,
- Data sources
  - Daily monitored PM_{10}, SO_2, NO_2, 8-hr O_3
  - Health data: total and cause-specific mortality, hospital admission
  - Temperature, humidity, holidays, etc.
- Endpoints
  - Common: Daily deaths
  - Unique: Tuberculosis & Impact of pollution intervention

Shanghai Time-Series Study

- Team: Dr. HD Kan, Fudan University
- Period: 2002-2005
- Population size
  - Total 16.7 million, including 7million in urban area and 4 million mobile population
- Major pollutants and sources
  - PM, SO_2, NOx
  - Traffic (vehicle), industry, power generation, home fuel useData sources
- Pollutant data:
  - daily PM_{10}, SO_2, NO_2, O_3, $PM_{2.5}$
  - Health data: total and cause-specific mortality
  - Weather, influenza etc
- Endpoints:
  - Common: Daily mortality
  - Unique: Aged local population, large mobile population, rapid increase of motor vehicle
  - Increased cardiac, cancer and respiratory diseases death

Wuhan Time-Series Study

- Team: Dr. ZM Qian, Penn State University
- Period: 7/2000-6/2004
- Population size
  - 7.5 million including 4.3 million in urban area
- Major pollutants and sources
  - PM, SO_2, NOx
  - Traffic, coal burning, industryData sources
- Pollutant data:
  - daily PM_{10}, SO_2, NO_2, O_3
  - Health data: total and cause-specific mortality
- Endpoints
  - Common: Daily Mortality
  - Unique: Temperature extremes & well distributed SES group among study subjects

Coordinated Time-Series Analysis

- Objectives
  - Develop a common protocol for study design and data analysis across the cities
  - Conduct coordinated analyses for common exposure and health endpoints
  - Understand the Asia relationship to established international scientific literature on conduct and interpretation of studies of short-term exposure
  - Stimulate the development of routine systems for the recording of daily mortality and hospital admissions for health studies
  - Build scientific capacity, establish Asia-wide network of scientists
  - Initial Results in 2006

Extensive science on air pollution health effects in developed countries….

What do emerging Asian studies tell us?

PM Health Effects

- High levels of PM (e.g. 500 μ/m^3) known to cause premature death
  - e.g. London 1952
- Recent studies in North and South America, Europe, Asia, have found association of PM with death at much lower levels
  - no evidence of a “threshold” (safe level)
- Recent progress toward identifying biological mechanisms, though not conclusive

PM: *Linked to Increased Mortality, Morbidity*

- A Number of Epidemiology Studies
- Acute Effects (black smoke)

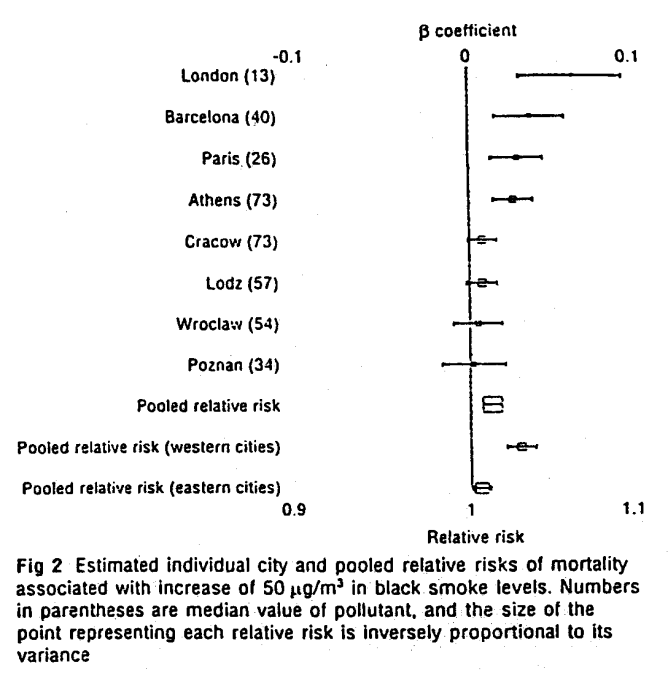
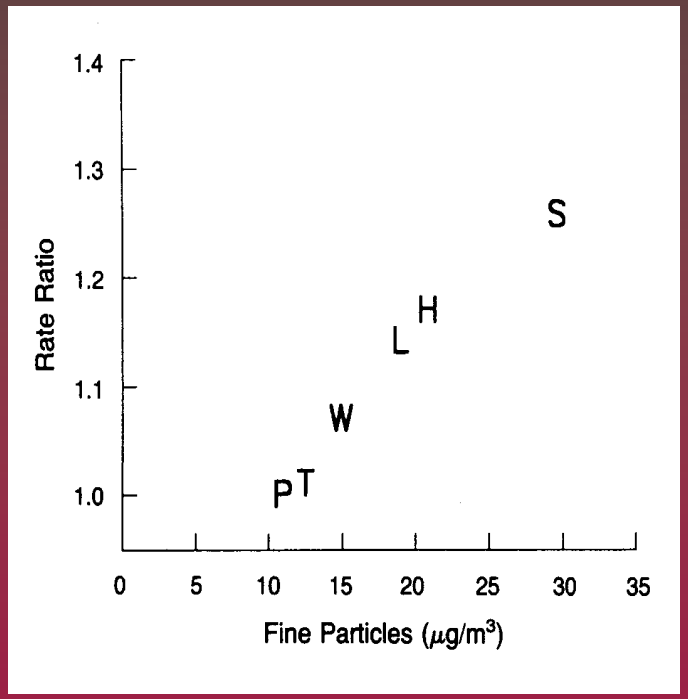


