Health Risk – Air Pollution

Health Risk Factors in Rapidly Changing Economies
Swiss Re Centre for Global Dialogue
October 15, 2014

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‘Airpocalypse’ Hits Harbin, Closing Schools

The New York Times

October 21, 2013

School was canceled, traffic was nearly paralyzed and the airport was shut down in the northeast Chinese city of Harbin on Monday as off-the-charts pollution dropped visibility to less than 10 meters in parts of the provincial capital.

A dark, gray cloud that the local weather bureau described as “heavy fog” has shrouded the city of 10 million since Thursday, but the smoke thickened significantly on Sunday, soon after the government turned on the coal-powered municipal heating system for the winter.

“You can’t see your own fingers in front of you,” the city’s official news site explained helpfully. In the same vein, a resident of Harbin commented on Sina Weibo, the popular microblog platform, “You can hear the person you are talking to, but not see him.” Another resident added that he couldn’t see the person he was holding hands with.

The Harbin government reported an air quality index (AQI) score of 500, the highest possible reading, with some neighborhoods posting concentrations of PM2.5 — fine particulate matter that are 2.5 microns in diameter or smaller and especially harmful to health — as high as 1,000 micrograms per cubic meter, according to the China News Service.

South China Morning Post 南華早報

Hazardous smog returns to Beijing and surrounding region amid holiday

Sunday, 06 October, 2013, 12:00am

Choking smog returned to blanket Beijing and surrounding areas yesterday, four days after a dangerous smog alert was lifted.

Meteorologists said pollution levels were likely to remain high until after the National Day "golden week" ends tomorrow - and the traffic crush as people returned from holiday would not help the problem.

The capital's air quality index registered above 300 for most of the day, according to the Beijing Municipal Environmental Monitoring Centre. That means the air was "severely polluted", the highest on the six-level scale. The National Meteorological Centre issued a yellow alert for haze for Beijing, Tianjin and parts of Shanxi and Hebei yesterday evening.

The US embassy's air-quality monitoring station showed that Beijing's air had been "very unhealthy" or "hazardous" since Friday night, with the level of PM2.5 - tiny particles that pose the highest health risks - reaching **372 per cubic metre** at 9am yesterday. The World Health Organisation recommends a daily limit of 20.

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World Health Organization

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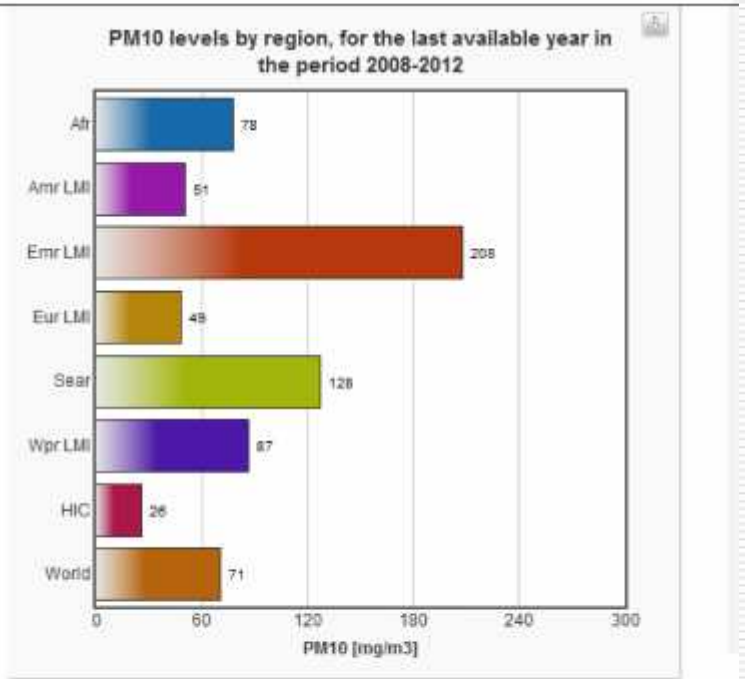
Public health, environmental and social determinants of health (PHE)

Ambient (outdoor) air pollution in cities database 2014

The database contains results of ambient (outdoor) air pollution monitoring from almost 1600 cities in 91 countries. Air quality is represented by annual mean concentration of fine particulate matter (PM10 and PM2.5, i.e. particles smaller than 10 or 2.5 microns).

The database covers the period from 2008 to 2013, with the majority of values for the years 2011 and 2012. The primary sources of data include publicly available national/subnational reports and web sites, regional networks such as the Asian Clean Air Initiative and the European Airbase, and selected publications. The database aims to be representative for human exposure, and therefore primarily captures measurements from monitoring stations located in urban background, residential, commercial and mixed areas.

The world's average PM10 levels by region range from 26 to 208 ug/m3, with a world's average of 71 ug/m3.



PM10: Fine particulate matter of 10 microns or less; Amr: America, Afr: Africa; Emr: Eastern Mediterranean, Sear: South-East Asia, Wpr: Western Pacific; LMI: Low- and middle-income; HI: high-income. PM10 values are regional urban population-weighted.

theguardian

India admits Delhi matches Beijing for air pollution threatening public health

World Health Organisation study finds Indian capital had dirtiest atmosphere of 1,600 cities around the world for PM2.5 particles

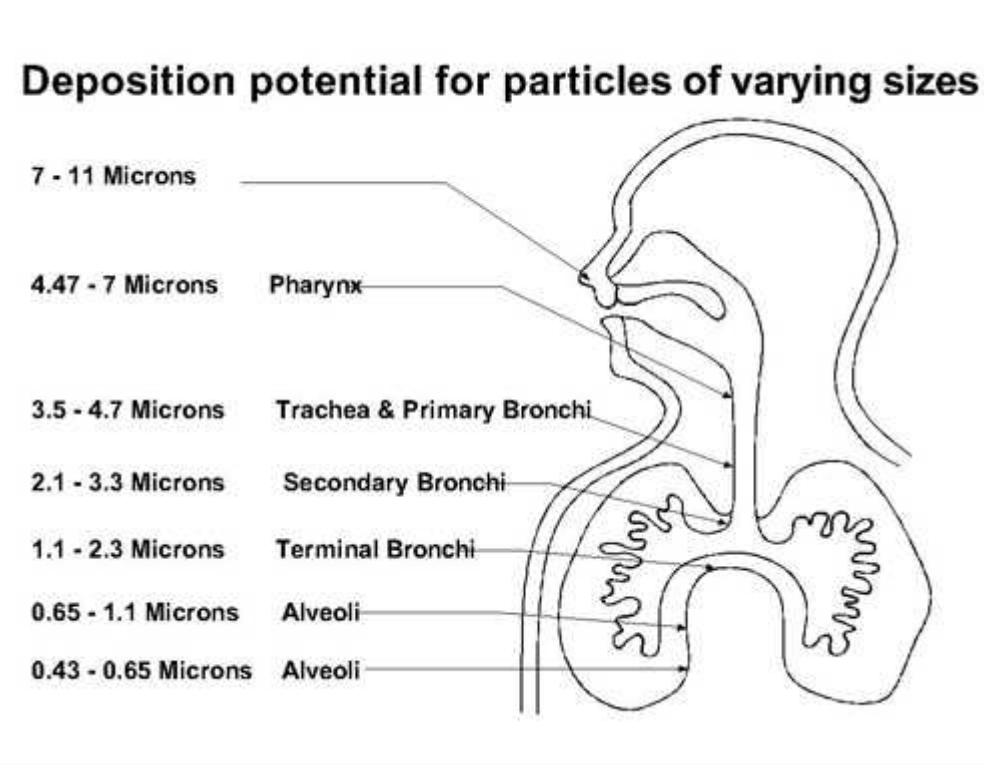
Children protect their faces from Delhi's smog. The WHO said Delhi had a yearly average PM2.5 level of 153 – London's is a tenth of that. Photograph: Hindustan Times/Getty Hindustan Times/Getty

India's state air monitoring centre has admitted that pollution in Delhi is comparable to that of Beijing, but disputed a World Health Organisation (WHO) finding that the Indian capital had the dirtiest atmosphere in the world.

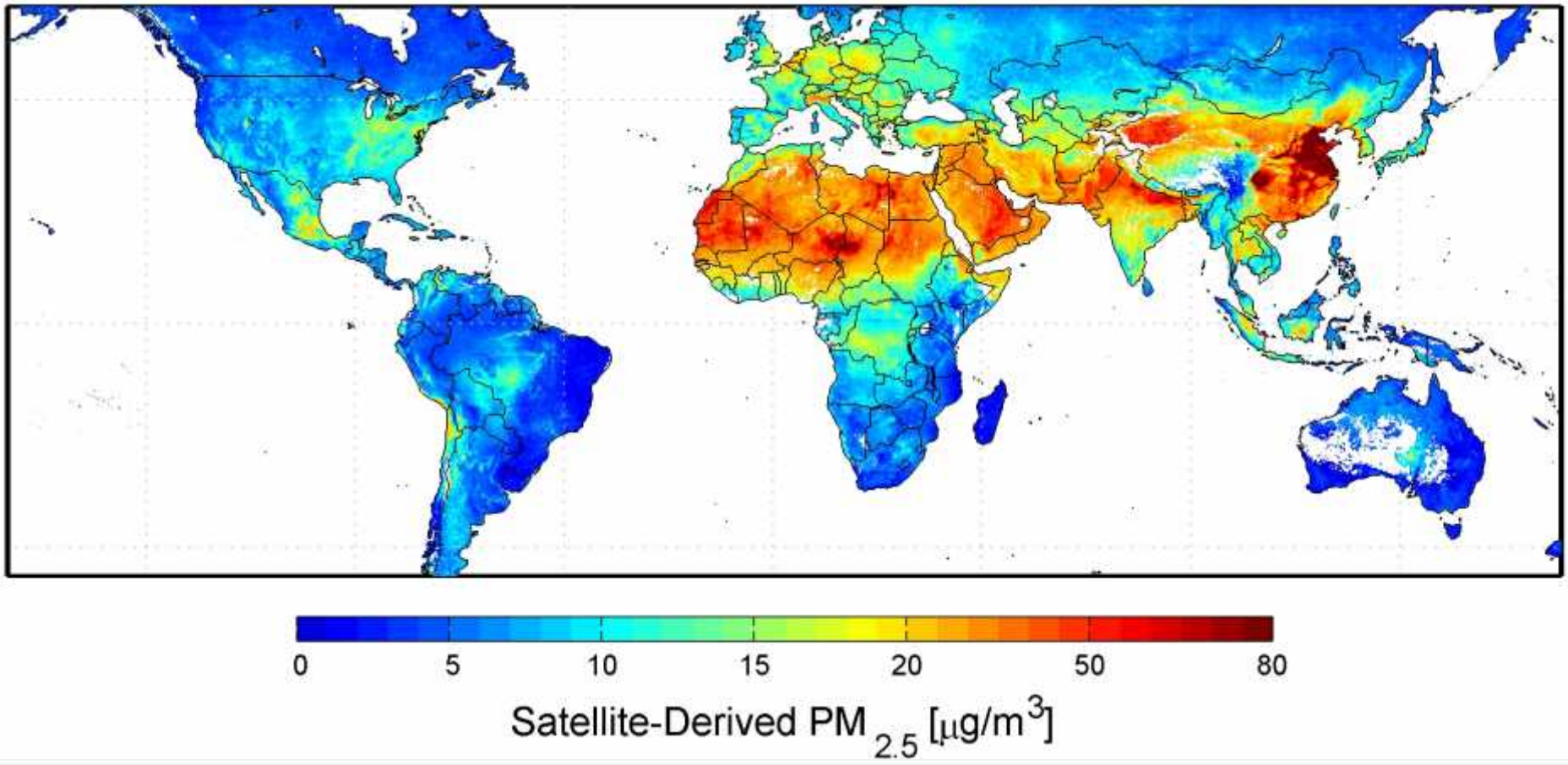
A study of 1,600 cities across 91 countries released on Wednesday by the WHO showed Delhi had the world's highest annual average concentration of small airborne particles (known as PM2.5) of 153.

What is Fine Particulate Air Pollution ($PM_{2.5}$)?

