

Lancet
Commission on Pollution and Health:
A Brief Description of Methods

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How would we answer this question?

- What is the total impact of disease and injury in the population? -- the overall target for public health interventions?
 - Which diseases are most important for which groups?
 - Are things getting better or worse?
- This is answered by the Global Burden of Disease

What is the most commonly reported measure of ill-health?

- Number of deaths
- Has advantages
 - Related to disease and injury
 - Easy to determine
 - Commonly tabulated
- But has severe problems as a measure
 - Everyone dies; health never achieved
 - Age is clearly important
 - Deaths + Illness = ?

Combined Measure of Ill-health

- Most fundamental metric is **loss of time**
- Same potential life length shared by all humans
- The degree to which a person does not achieve this life length is a measure of ill-health
- Can be used for disabilities (illness and injury), as well, but need to weight the relative severity of disabilities as well as tabulate their duration

Disability Adjusted Life Year

The DALY

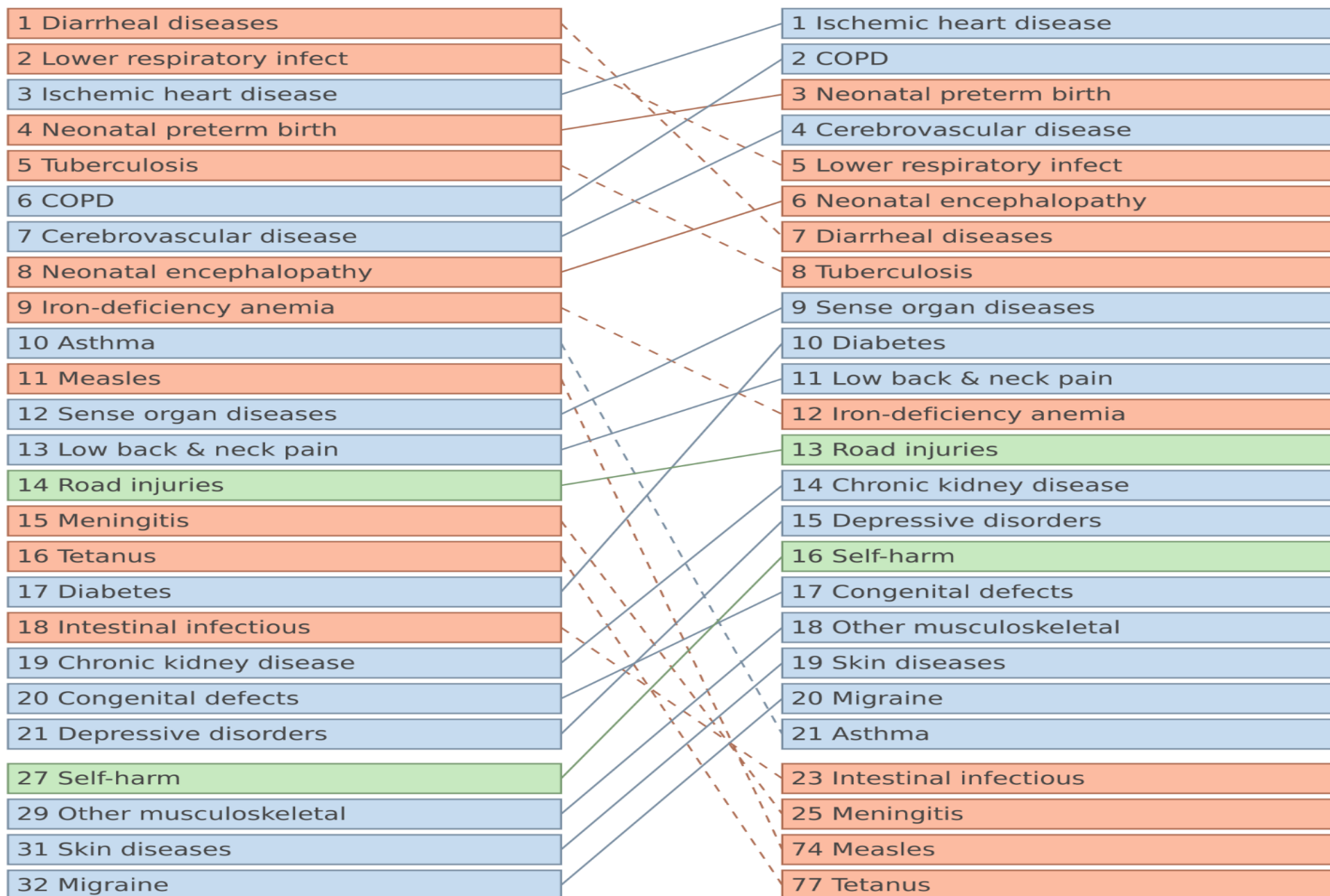
- Principle #1: The only differences in the rating of a death or disability should be due to age, not to income, culture, location, sex, social class.
- Principle #2: Everyone in the world has right to best life expectancy in world
- $DALY = YLL + YLD$
 - Years of Lost Life (due to mortality)
 - Years Lost to Disability (due to injury & illness)

Years of Lost Life - YLLs

Age at Death	YLLs
0	86
1	85.3
5	81.5
15	71.5
25	61.7
35	51.9
50	37.5
80	12.4
100	5.5

Based on
composite best
life expectancy in
the world for men
and women – 86
years at birth

India
Both sexes, Age-standardized, DALYs per 100,000
1990 rank **2015 rank**



How would we answer this second question?

- How do we compare the impacts of different risk factors and potential interventions that affect different populations?
 - For example, what is the burden of disease from environmental factors?
 - How does the impact of tobacco smoking compare to that from pollution?
- This is answered by the Comparative Risk Assessment of the Global Burden of Disease

Environmental Health Effects

- Example of results from outdoor air pollution studies
 - Asthma attacks
 - Missing workdays
 - Missing school days
 - Days with cough
 - Emergency room visits
 - Hospital admissions
 - Physician visits
 - Medication use
 - Daily death rate
 - Lung function
 - Self-reported health status
 - Etc.
- How can these be compared across time, cities, countries, age groups, sectors (e.g., transport versus power plants), etc.?
- Let alone compared with the health impacts from completely different risk factors, such as water pollution, lead exposure, high cholesterol, unsafe sex, etc.?

Disability Adjusted Life Year: the DALY and Premature Deaths

These are the metrics used
in the Commission Report

What do we mean by
pollution? →

No pesticide exposures,
No endocrine disruptors,
No climate change,
Etc.

Air (total)

Household air

Ambient particulate

Ambient ozone

Water (total)

Unsafe sanitation

Unsafe source

Occupational

Carcinogens

Particulates

Soil, heavy metals, and
chemicals

Lead

Total

METHODOLOGY

- Review restricted to combinations of pollution risk factors and disease for which there is convincing or probable evidence of causal association
- Likely to be underestimates of the full burden of disease attributable to the pollution exposures

METHODOLOGY

- Soil pollution caused by toxic chemicals and heavy metals at contaminated sites
- Blacksmith Institute/ Pure Earth Toxic Sites Identification program