Fig 2 Estimated individual city and pooled relative risks of mortality associated with increase of 50 μg/m³ in black smoke levels. Numbers in parentheses are median value of pollutant, and the size of the point representing each relative risk is inversely proportional to its variance

Europe (APHEA)

Long Term Effects PM 2.5

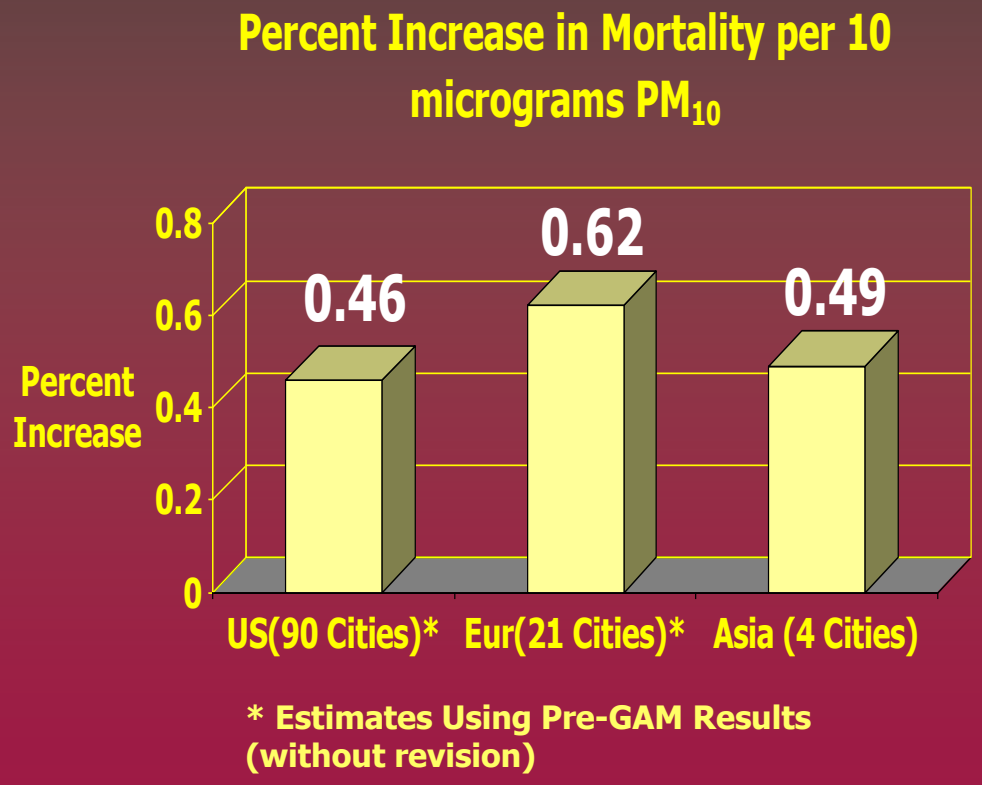


US (Six Cities)

EVIDENCE FROM ASIA:

HEI Meta-Analysis of Asian Studies of Daily Mortality/Hospital Admissions (**P**ublic Health and **A**ir **P**ollution in **A**sia (PAPA) 2004)