- Anything collected on a filter
  - Solid particles or liquid droplets
  - Not gases



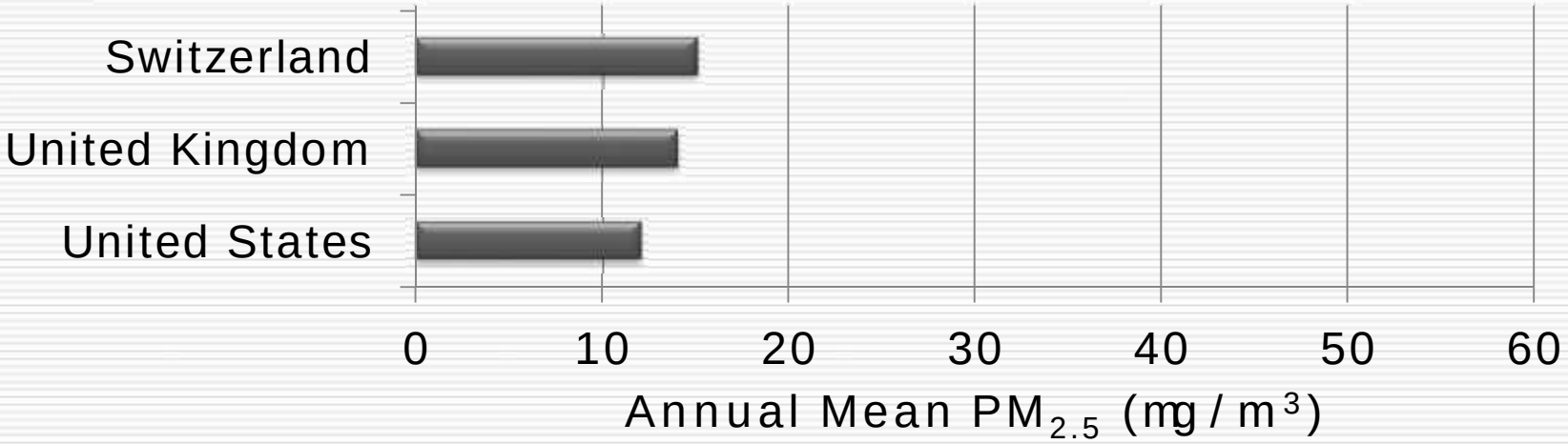
Global Satellite-Derived $PM_{2.5}$: 2001–2006 Average



Von Donkelaar et al Envir Hlth Pers 2010;118:847

WHO Tabulation of $PM_{2.5}$

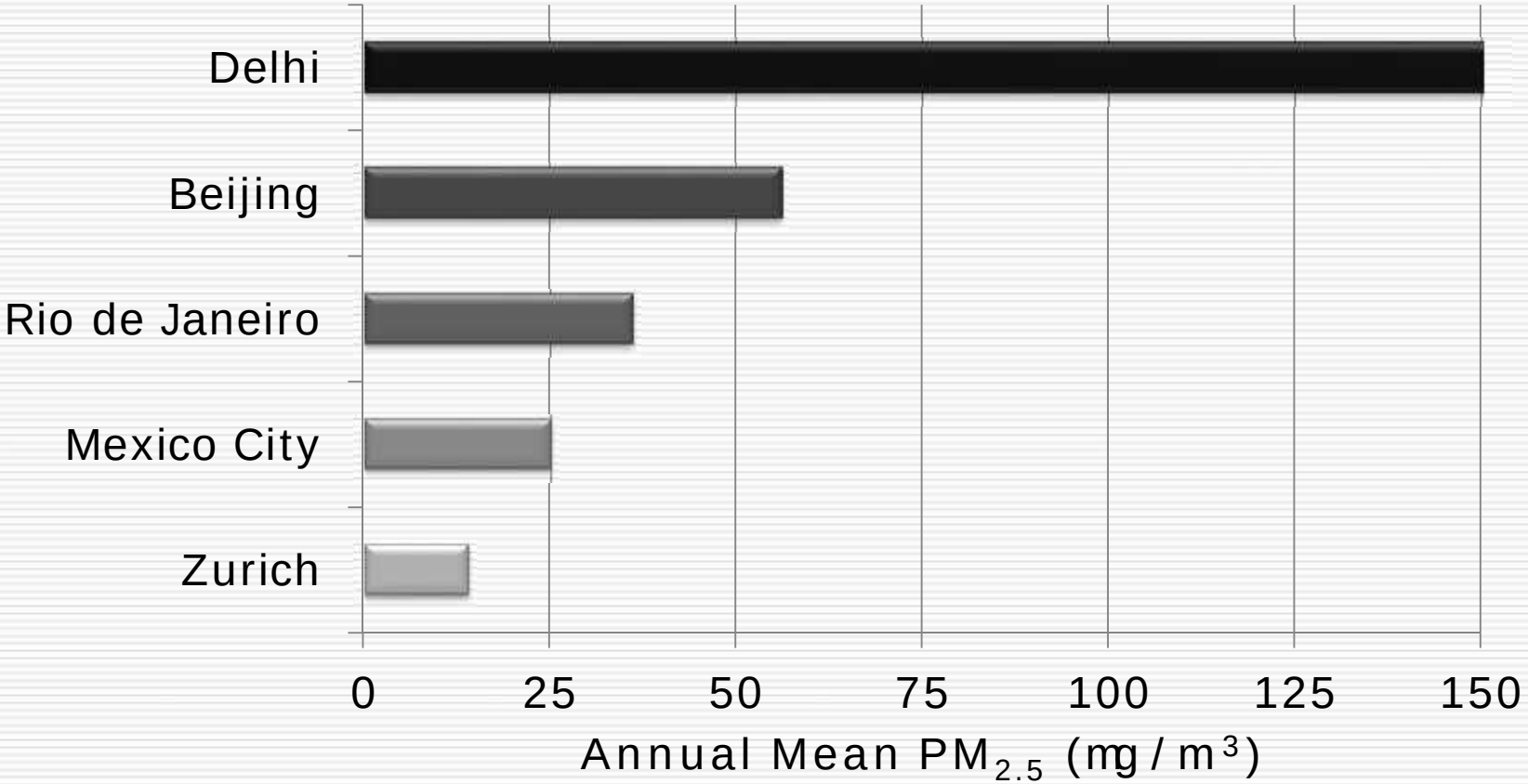
2012 Means by Country



http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/

WHO Tabulation of $PM_{2.5}$

2012 Means – Cities



http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/

Beijing still struggling to deal with traffic congestion.

South China Morning Post Nov 10, 2013

CHINADAILY

Coal and cars combine to increase pollution in North By Wang Qian 2010-12-08

Household Air Pollution - a Major Avoidable Risk Factor for Cardiorespiratory Disease

An Indian woman trying to ignite dried dung in a brick stove

An Ethiopian woman preparing to cook over a three-stone fire in a wooden outbuilding

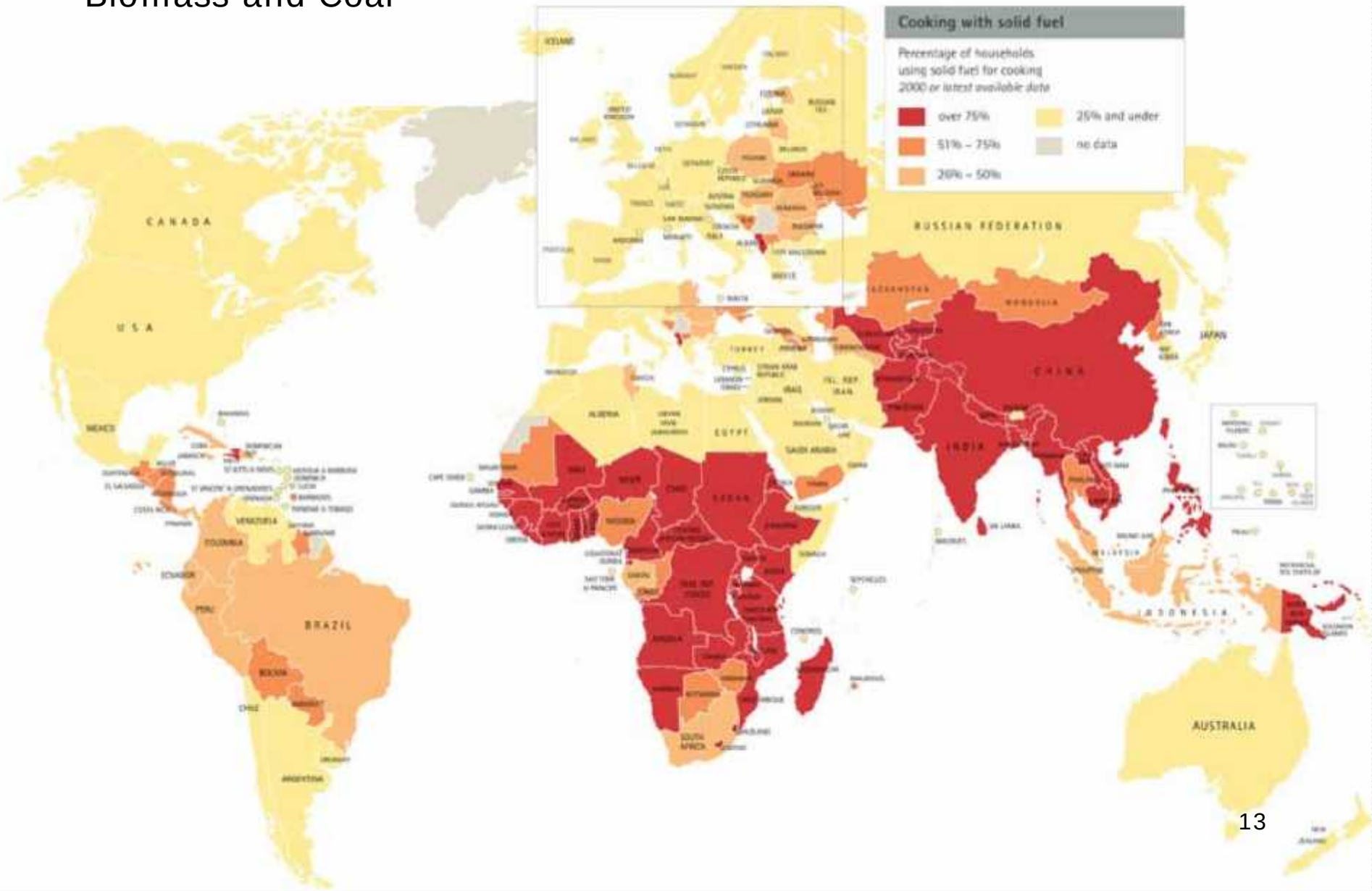
A Malawian woman cooking over a three-stone fire in building used as living and sleeping quarters

A Peruvian mother holding a young child while cooking in a smoky kitchen blackened by soot

Chest. 2012;142(5):1308-1315.