METHODOLOGY

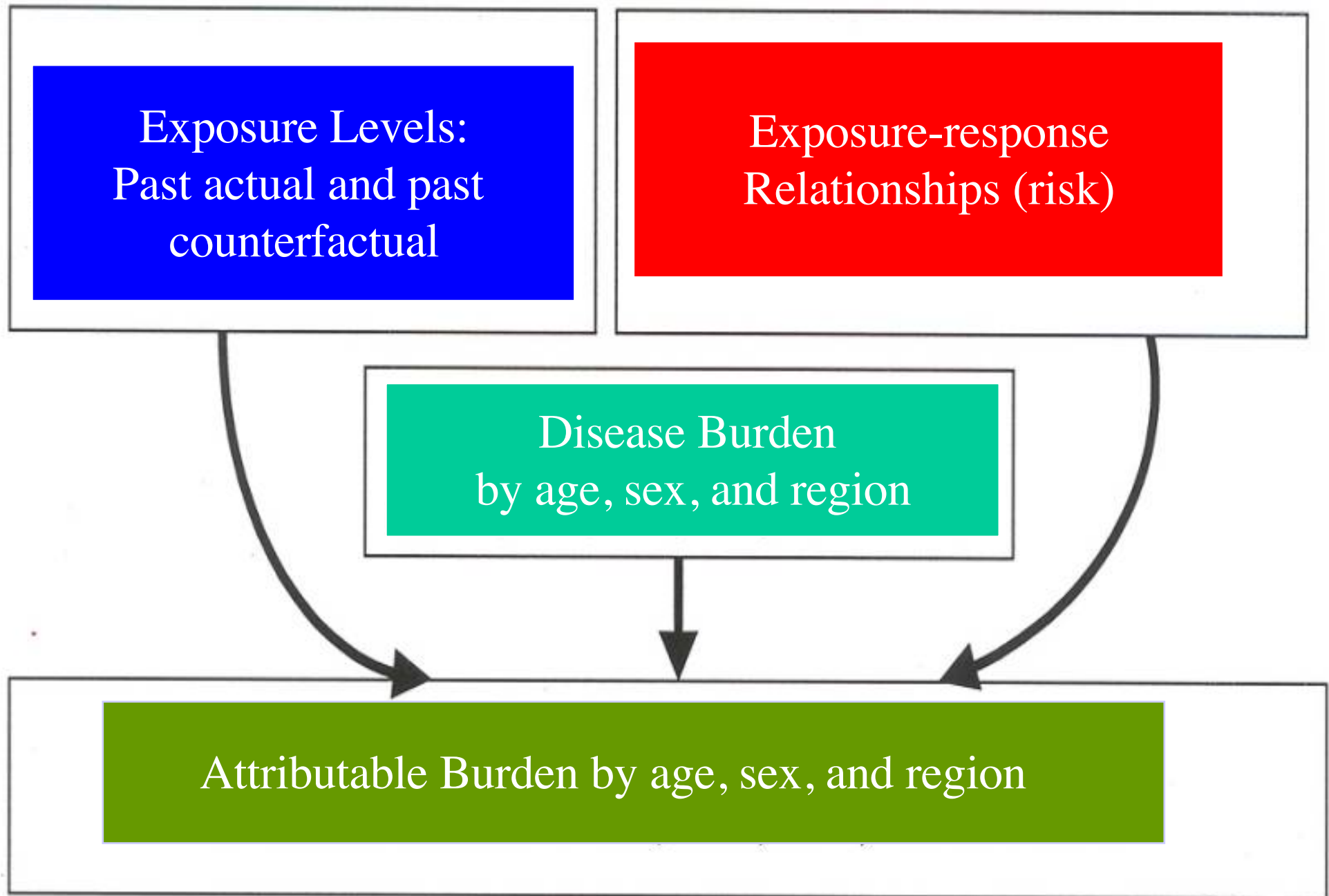
Common types of contaminated sites

- Used lead-acid battery recycling
- Artisanal and small-scale gold mining where elemental mercury is used

POLLUTION RISK FACTORS

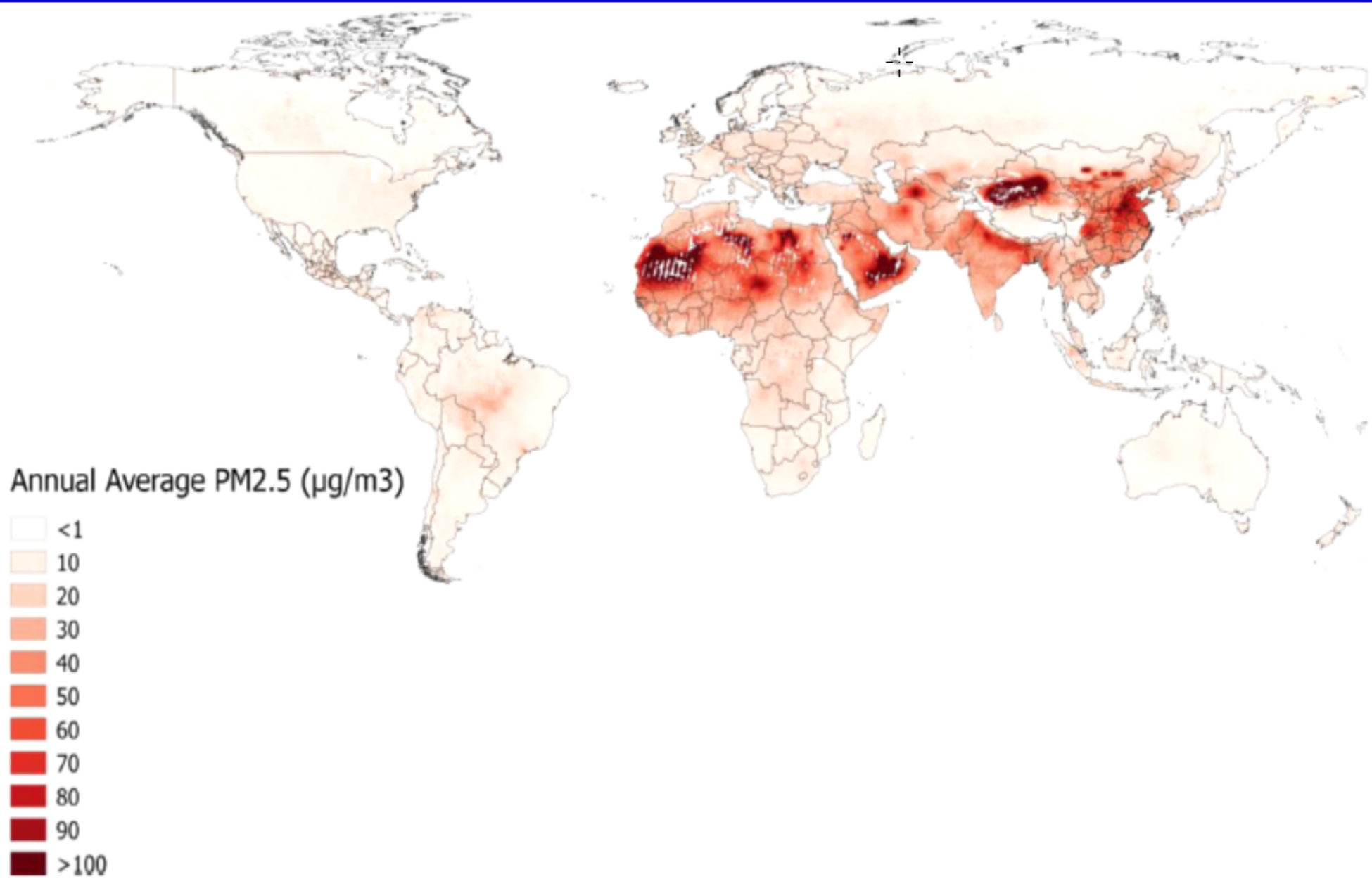
- Pollution (PM2.5), and tropospheric ozone pollution
- Water pollution: unsafe sanitation, and unsafe water sources
- Soil, chemical, and heavy metal pollution: lead (including contaminated sites polluted by lead from battery recycling operations), and mercury from gold mining
- Occupational pollution: occupational carcinogens, and occupational particulates, gases, and fumes