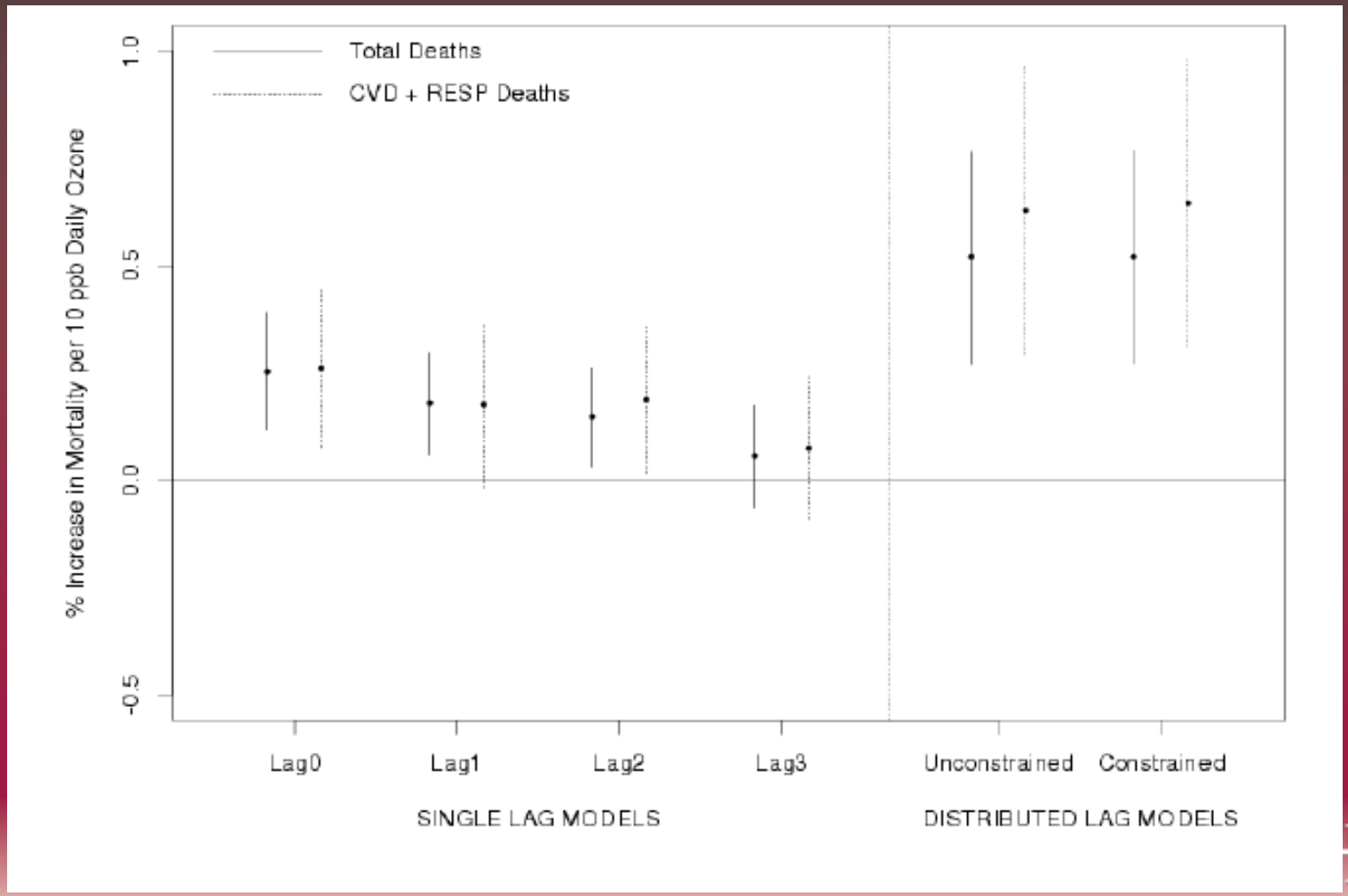
- 28 recent daily time series studies examined in depth
- Studies find effects of air pollution on rate of death, illness
  - ~0.5% increase per 10 μg/m^3 of PM_{10}
  - High levels of air pollution in Asian cities (>100 μg/m^3), imply a substantial public health impact
- *Limitations*
  - Small number of cities
  - Not geographically representative (poorest, most polluted countries under-represented)