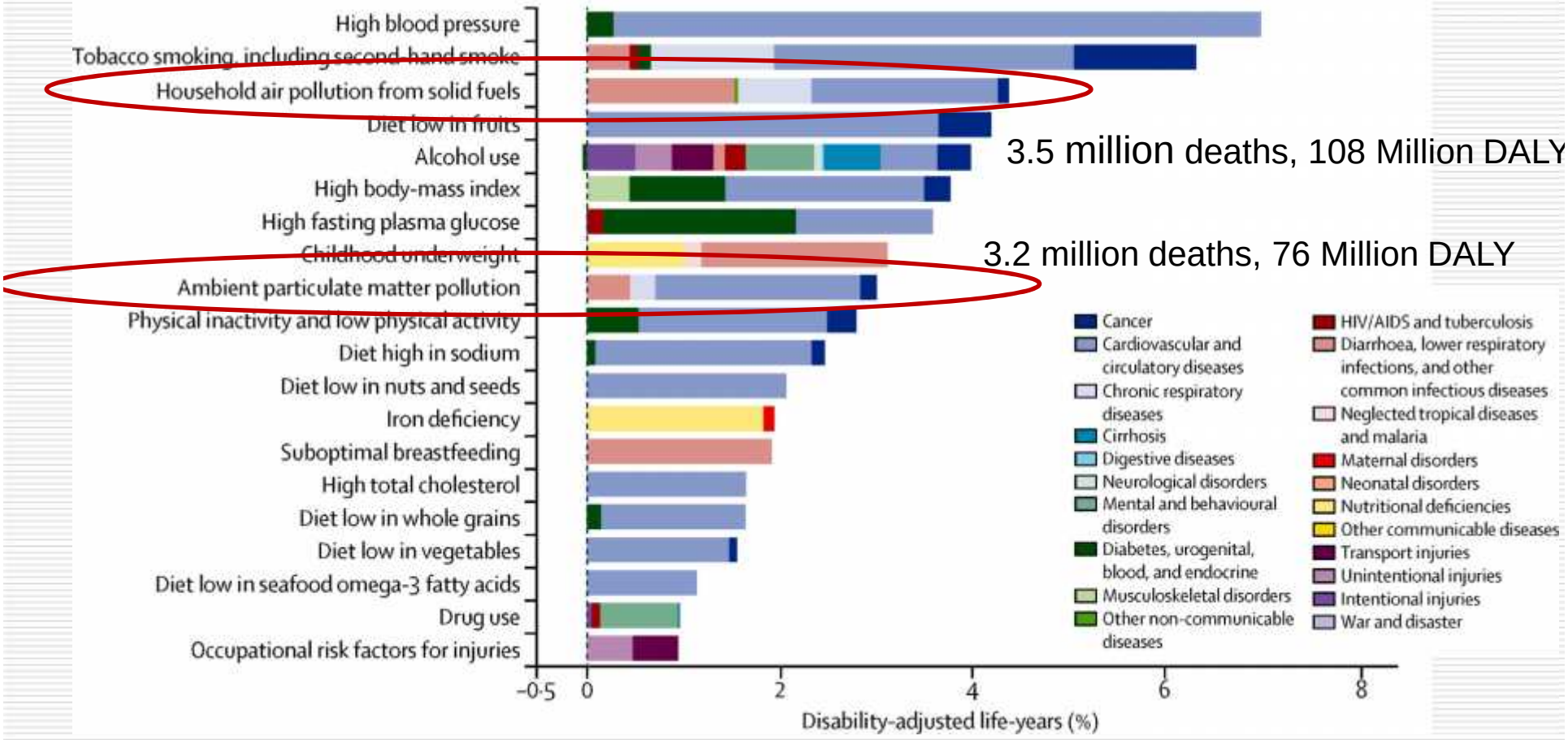
Cooking with Solid Fuels

Biomass and Coal



Comparative Risk Assessment
Global Burden of Disease Study 2010

Burden of disease attributable to 20 leading risk factors in 2010

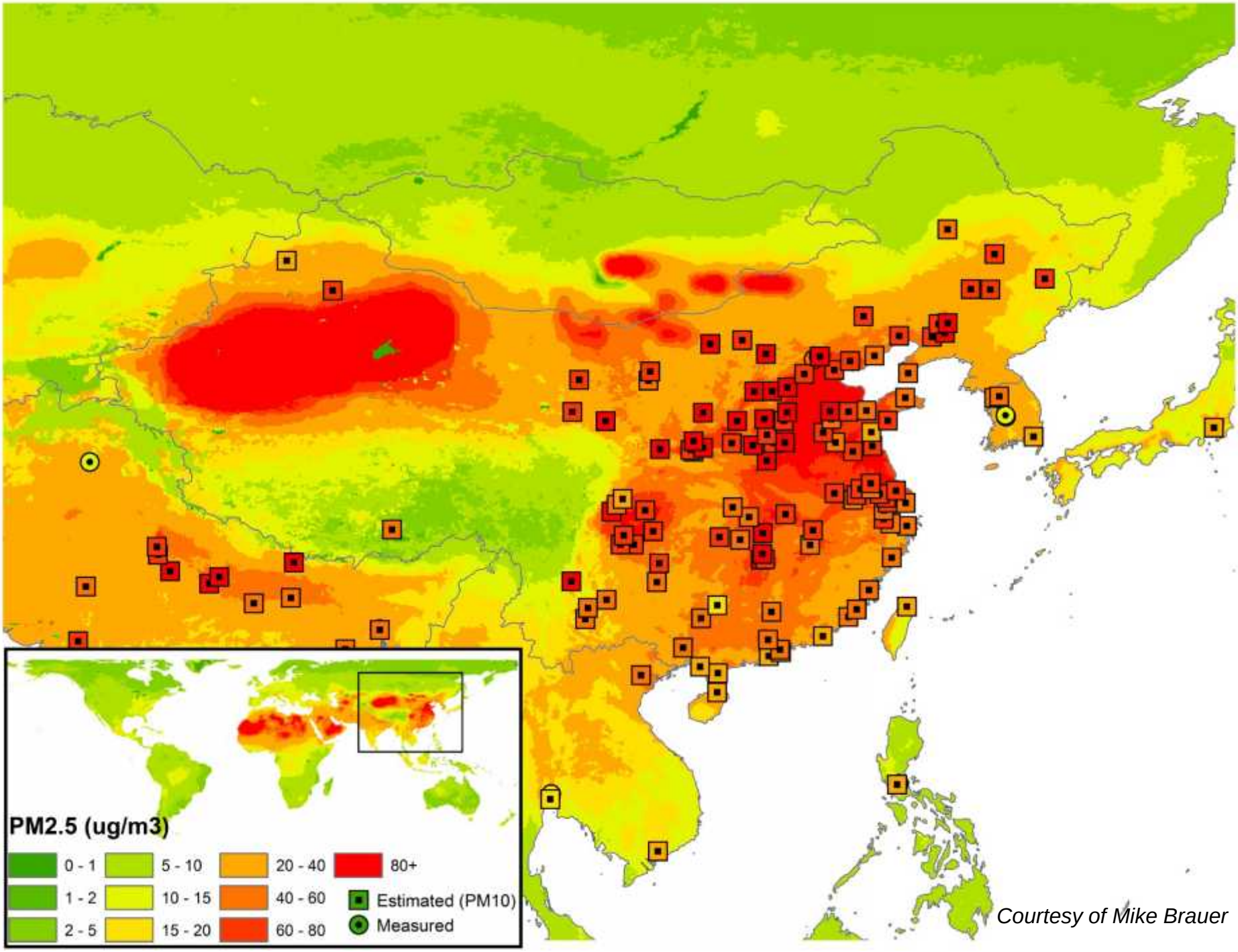


3.5 million deaths, 108 Million DALY

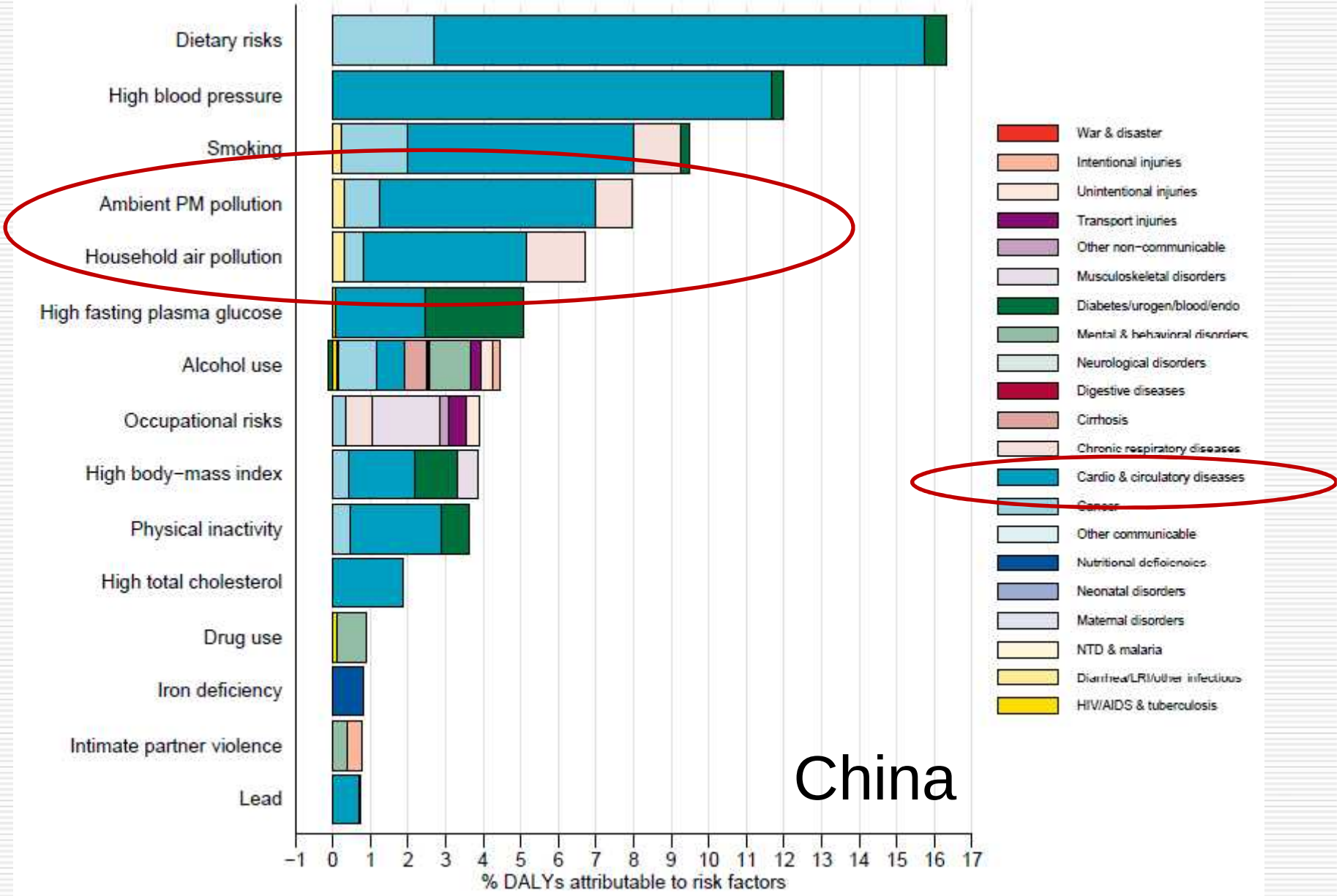
3.2 million deaths, 76 Million DALY

The Lancet, 2012; 380(9859): 2224 - 2260

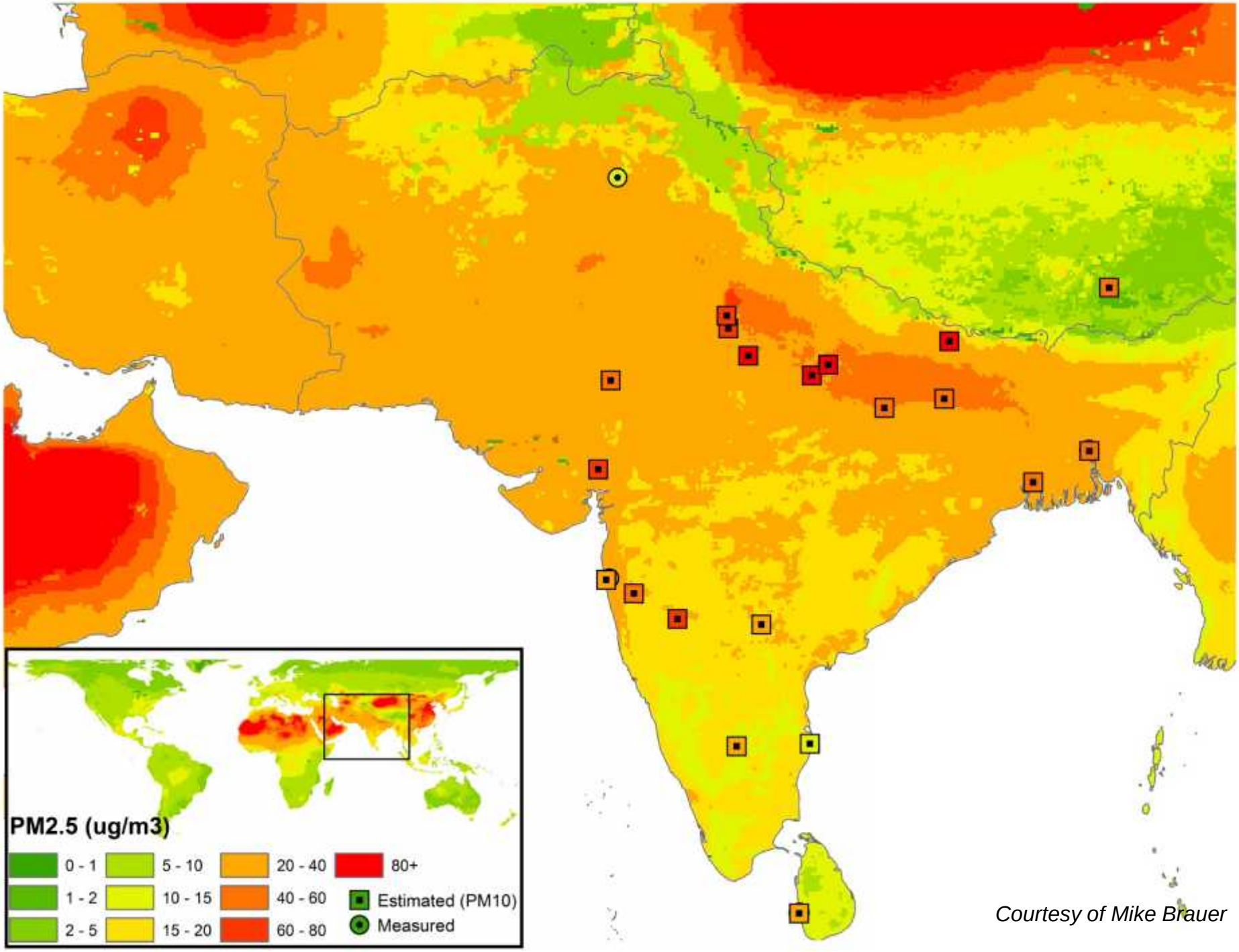
Burden of Disease: India, China, Brazil, and Mexico



Courtesy of Mike Brauer



http://www.healthmetricsandevaluation.org/gbd/country-profiles



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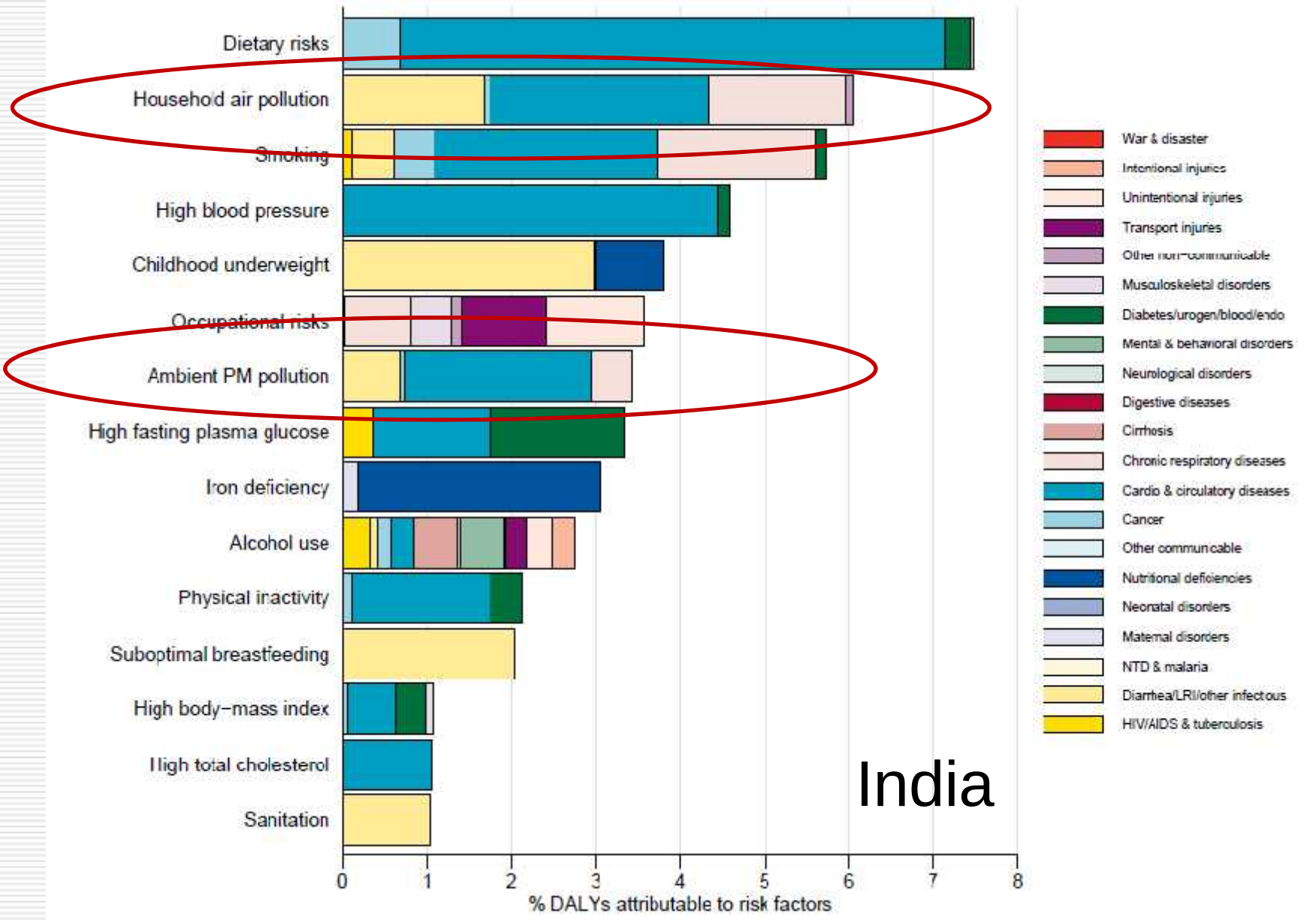