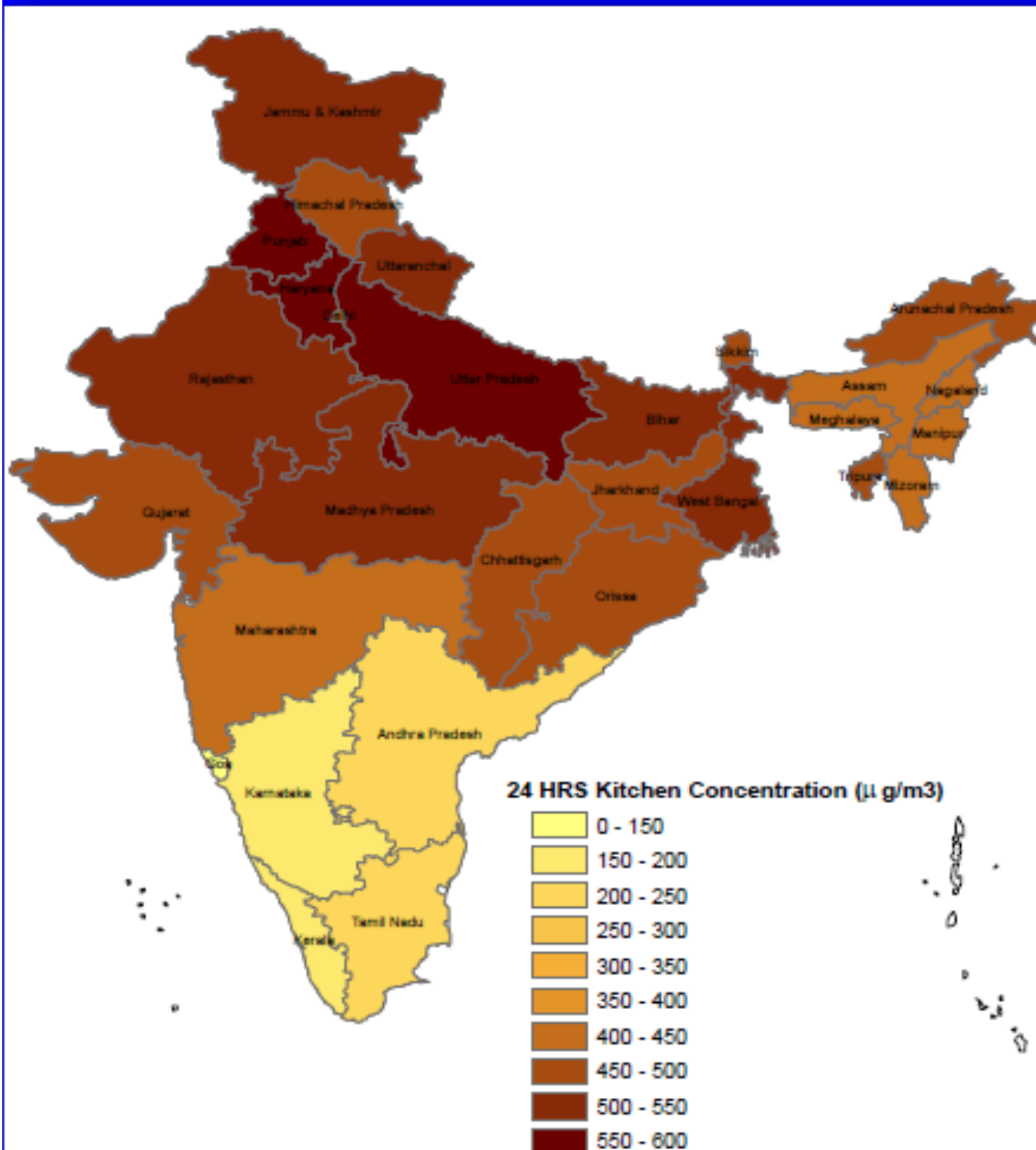
Comparative Risk Assessment Method



Source of Data

1. Exposures – population-weighted surveys, measurements, and modeling
2. Risks – epidemiological studies of exposure/health outcome to obtain relative risks (RR) by disease
3. Counterfactual – depends on risk factor
4. Background Disease Rate from GBD





State-wise
estimates of
24-h kitchen
concentrations
of $\text{PM}_{2.5}$
in India