Ozone Health Effects

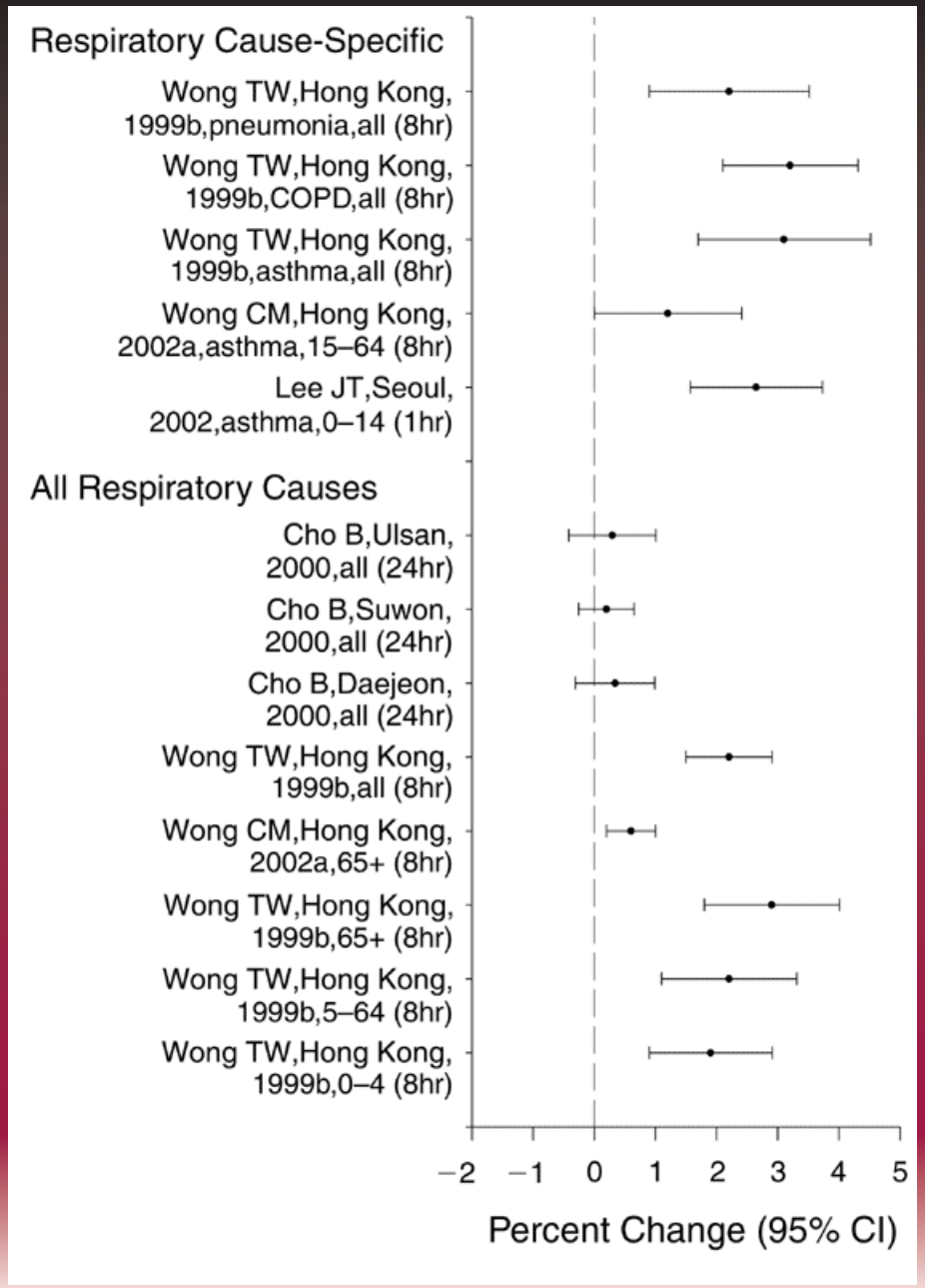
- Known to cause inflammation in respiratory tract
- Reduces ability to breathe (lung function) for some people
- Increases hospitalization for asthma, other lung diseases
- Recent systematic evidence of effects on premature mortality
- Effects have been demonstrated for short term exposure, long term effects are less certain

Ozone Effects on Mortality
95 US Cities
(Approximately 0.5% increase in mortality /10ppb)



Evidence from Asia: Ozone and Respiratory Hospital Admissions

(PAPA, 2004)