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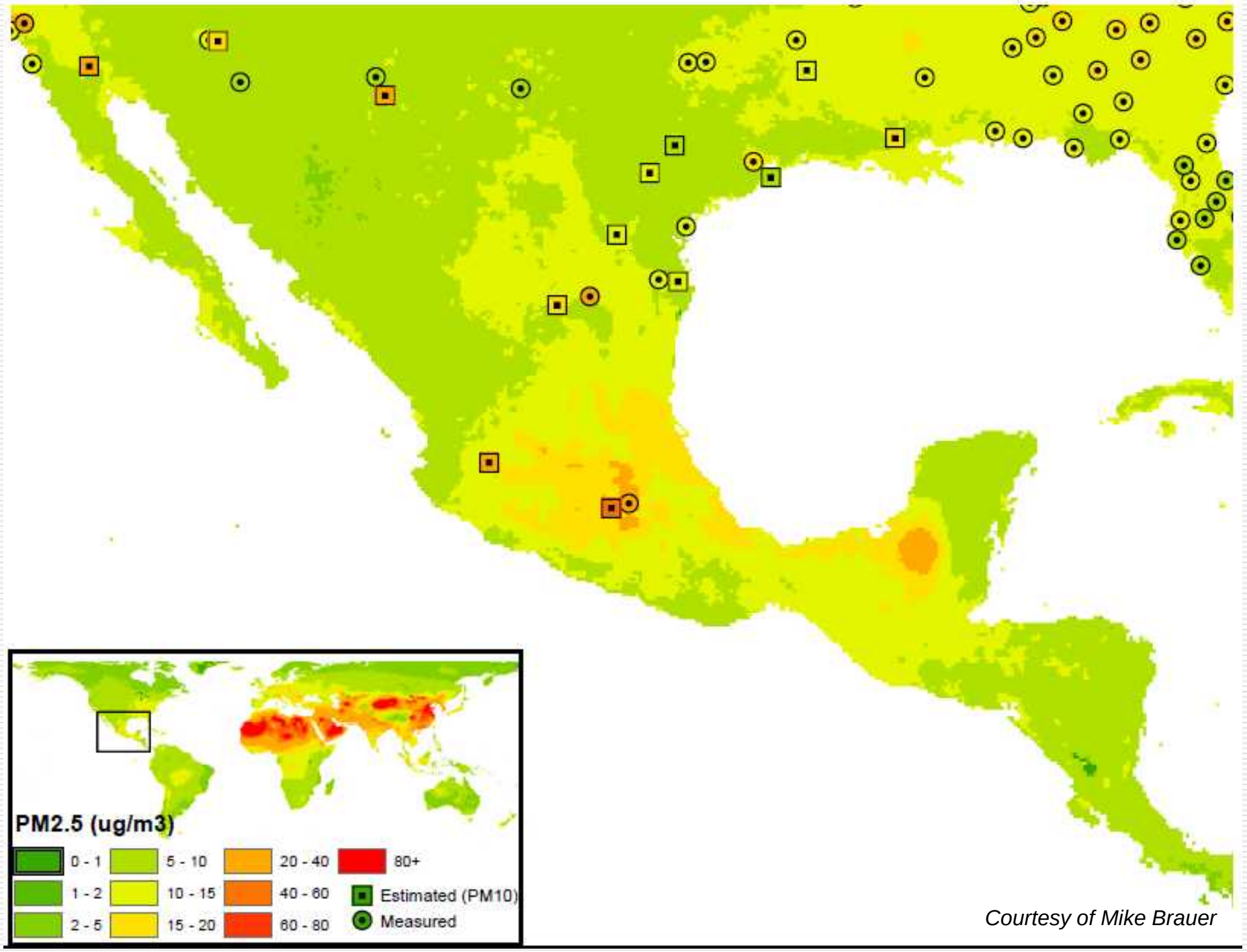

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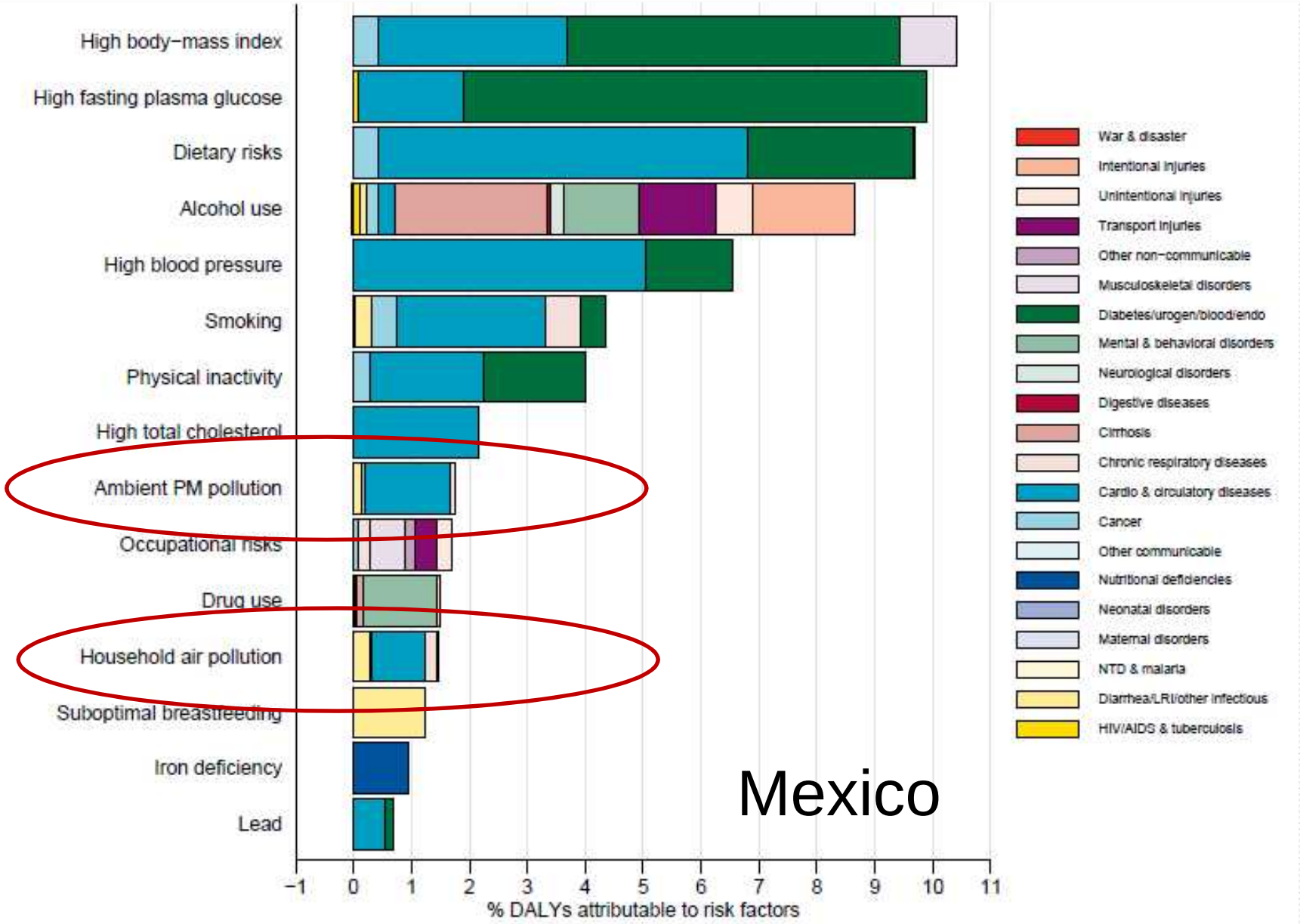
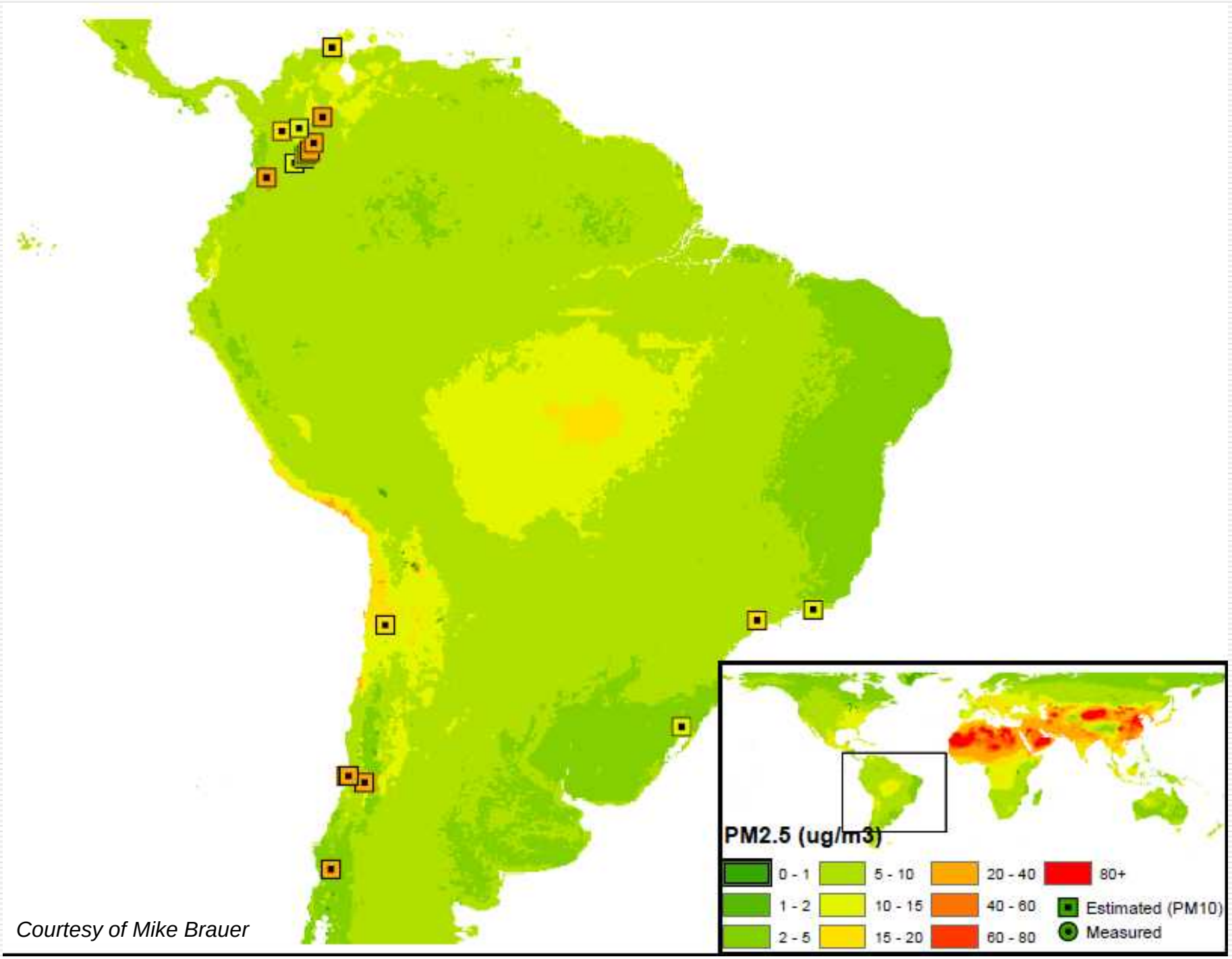

High body−mass index
High fasting plasma glucose
Dietary risks
Alcohol use
High blood pressure
Smoking
Physical inactivity
High total cholesterol
Ambient PM pollution
Occupational risks
Drug use
Household air pollution
Suboptimal breastfeeding
Iron deficiency
Lead
−1
0
1
2
3
4
5
6
7
8
9
10
11
% DALYs attributable to risk factors
War & disaster
Intentional injuries
Unintentional injuries
Transport injuries
Other non−communicable
Musculoskeletal disorders
Diabetes/urogen/blood/endo
Mental & behavioral disorders
Neurological disorders
Digestive diseases
Cirrhosis
Chronic respiratory diseases
Cardio & circulatory diseases
Cancer
Other communicable
Nutritional deficiencies
Neonatal disorders
Maternal disorders
NTD & malaria
Diarrhea/LRI/other infectious
HIV/AIDS & tuberculosis
Mexico