Solid-fuel using
households

Balakrishnan et al.,
2013

Generalized Exposure-Response: Outdoor Air, SHS, and Smoking

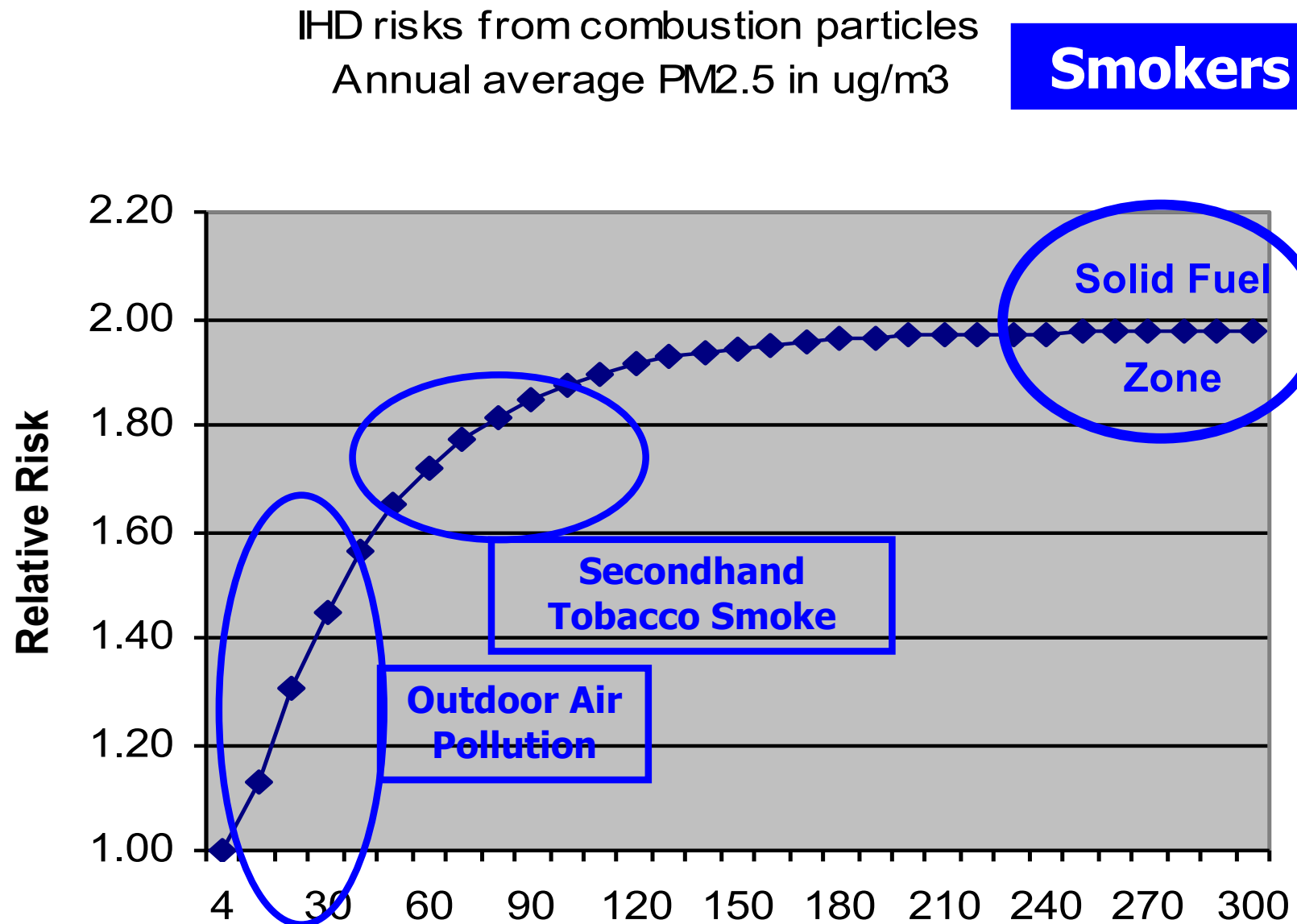
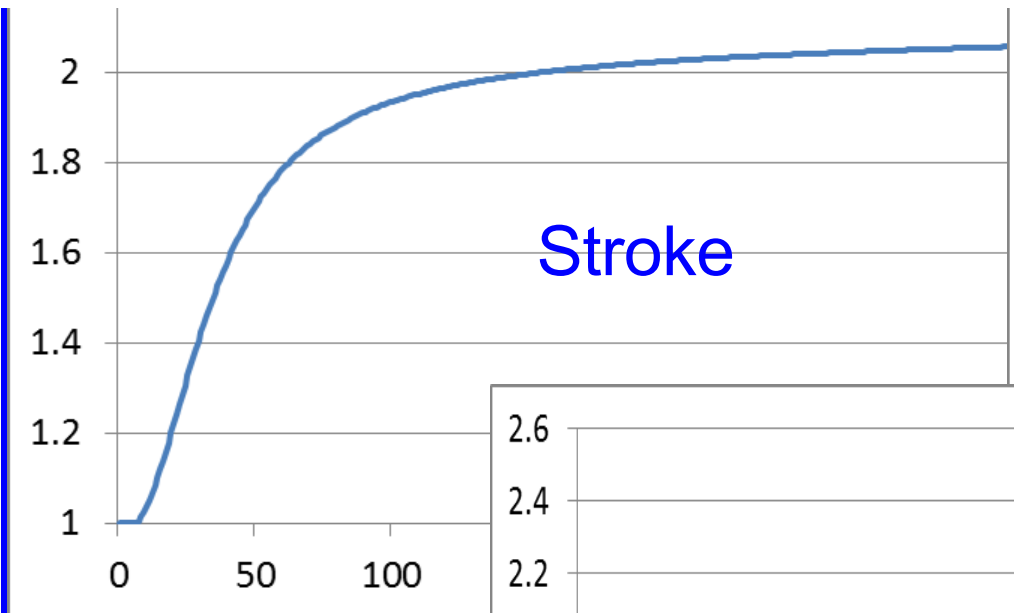
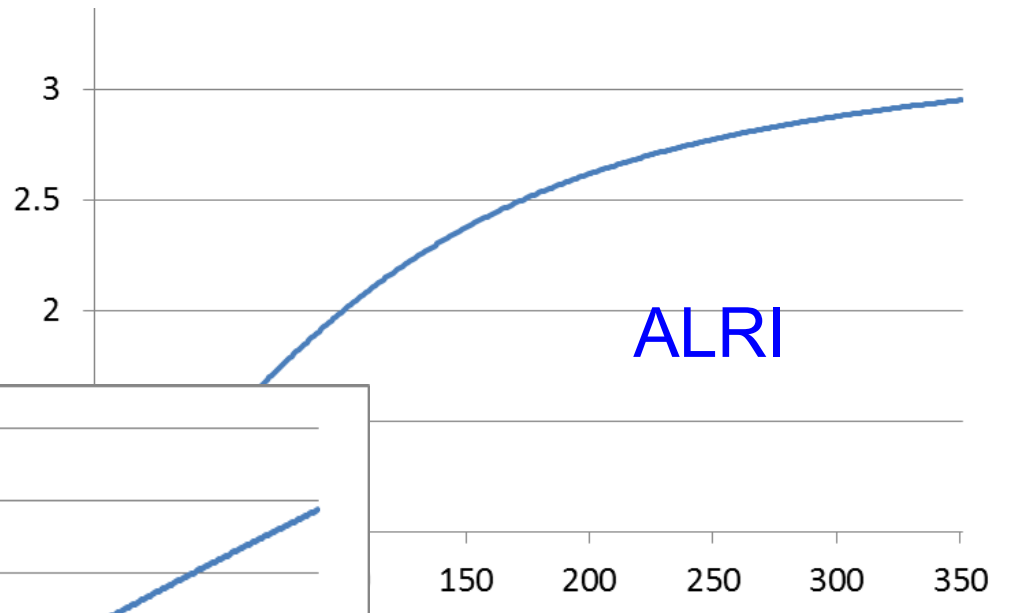


Table 2. Adjusted relative risk estimates^a for various increments of exposure from cigarette smoking (versus never smokers), second hand cigarette smoke, and ambient air pollution from the present analysis and selected comparison studies.