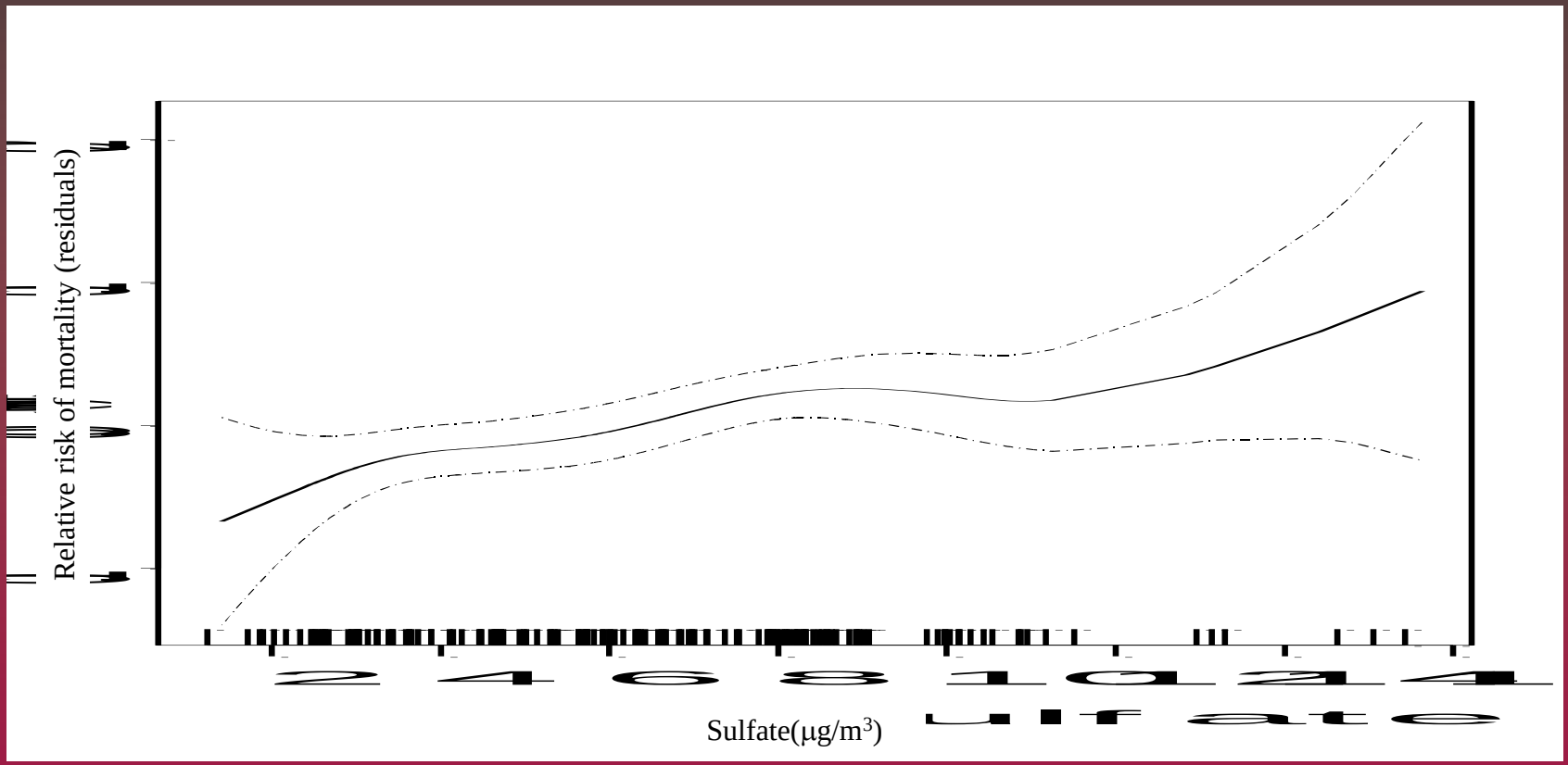


Sulfur Dioxide

- Emitted from fossil fuel combustion
  - especially from coal burning facilities, high sulfur fuels
- Can impair breathing in asthmatic children and adults
- Has been associated, along with PM, with
  - increased aggravation of heart and lung disease
  - premature mortality
- Recent study in Hong Kong (Lancet 2002) has found:
  - substantial reductions in SO2 emissions can result in measurable improvements in mortality and illness