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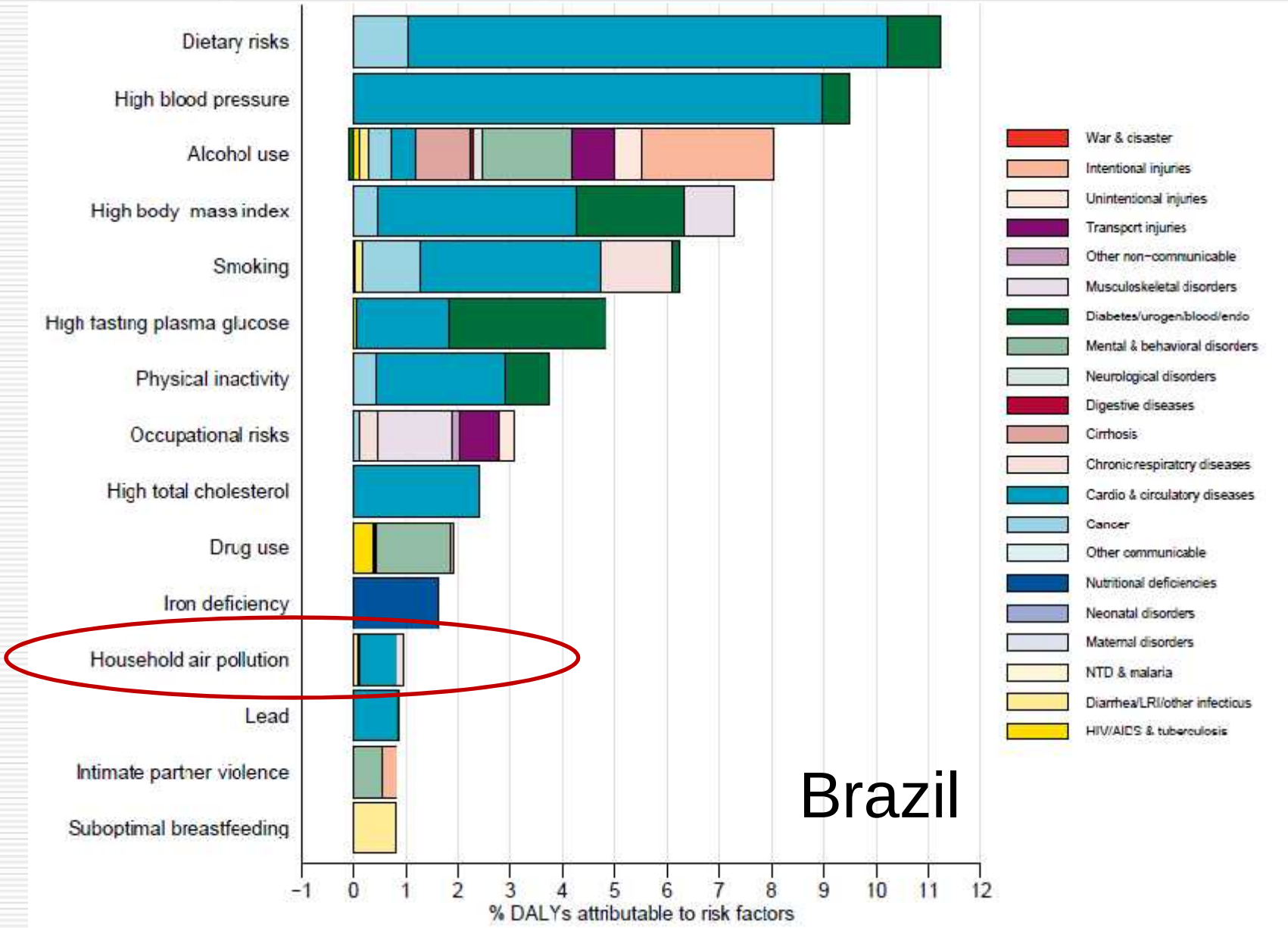


http://www.healthmetricsandevaluation.org/gbd/country-profiles

How do they estimate these numbers?

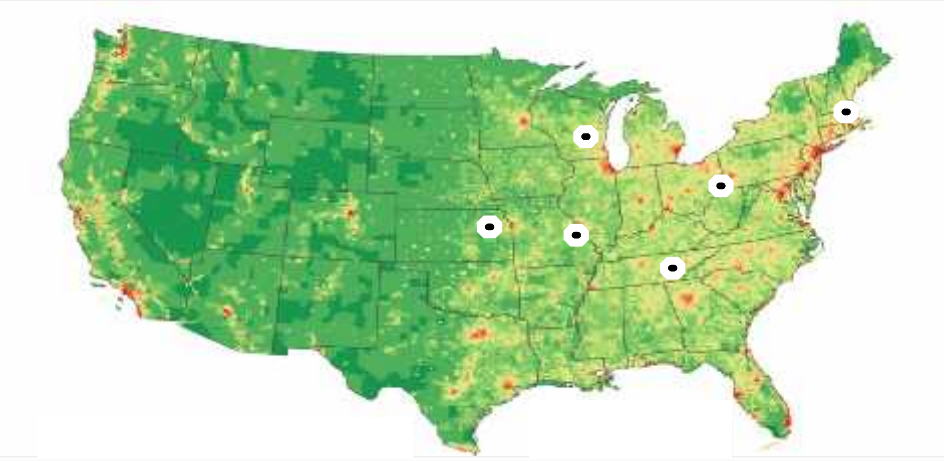
Dose – Response

Exposure

Population statistics

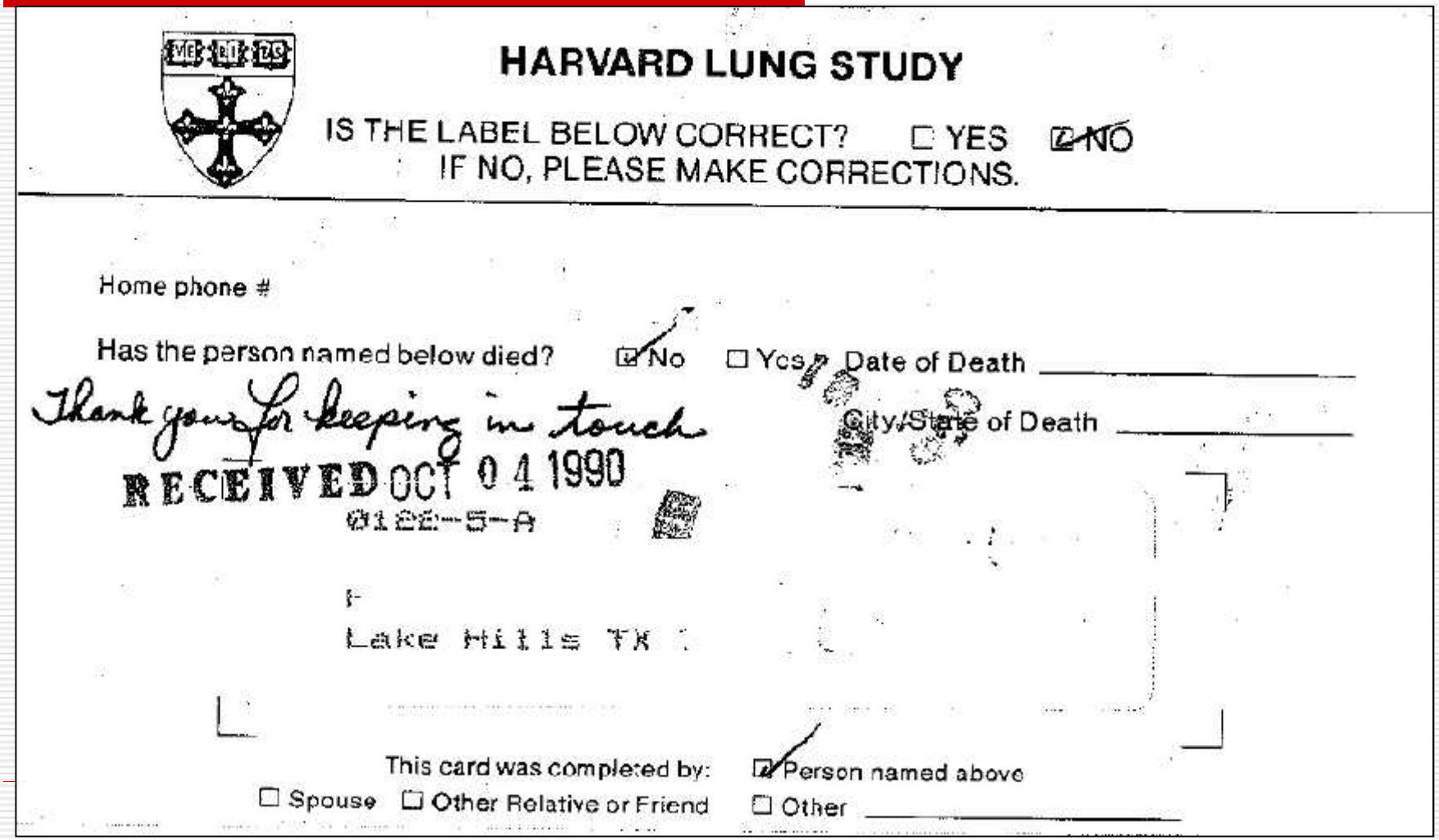
Six Cities Adult Mortality Study

- 8111 adults in 6 cities
  - Dirty: Steubenville & St. Louis
  - Moderate: Watertown & Kinston/Harriman
  - Clean: Topeka & Portage
- Enrolled starting in 1974
- 14-16 years of mortality follow-up



Dockery et al, NEJM 1993;329:1753

Follow-up



HARVARD LUNG STUDY

IS THE LABEL BELOW CORRECT? ☐ YES ☑ ~~NO~~
IF NO, PLEASE MAKE CORRECTIONS.

Home phone #

Has the person named below died? ☑ No ☐ Yes Date of Death _____

City/State of Death _____

Thank you for keeping in touch

RECEIVED OCT 0 4 1990

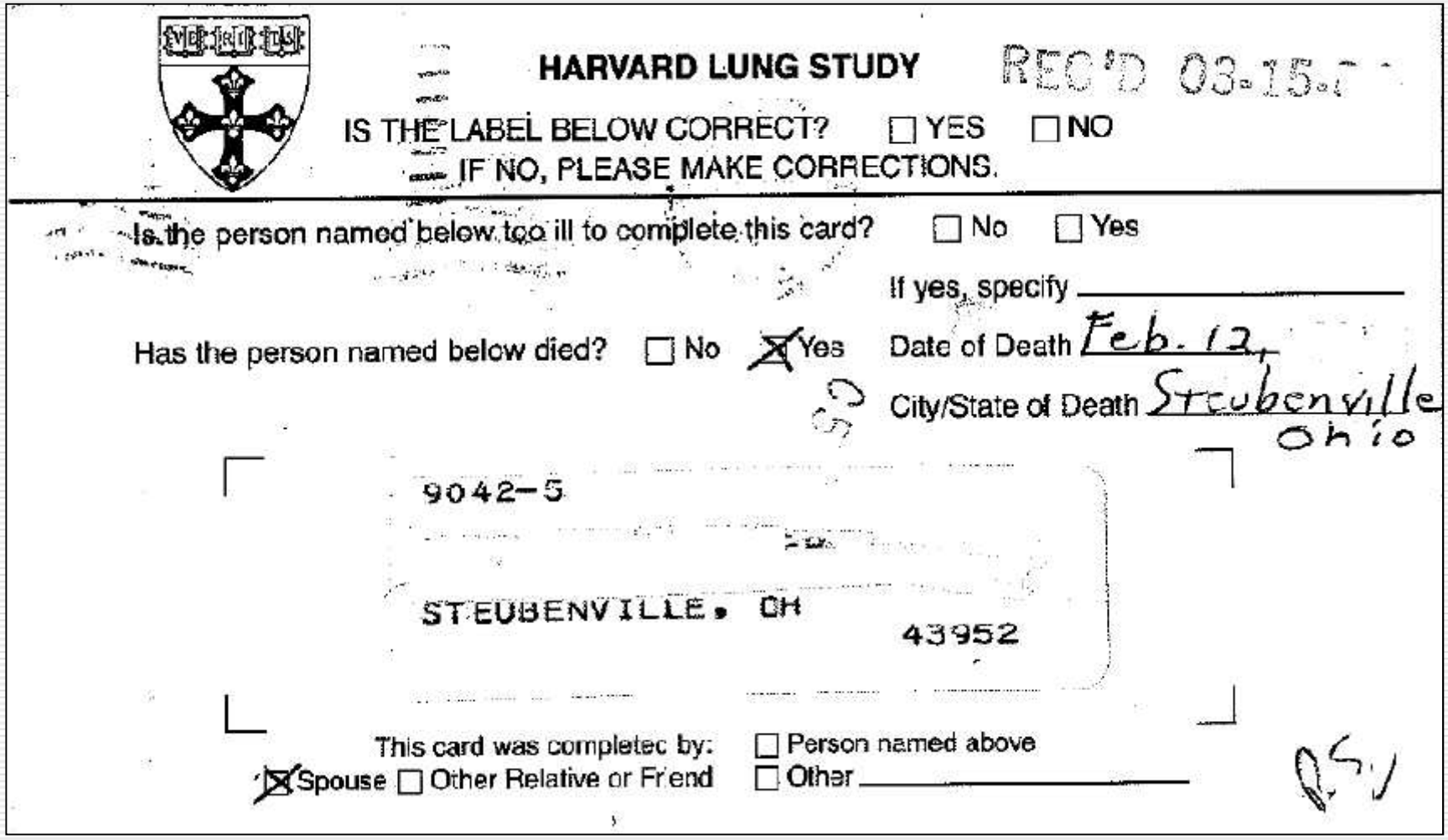
012E-5-A

Lake Hills TX

This card was completed by: ☑ Person named above

☐ Spouse ☐ Other Relative or Friend ☐ Other _____

Follow-up



HARVARD LUNG STUDY

REC'D 03-15-[illegible]

IS THE LABEL BELOW CORRECT? ☐ YES ☐ NO

IF NO, PLEASE MAKE CORRECTIONS.