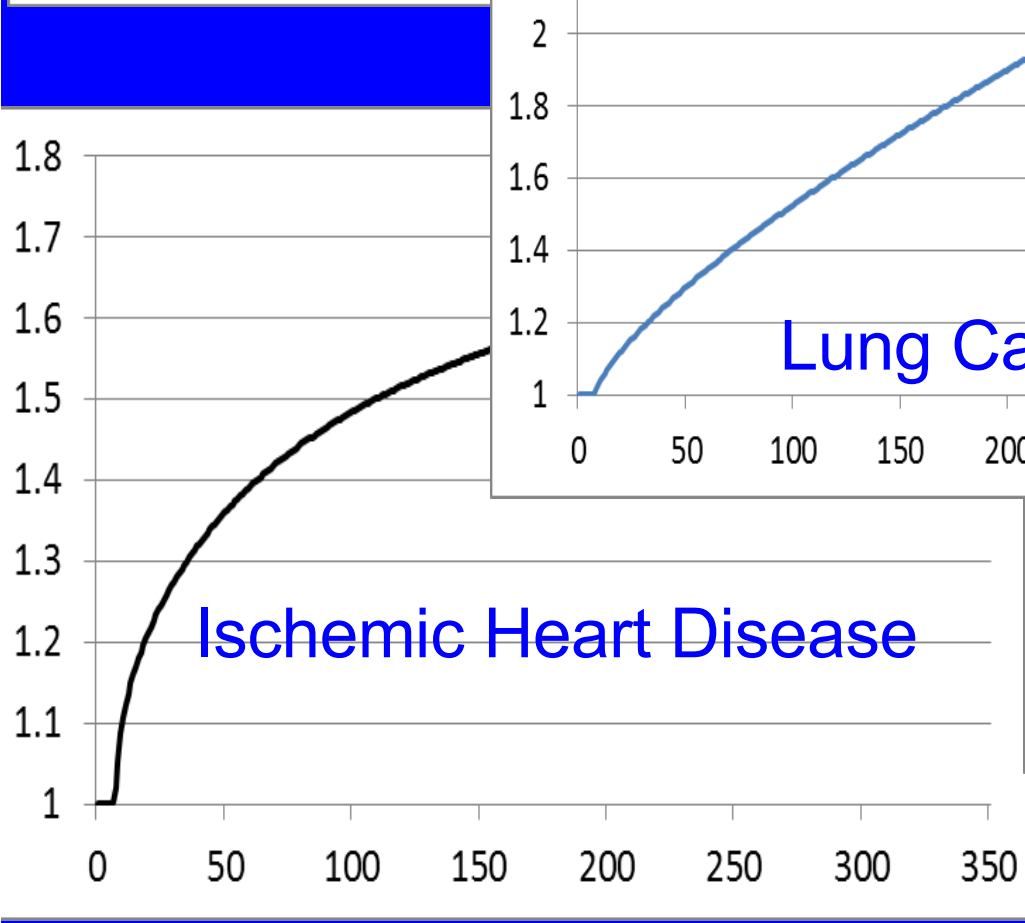
Source of risk estimate	Increments of Exposure	Adjusted RR (95% CI)				Estimated Daily Dose PM _{2.5} (mg) ^b
		Lung Cancer	IHD	CVD	CPD	
ACS- present analysis	≤3 (1.5) cigs/day	10.44 (7.30-14.94)	1.61 (1.27-2.03)	1.58 (1.32-1.89)	1.72 (1.46-2.03)	18
ACS- present analysis	4-7 (5.5) cigs/day	8.03 (5.89-10.96)	1.64 (1.37-1.96)	1.73 (1.51-1.97)	1.84 (1.63-2.08)	66
ACS- present analysis	8-12 (10) cigs/day	11.63 (9.51-14.24)	2.07 (1.84-2.31)	2.01 (1.84-2.19)	2.10 (1.94-2.28)	120
ACS- present analysis	13-17 (15) cigs/day	13.93 (11.04-17.58)	2.18 (1.89-2.52)	1.99 (1.77-2.23)	2.08 (1.87-2.32)	180
ACS- present analysis	18-22 (20) cigs/day	19.88 (17.14-23.06)	2.36 (2.19-2.55)	2.42 (2.28-2.56)	2.52 (2.39-2.66)	240
ACS- present analysis	23-27 (25) cigs/day	23.82 (18.80-30.18)	2.29 (1.91-2.75)	2.33 (2.02-2.69)	2.33 (2.03-2.67)	300
ACS- present analysis	28-32 (30) cigs/day	26.82 (22.54-31.91)	2.22 (1.97-2.49)	2.17 (1.98-2.38)	2.39 (2.19-2.60)	360
ACS- present analysis	33-37 (35) cigs/day	26.72 (18.58-38.44)	2.58 (1.91-3.47)	2.52 (1.98-3.19)	2.83 (2.28-3.52)	420
ACS- present analysis	38-42 (40) cigs/day	30.63 (25.79-36.38)	2.30 (2.05-2.59)	2.37 (2.16-2.59)	2.61 (2.40-2.84)	480
ACS- present analysis	43+ (45) cigs/day	39.16 (31.13-49.26)	2.00 (1.62-2.48)	2.17 (1.84-2.56)	2.37 (2.04-2.76)	540
ACS-air pol. original	24.5 µg/m ³ ambient PM _{2.5}	-----	-----	-----	1.31(1.17-1.46)	0.44
ACS-air pol. extend.	10 µg/m ³ ambient PM _{2.5}	1.14(1.04-1.23)	1.18(1.14-1.23)	1.12(1.08-1.15)	1.09(1.03-1.16)	0.18
HSC-air pol. original	18.6 µg/m ³ ambient PM _{2.5}	-----	-----	-----	1.37(1.11-1.68)	0.33
HSC-air pol. extend.	10 µg/m ³ ambient PM _{2.5}	1.21(0.92-1.69)	-----	1.28(1.13-1.44)	-----	0.18
WHI-air pol.	10 µg/m ³ ambient PM _{2.5}	-----	-----	1.24(1.09-1.41) ^c	-----	0.18
SGR-SHS	Low- moderate SHS exp.	-----	-----	1.16(1.03-1.32)	-----	0.36
SGR-SHS	Moderate-high SHS exp	-----	-----	1.26(1.12-1.42)	-----	0.90
SGR-SHS	Live with smoking spouse	1.21(1.13-1.30)	-----	-----	-----	0.54
SGR-SHS	Work with SHS exposure	1.22(1.13-1.33)	-----	-----	-----	0.72
INTERHEART	1-7 hrs/wk SHS exp.	-----	1.24(1.17-1.32) ^d	-----	-----	0.36
INTERHEART	Live with smoking spouse	-----	1.28(1.12-1.47) ^d	-----	-----	0.54