Effects of Sulfate on Premature Mortality

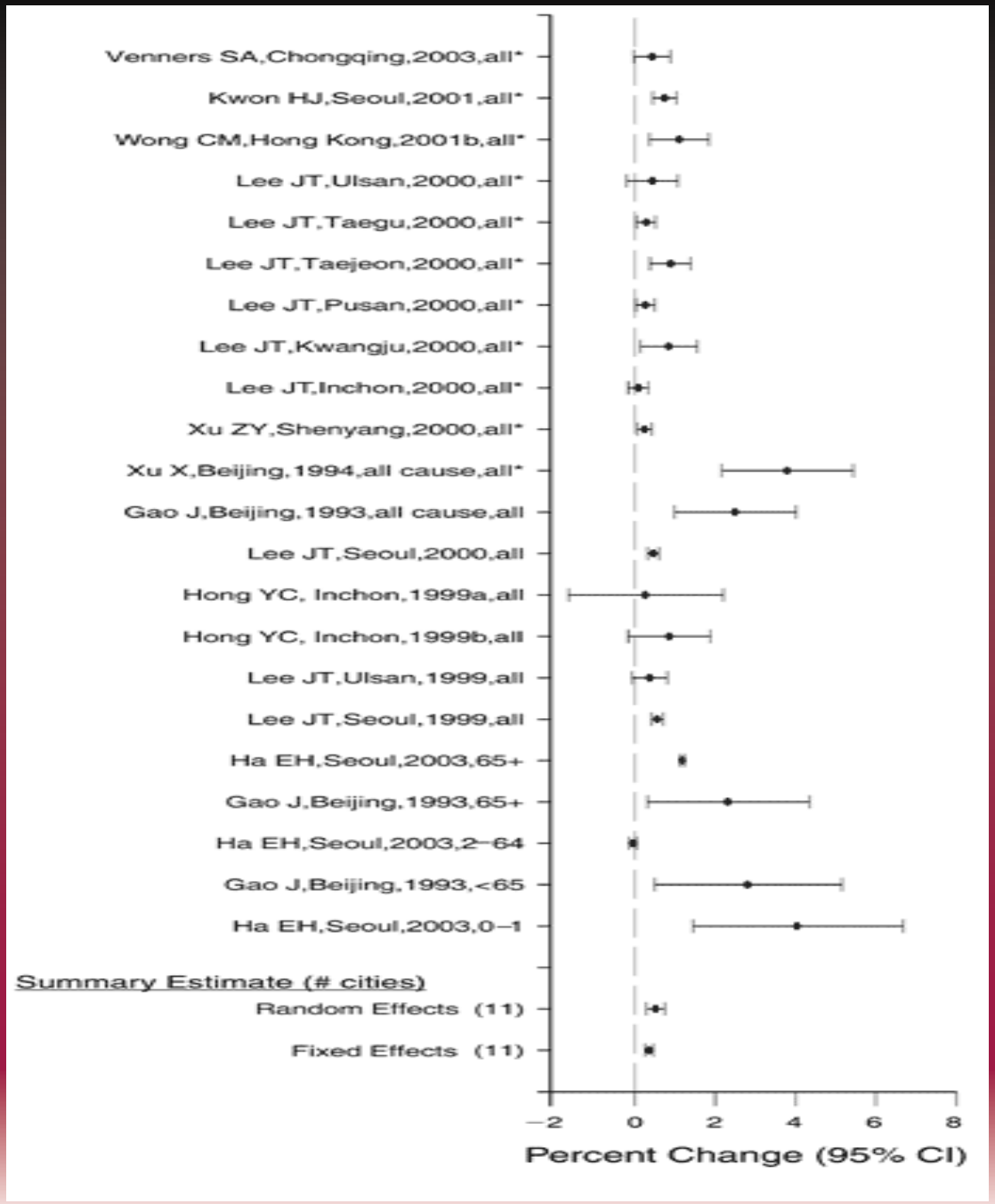
Source: HEI Reanalysis of the American Cancer Society Study (Krewski 2000)



Acute Evidence from Asia

SO2 and All Cause Mortality

PAPA Review



Health Benefits of Emission Reductions

In Asia: Hong Kong Fuel Sulfur Reduction

(A.J. Hedley et al Lancet 8\2002)

-July 1, 1999 Hong Kong Environmental Protection Department restricted sulfur content of fuels to .05% (by weight)