Is the person named below too ill to complete this card? ☐ No ☐ Yes

If yes, specify _____

Has the person named below died? ☐ No ☒ Yes Date of Death Feb. 12,

City/State of Death Steubenville Ohio

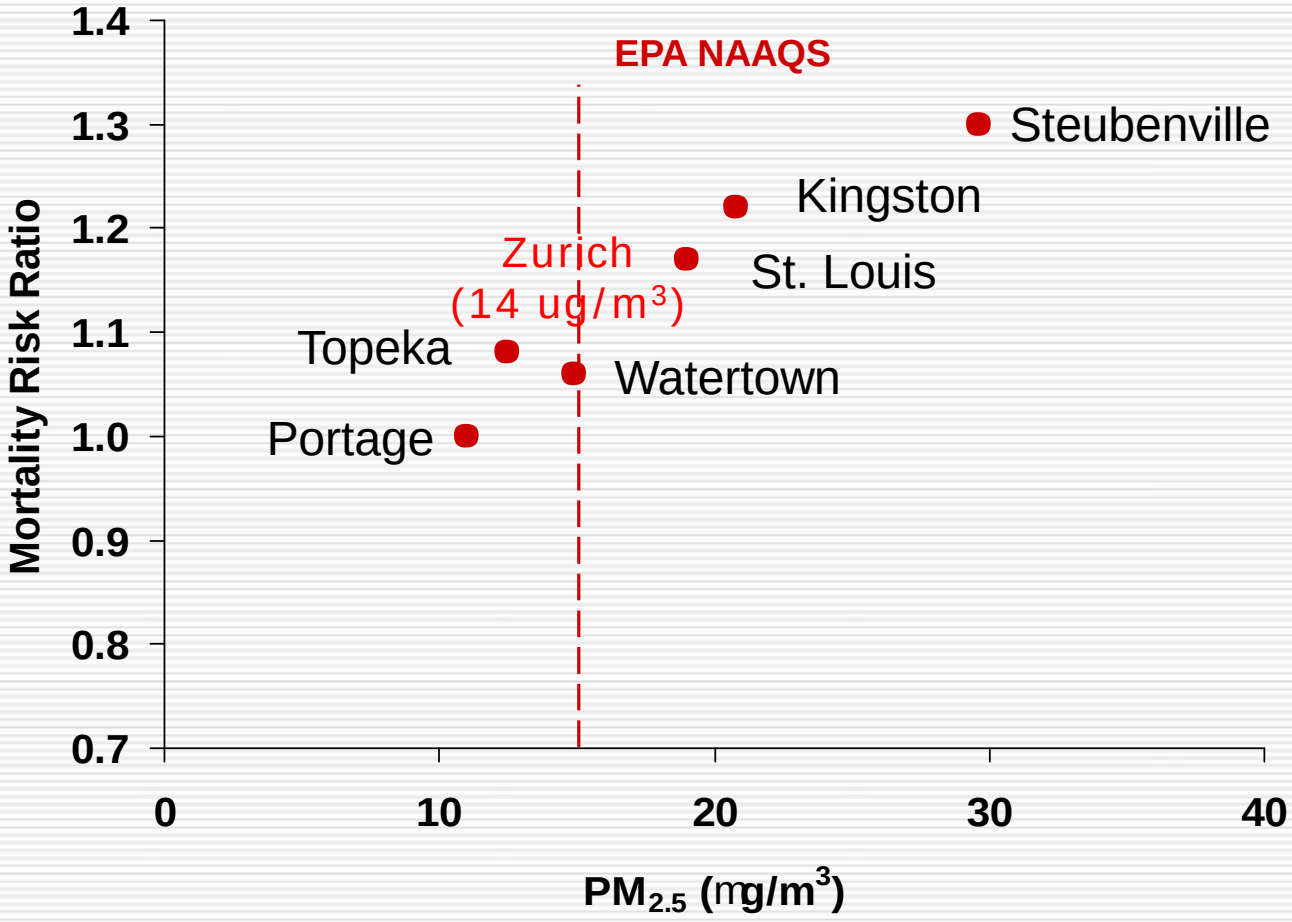
9042-5

STEUBENVILLE, OH 43952

This card was completec by: ☐ Person named above

☒ Spouse ☐ Other Relative or Friend ☐ Other _____

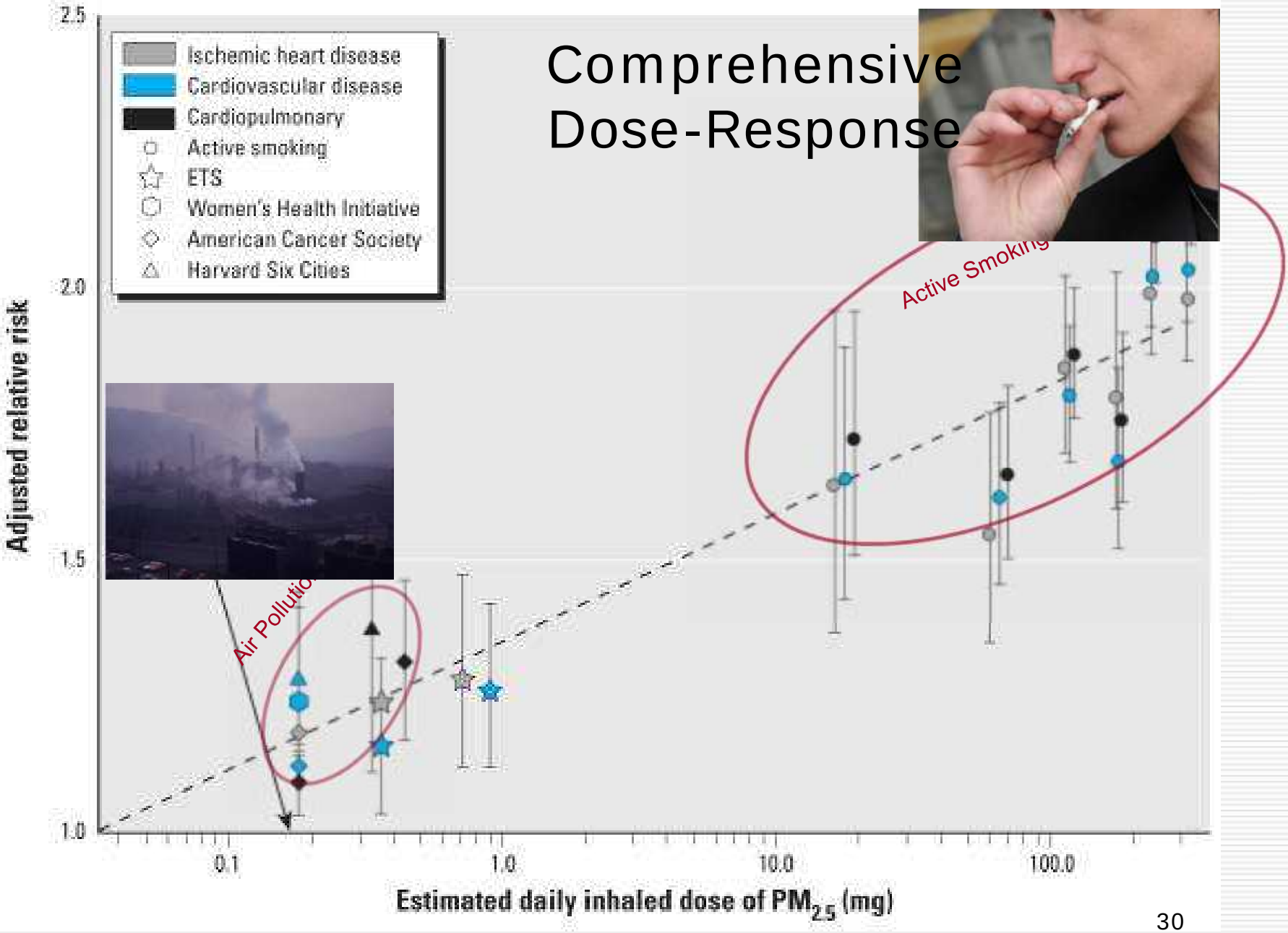
Six Cities Adult Mortality



Delhi
(153 ug/m³)

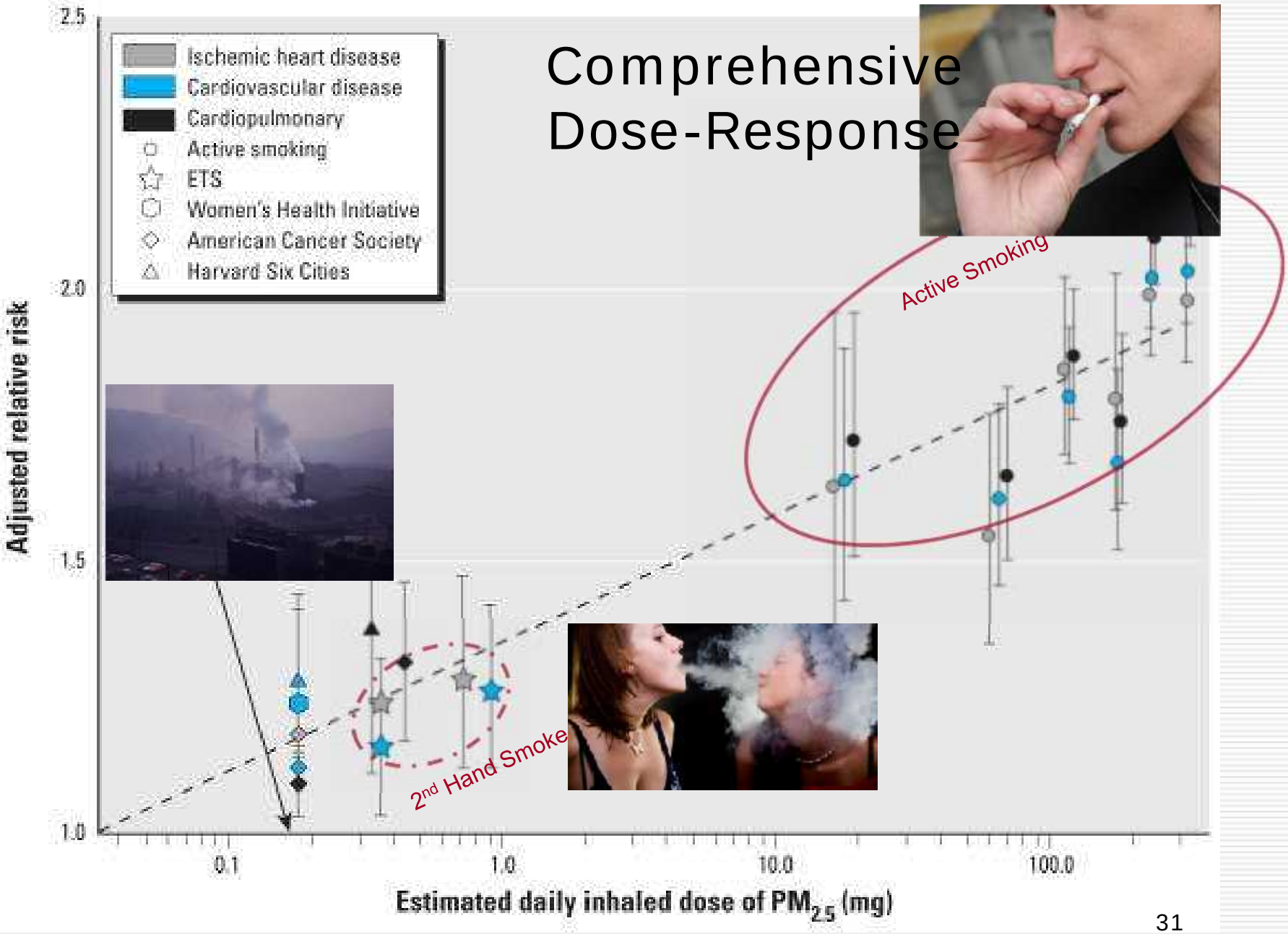
Beijing
(56 ug/m³)