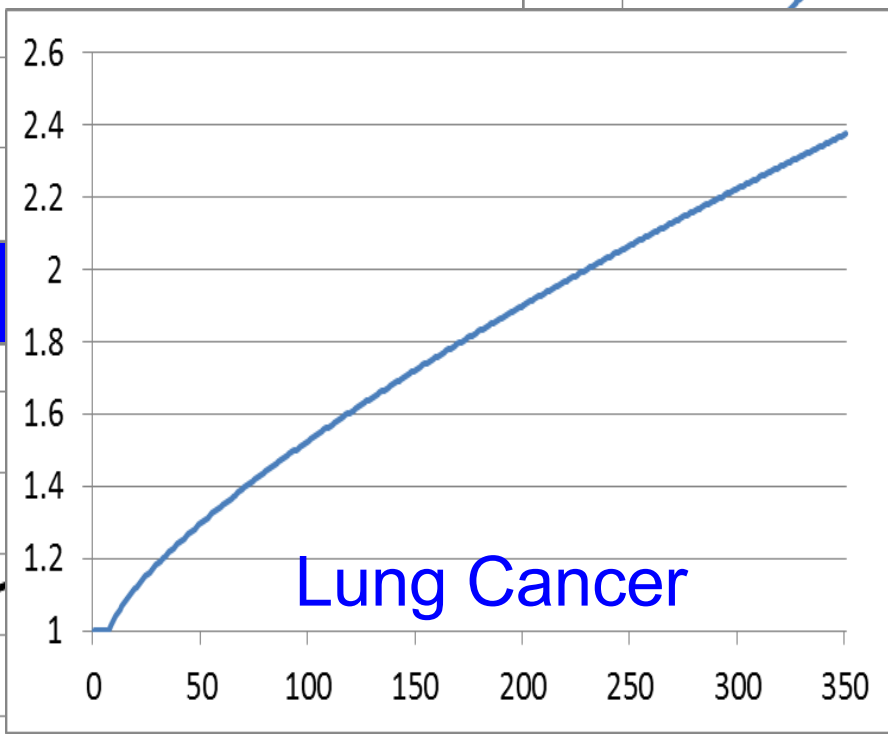
Stroke



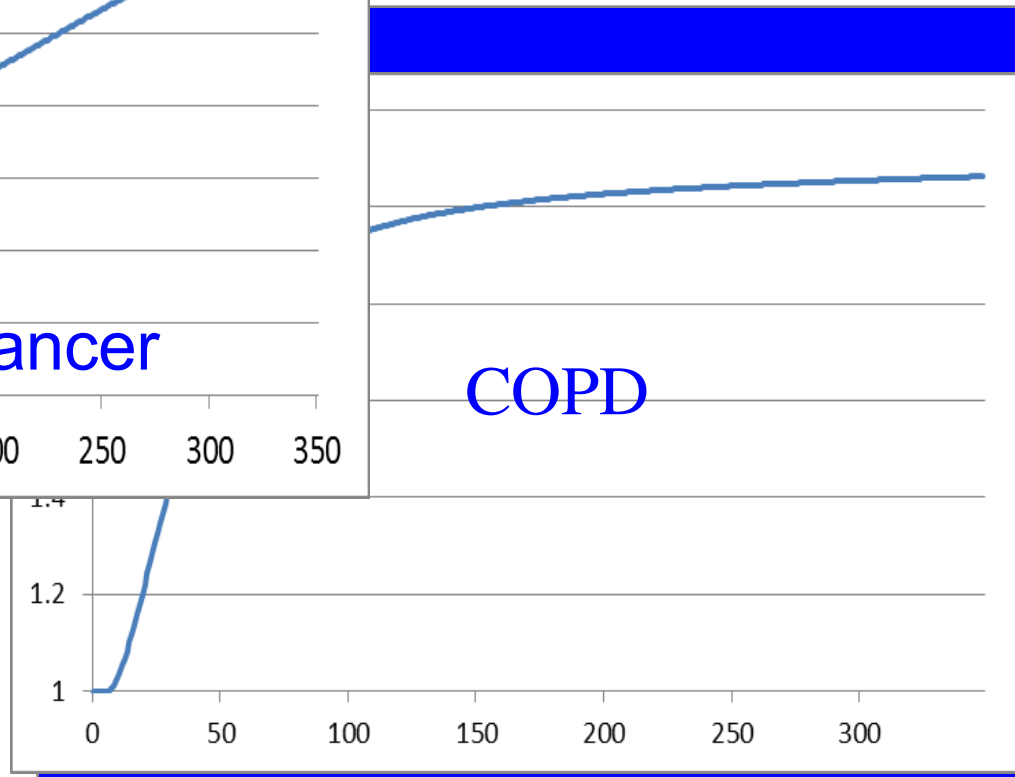
ALRI



Ischemic Heart Disease



Lung Cancer



COPD

ug/m³ annual average PM_{2.5}

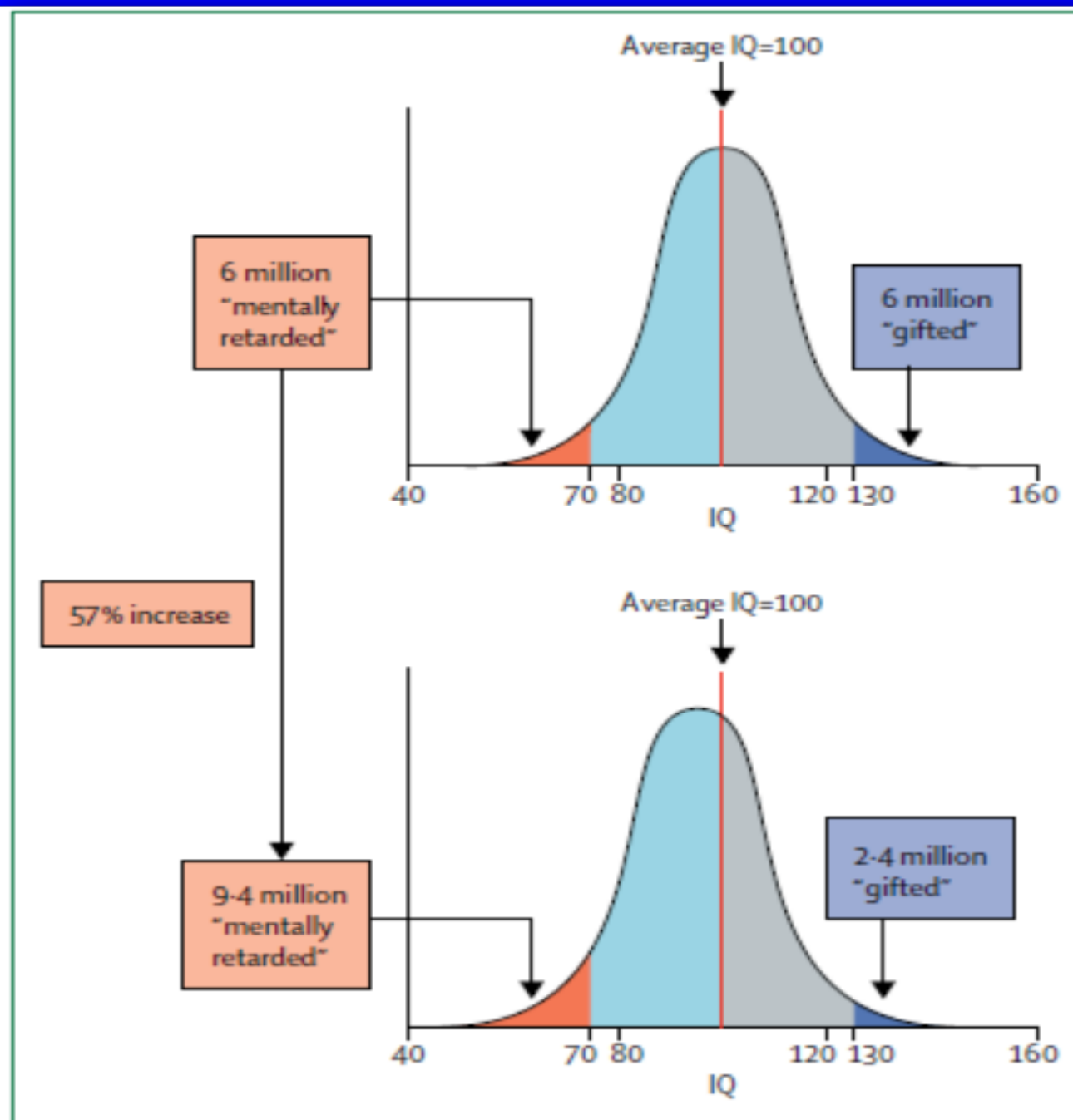
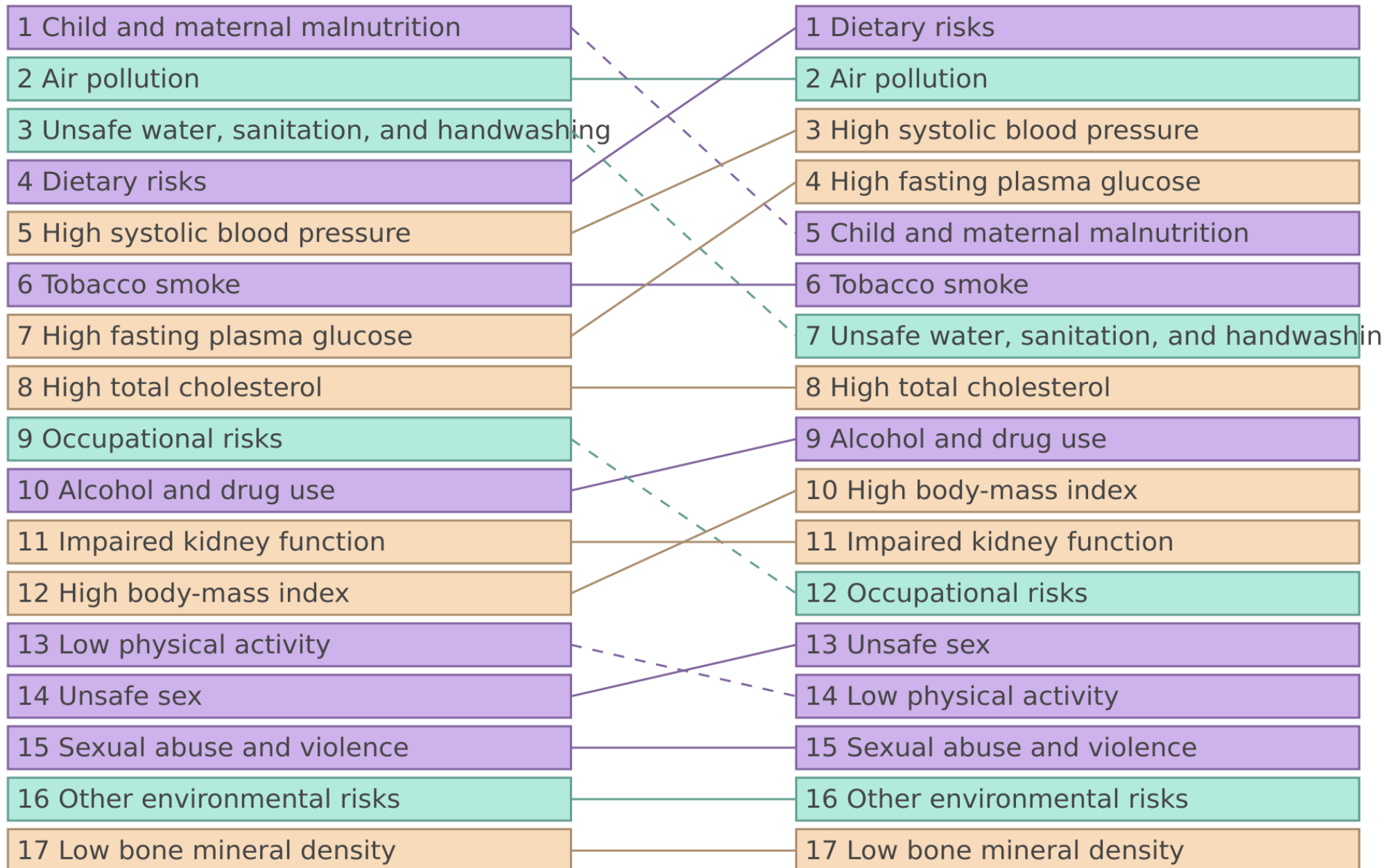
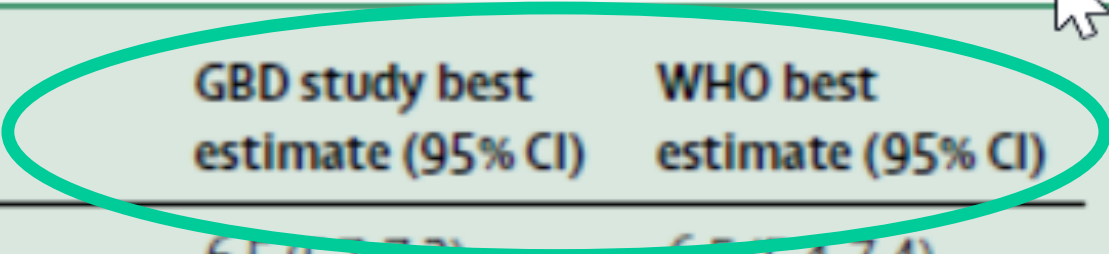