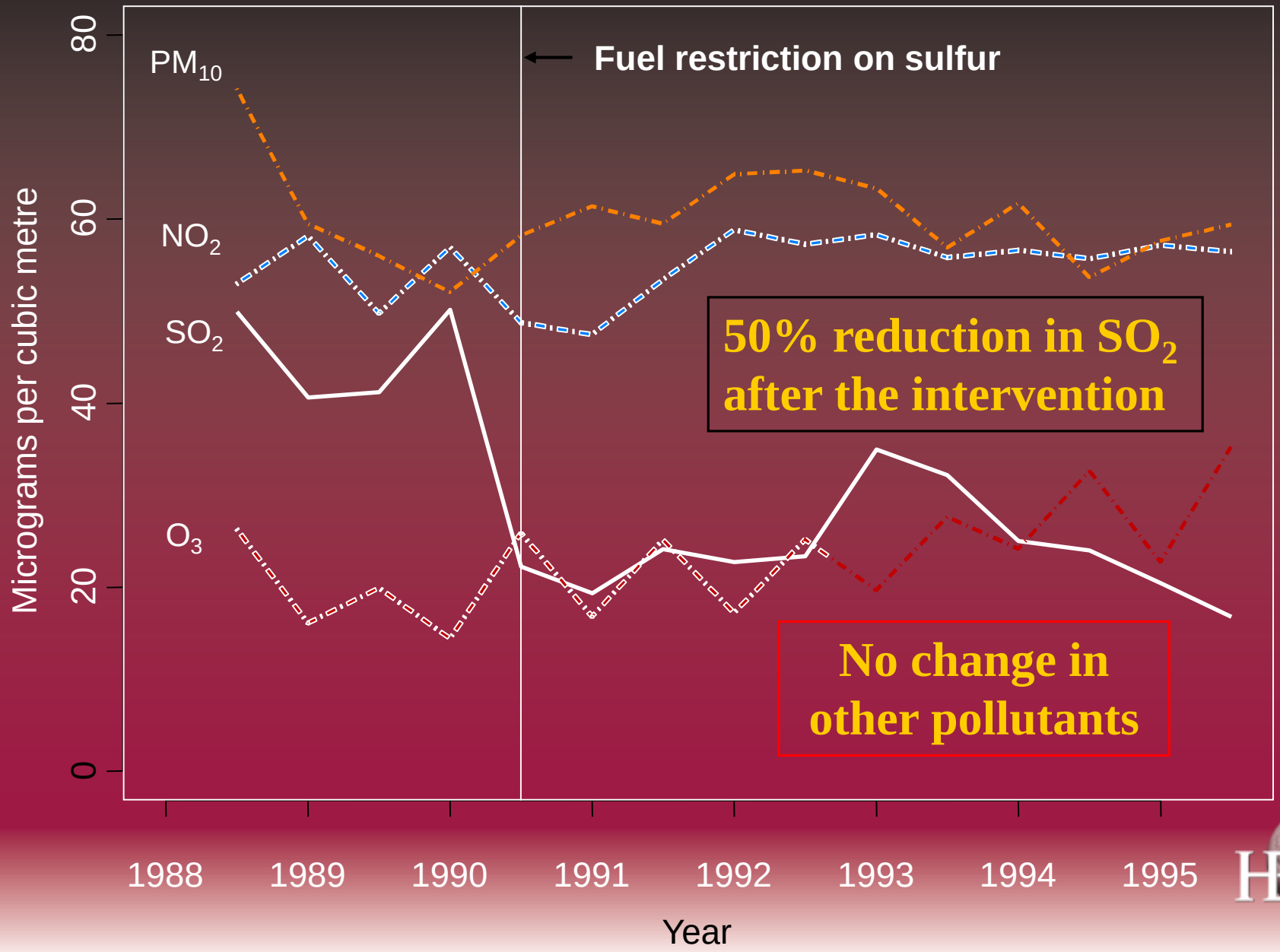
-Many fuel sources affected (e.g. industrial, vehicles)