Comprehensive Dose-Response



Pope et al, Circulation. 2009;120:941-948

Comprehensive Dose-Response



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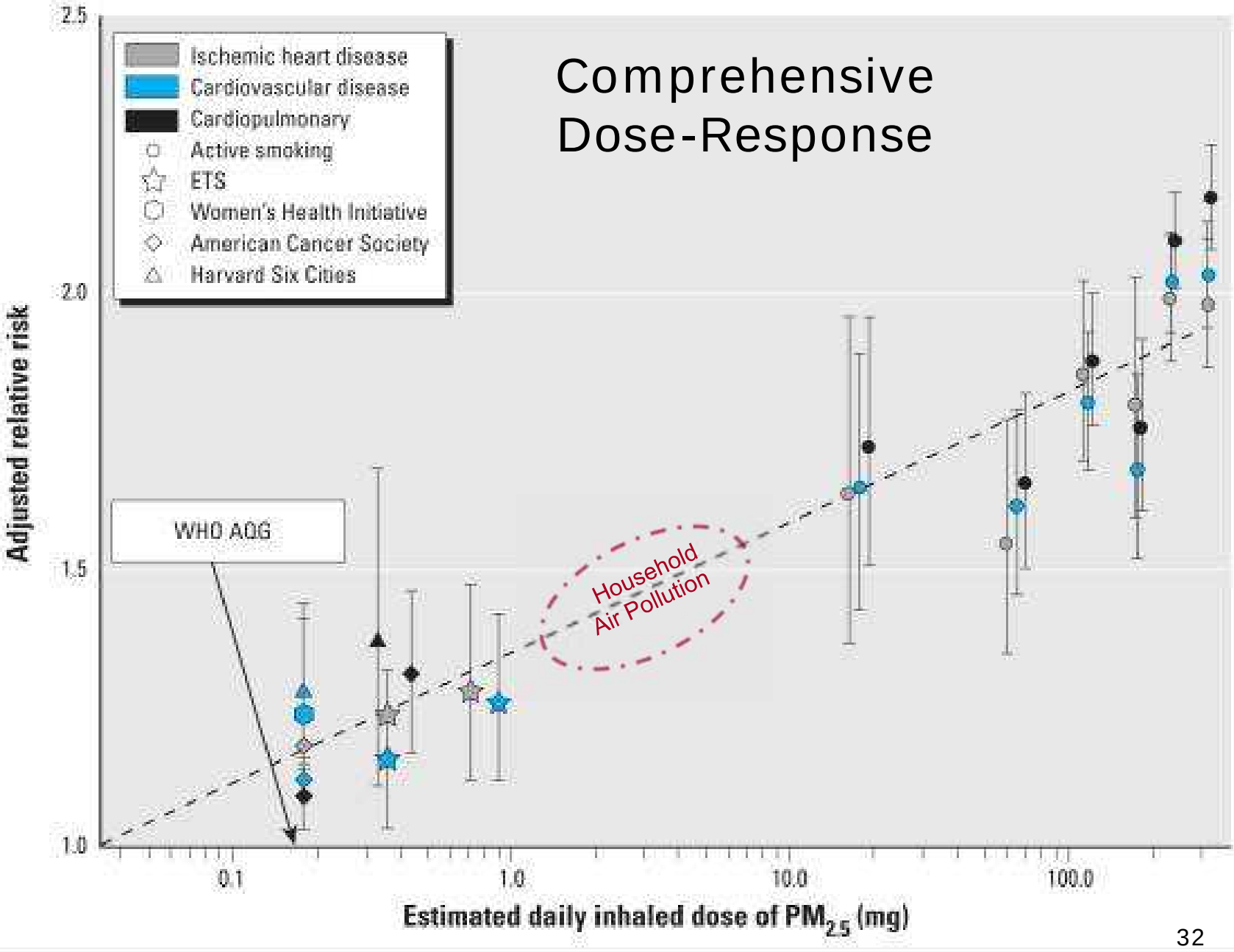
Comprehensive Dose-Response

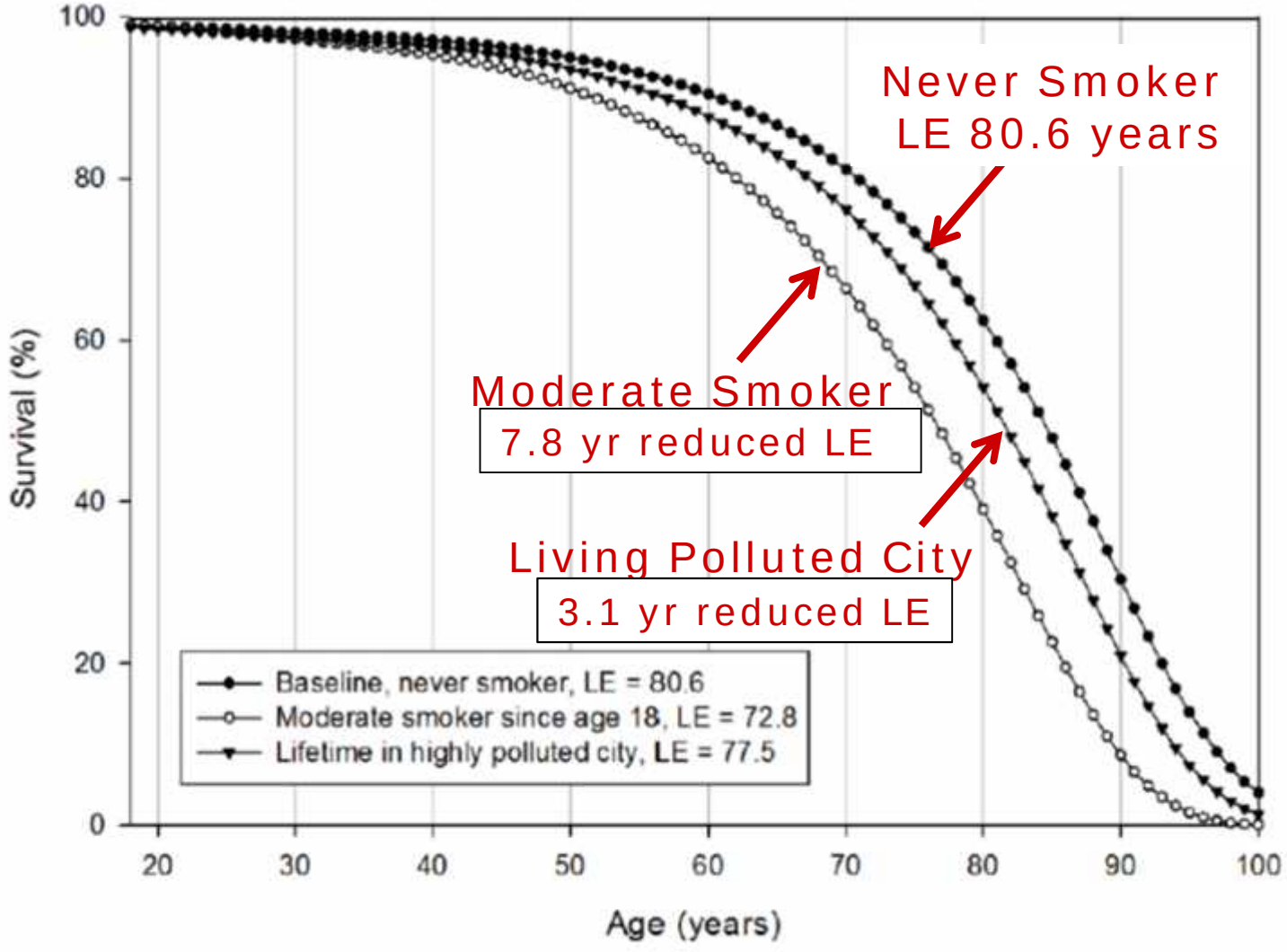


Pope et al, Circulation. 2009;120:941-94

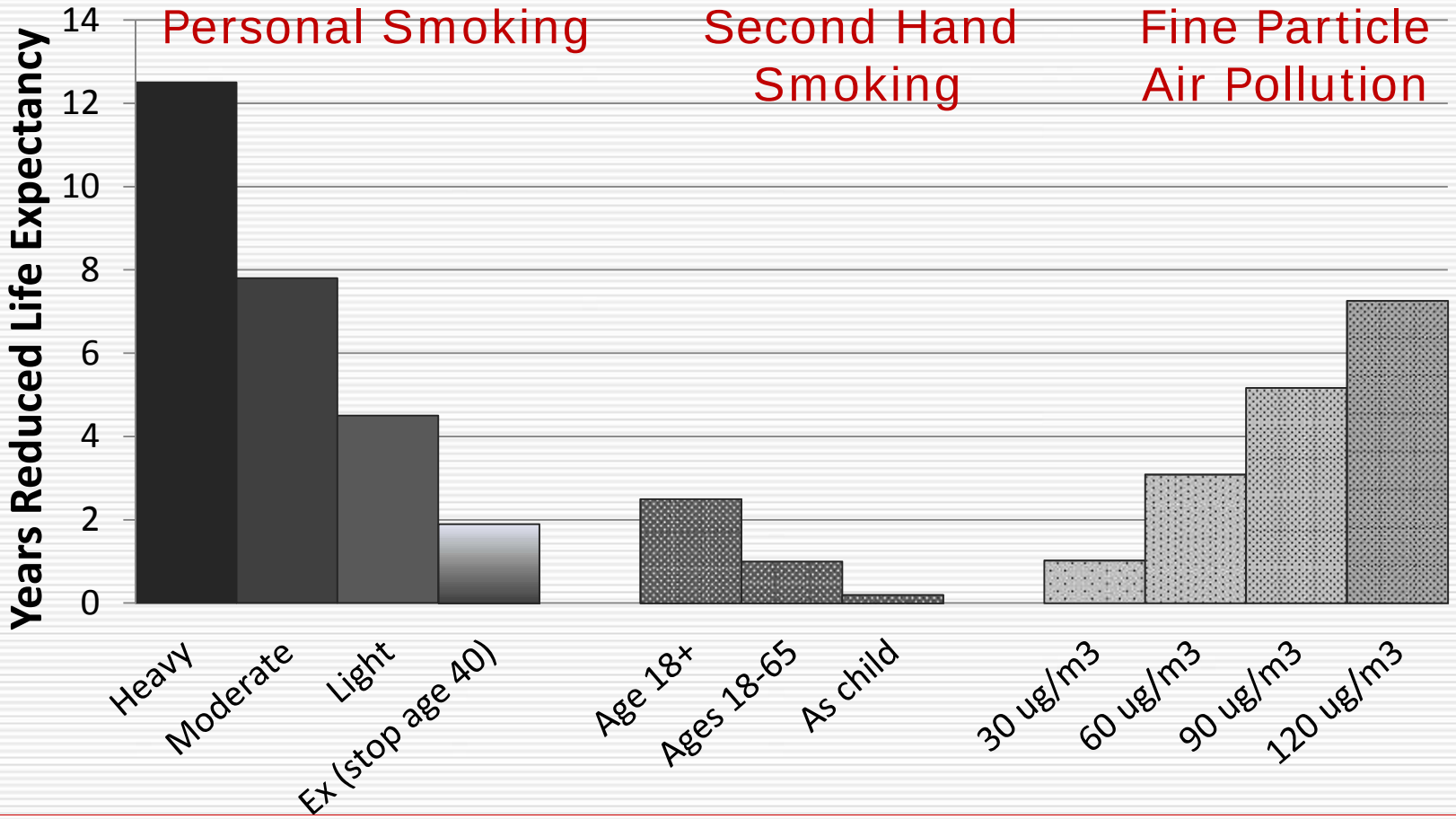
What does this mean for the individual?

What is effect of life expectancy?

Survival curves 18-100 years and estimated life expectancy (LE) for alternative excess risk assumptions

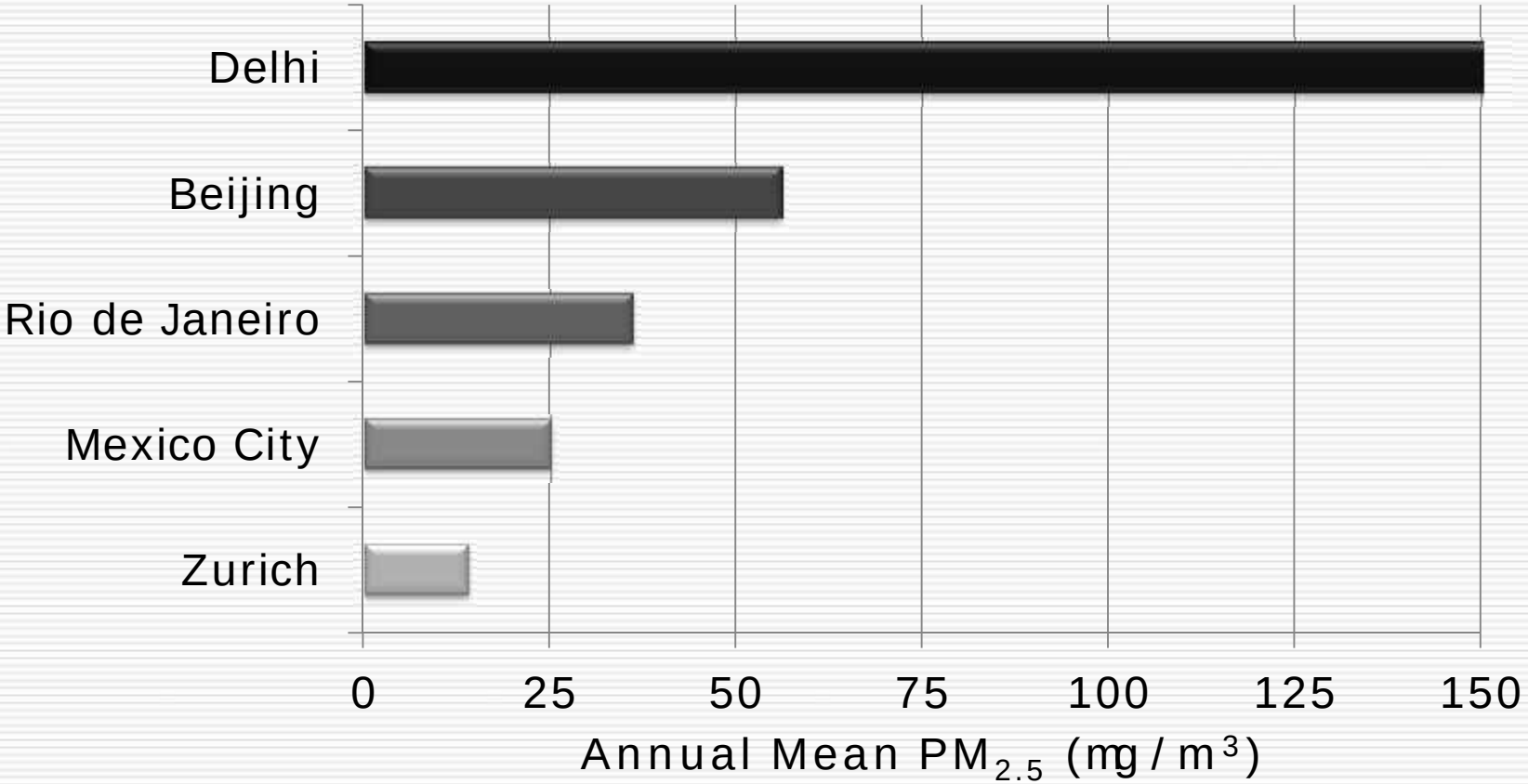


Estimated Years reduced life expectancy
- exposures to cigarette smoke and fine particle air pollution