Figure 14: Model of intelligence losses associated with a mean 5-point drop in IQ of a population of 100 million

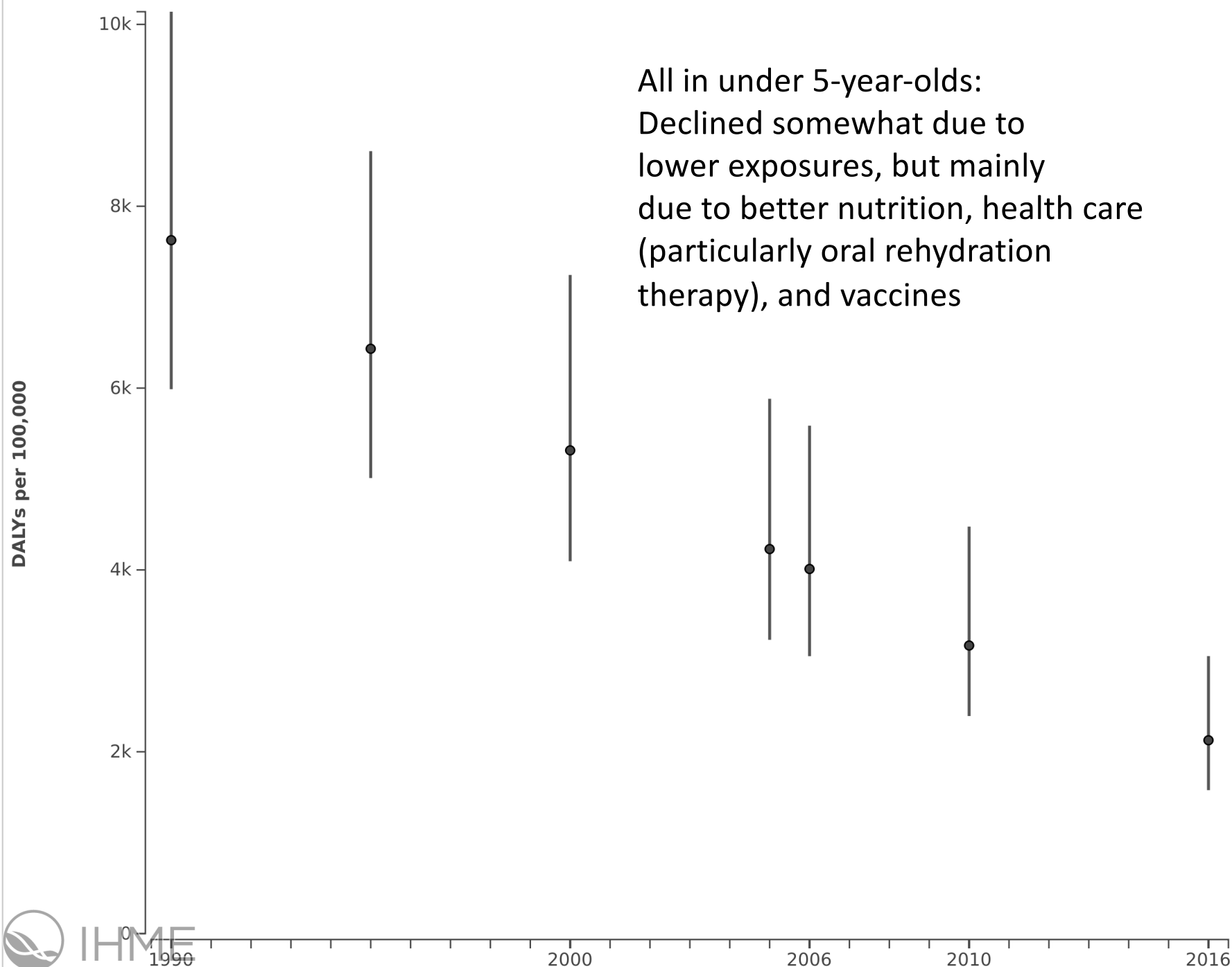
India
Both sexes, Age-standardized, DALYs per 100,000
1990 rank **2015 rank**





	GBD study best estimate (95% CI)	WHO best estimate (95% CI)
Air (total)	6.5 (5.7-7.3)	6.5 (5.4-7.4)
Household air	2.9 (2.2-3.6)	4.3 (3.7-4.8)
Ambient particulate	4.2 (3.7-4.8)	3.0 (3.7-4.8)
Ambient ozone	0.3 (0.1-0.4)	..
Water (total)	1.8 (1.4-2.2)	0.8 (0.7-1.0)
Unsafe sanitation	0.8 (0.7-0.9)	0.3 (0.1-0.4)
Unsafe source	1.3 (1.0-1.4)	0.5 (0.2-0.7)
Occupational	0.8 (0.8-0.9)	0.4 (0.3-0.4)
Carcinogens	0.5 (0.5-0.5)	0.1 (0.1-0.1)
Particulates	0.4 (0.3-0.4)	0.2 (0.2-0.3)
Soil, heavy metals, and chemicals	0.5 (0.2-0.8)	0.7 (0.2-0.8)
Lead	0.5 (0.2-0.8)	0.7 (0.2-0.8)
Total	9.0	8.4

India
All causes attributable to Unsafe water, sanitation, and handwashing
Both sexes, Age-standardized



DATA SOURCES

- Institute for Health Metrics and Evaluation
2015 Global Burden of Disease analysis
- World Health Organization
2012 Burden of Disease analysis
- Pure Earth/GAHP Toxic Sites Inventory
Soil pollution at contaminated sites

METHODOLOGY

Limitations of the Commission

- Economic analysis does not include information about the costs of environmental damage caused by pollution.
- No cost-effectiveness estimates made (these are available, however, in the Disease Control Priorities project recently published by the World Bank.)
- The results based on data from the 2015 Global Burden of Disease study; information that is now 2 years old
- It does not reflect other estimates in its main conclusion, e.g. WHO

Single

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India, Both sexes, All ages, 2016