-Near term impact

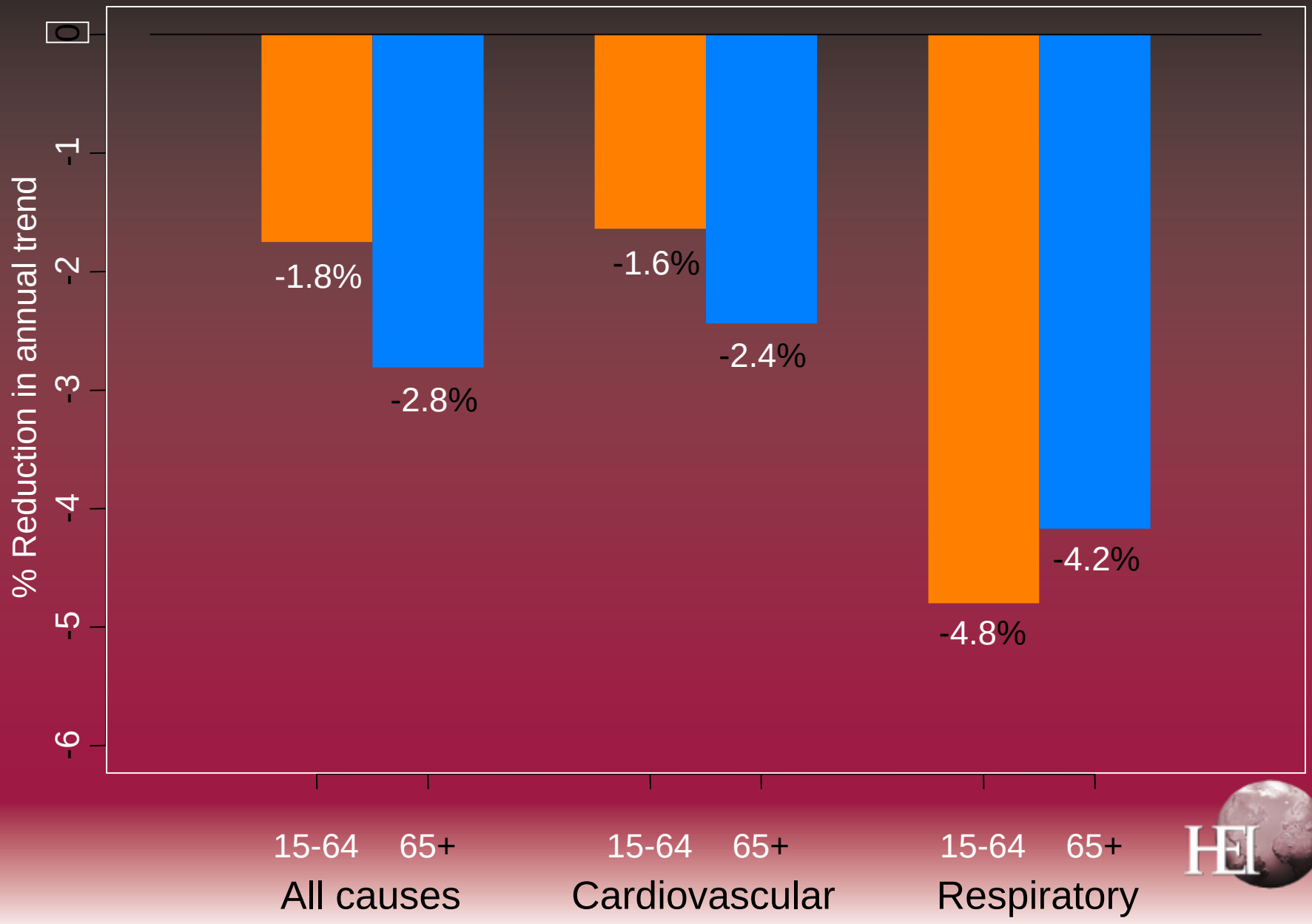
- ambient SO2 levels
- health

-Adjusted for seasonality, other factors

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



REDUCTIONS IN DEATHS AFTER SULFUR RESTRICTION



Conclusions

- Many pollutants of concern
  - CO, SO2, PM, NOx. Lead, Air Toxics (including metals), Ozone (VOX\Nox)
  - Progress made in some areas
- Many Sources
  - Combustion, Non Combustion
  - Regional differences exist, depending on fuels, weather patterns, industrial profile, SES, suggesting both general and regionally specific priorities
- PAPA, WHO others document effects in both Western and, increasingly, in Asian population

- Greater monitoring, source characterization needed
  - To inform health impact assessment, control measures, especially in highly populated areas
- However, several pollutants of concern common across sectors, regions,

Potential Priorities

- Pollutants associated with morbidity, mortality and found in urban, rural areas at high levels
  - Particulates
    - Also recommend additional monitoring, for PM10, 2.5
  - SO2
    - Contributes to sulfate formation, SO2 also respiratory irritant, some mortality evidence
- Of concern but less studied in Asia
  - Ozone
    - Associated with respiratory problems, asthma exacerbation
    - May be a concern with increased vehicles
    - Limited monitoring in Asian cities, suburban areas should be enhanced
  - Air Toxics
    - Benzene, metals, diesel, though monitoring difficult, expensive, even in developed regions

Thank You!

Robert O'Keefe
rokeefe@healtheffects.org
www.healtheffects.org