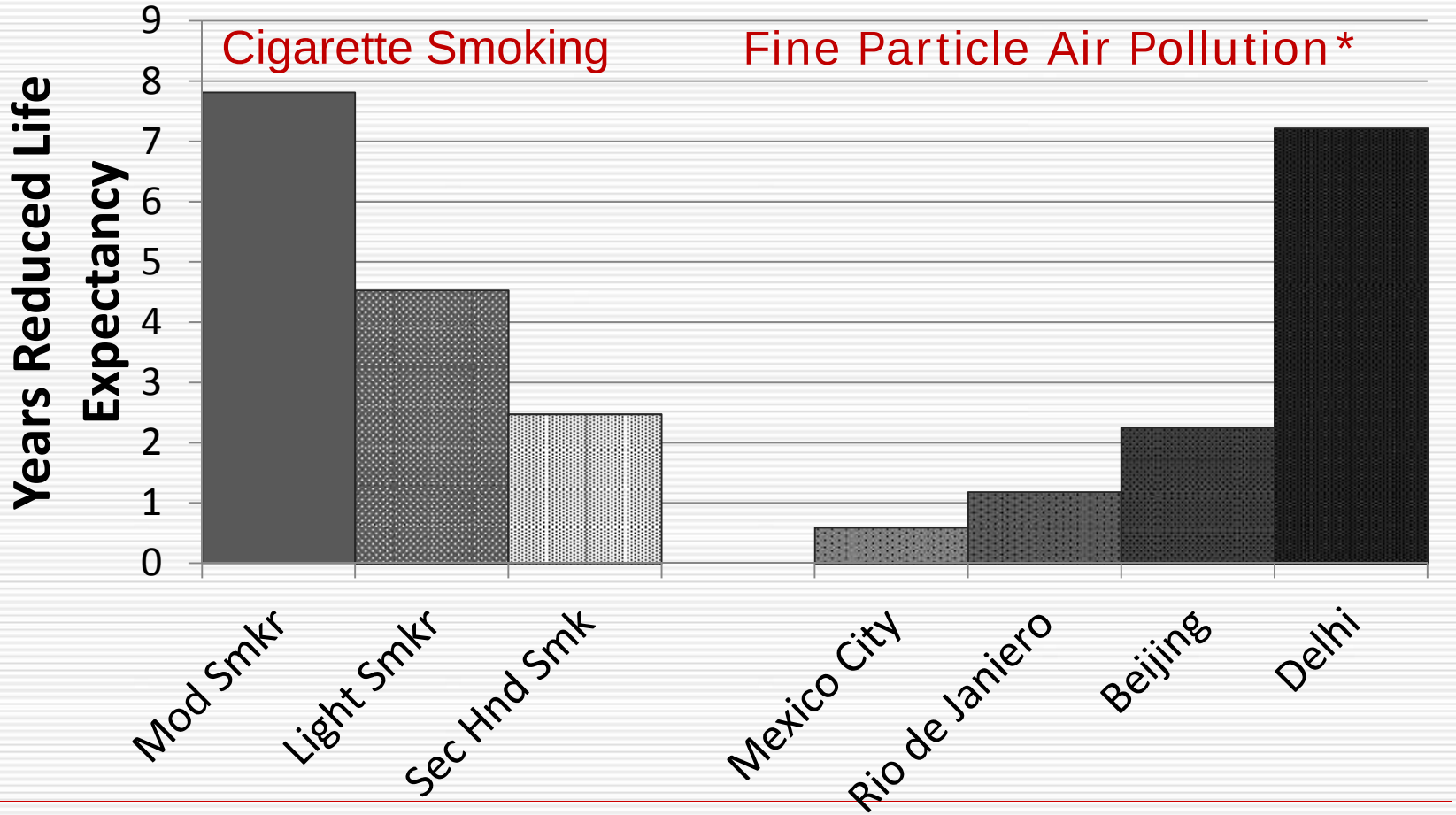
WHO Tabulation of $PM_{2.5}$

2012 Means – Cities



http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/

Years Reduced Life Expectancy - Lifetime Exposure



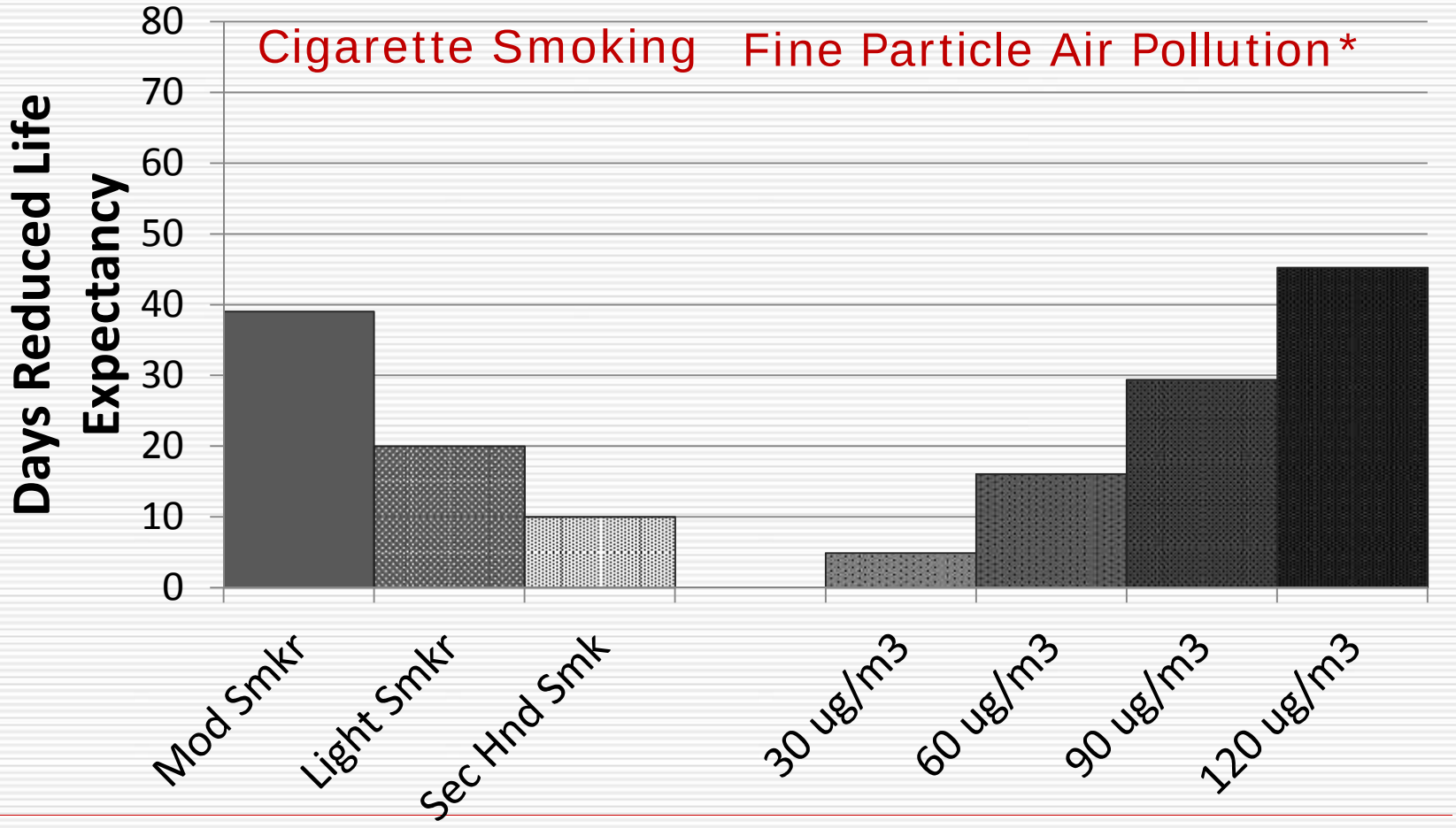
* Compared to Zurich

Incremental Risk

- Estimate of effect of each year of exposure
- Effect of potential changes in exposures or behaviors.
- Comparative risk for a worker or student who temporarily moves to such an environment.
- Consider 50-year old non-smoker who spends one year in mild, moderate, and high $PM_{2.5}$ air pollution.

Estimated days of reduced life expectancy

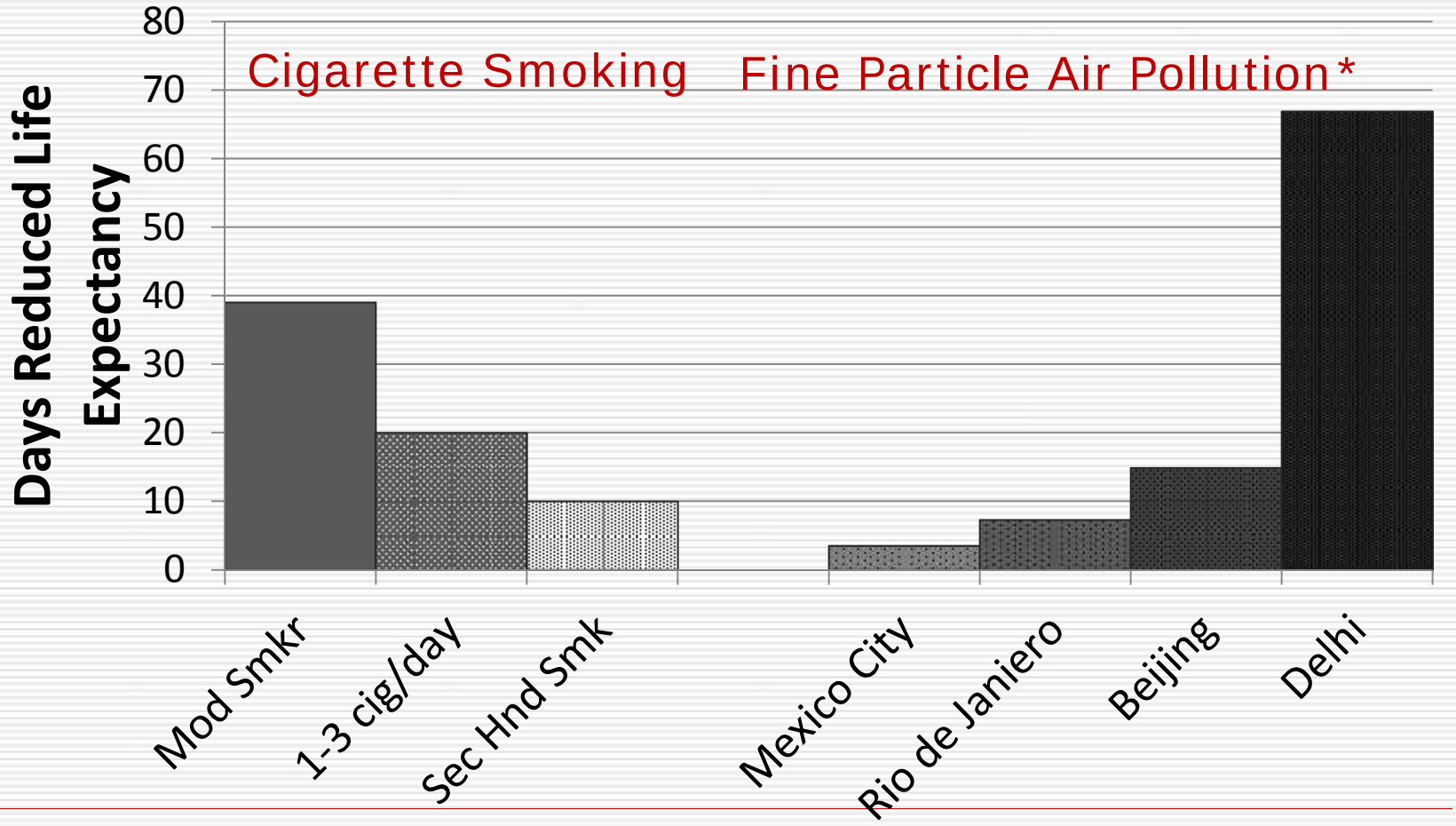
1 year exposures to cigarette smoke and fine particle air pollution
50 years of age



* Compared to 15 ug/m3

Estimated days of reduced life expectancy

1 year exposures to cigarette smoke and fine particle air pollution
50 years of age



* Compared to Zurich

Effect of Age of living in Delhi?

- Baseline risk goes up with age
- Impact of each year of exposure to high pollution increases with age
  - 35 yrs – 29 days reduced LE
  - 50 yrs – 67 days reduced LE
  - 65 yrs – 116 days reduced LE

What does this mean for the individual?

- Not suggesting that their life is measurably shortened.
  - Rather these estimates reflect the increase probability of death in each year.
- How would they die?
  - Acute events such as myocardial infarction, stroke, asthma attack, or traffic accident.
- Assume that once the air pollution exposure is removed (for example, by moving to a cleaner city) their excess risk of dying returns to normal.

Summary

- Each year of living in highly polluted city (e.g. Delhi) reduces expected average life expectancy by 30 to 120 days compared to living in cleaner city (e.g. Zurich)
  - Comparable to effects of being moderate smoker
- Over a lifetime, this amounts to up about 7 years lost life expectancy

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