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Category All risk factors

Level 2

Measure Deaths YLDs DALYs

Location India

Year 2016

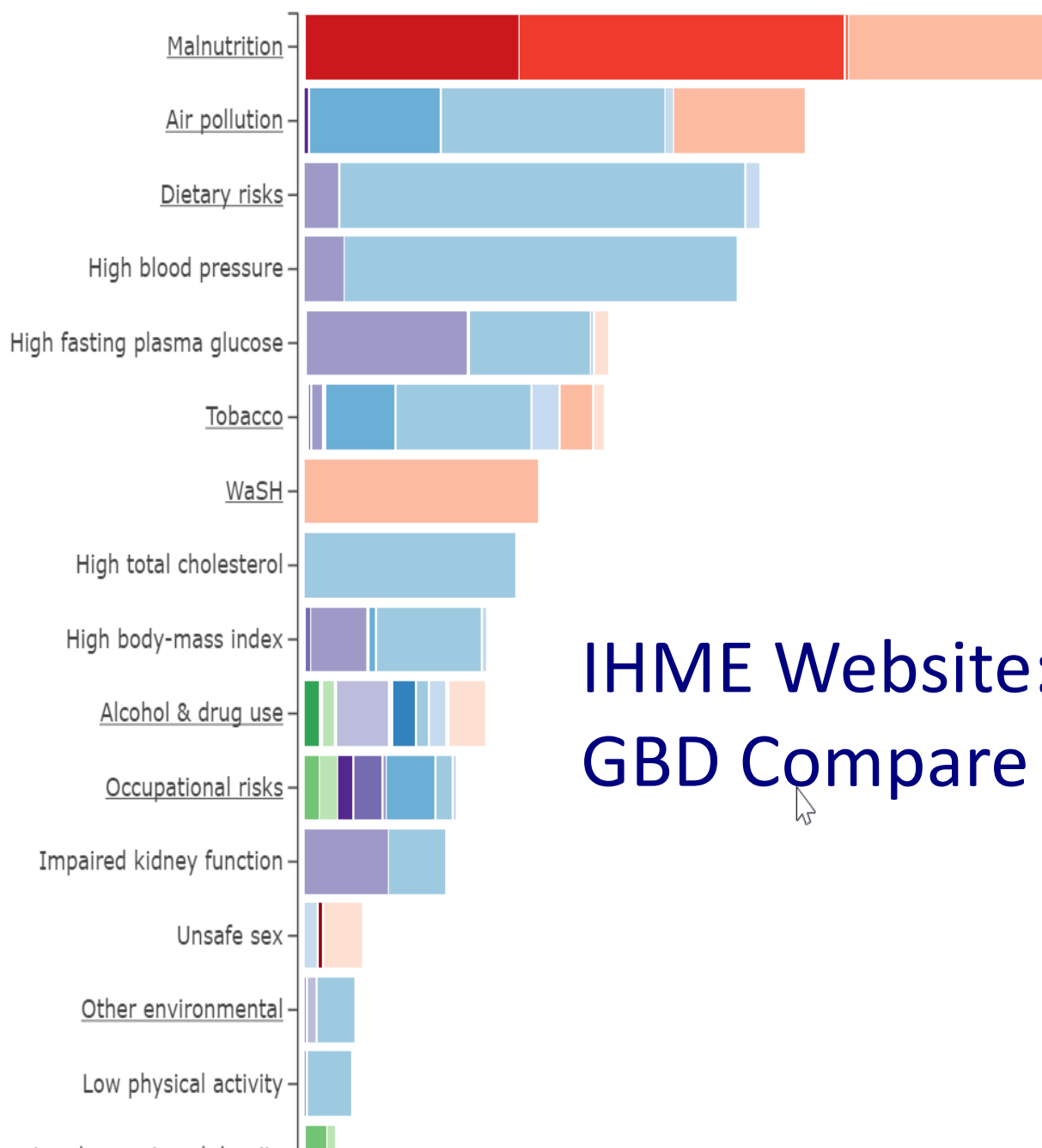
Age All <5 5-14

15-49 50-69 70+

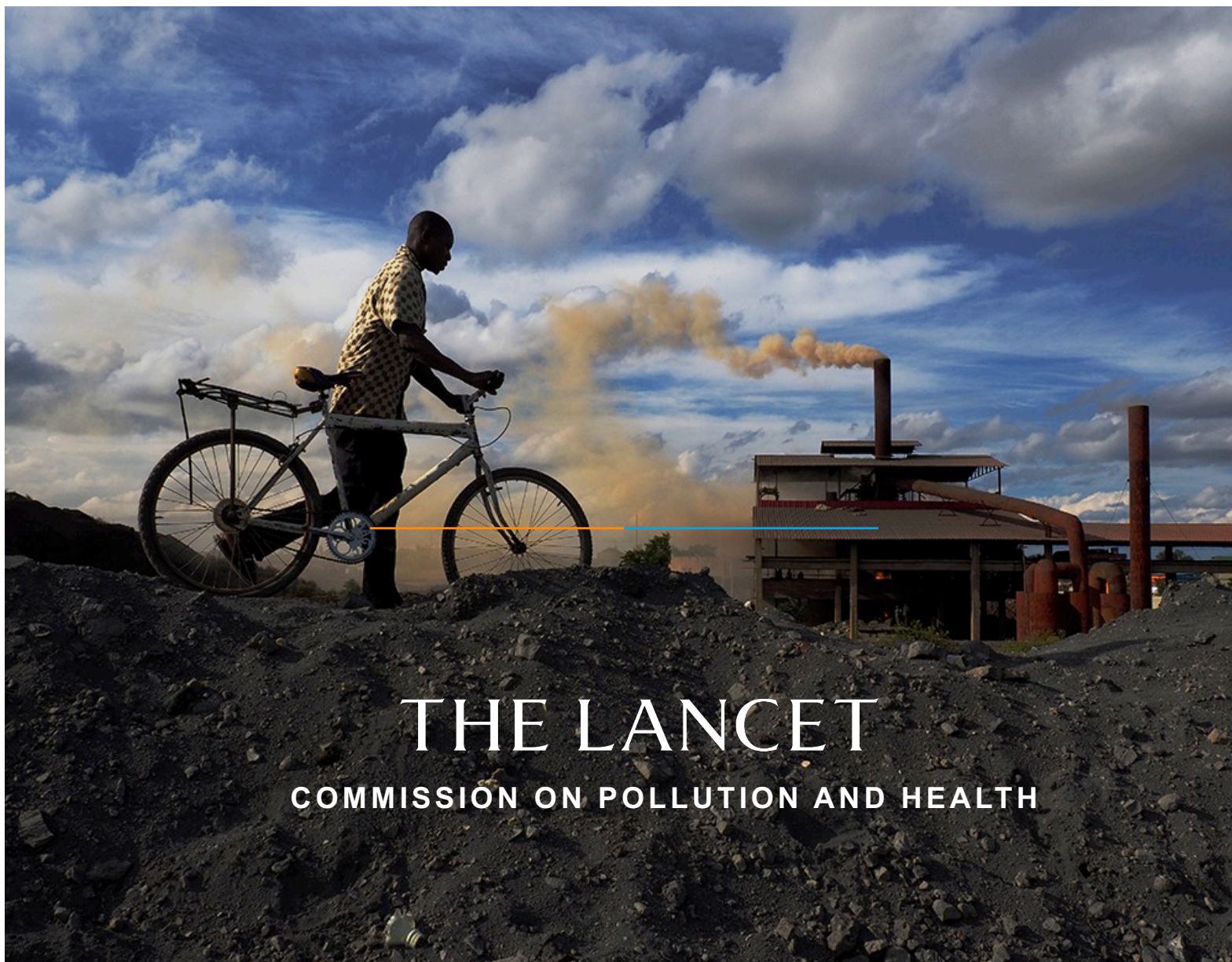
Sex Male Female Both

Units # Rate %

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