

Household Air Pollution and Chronic Disease in Developing Countries

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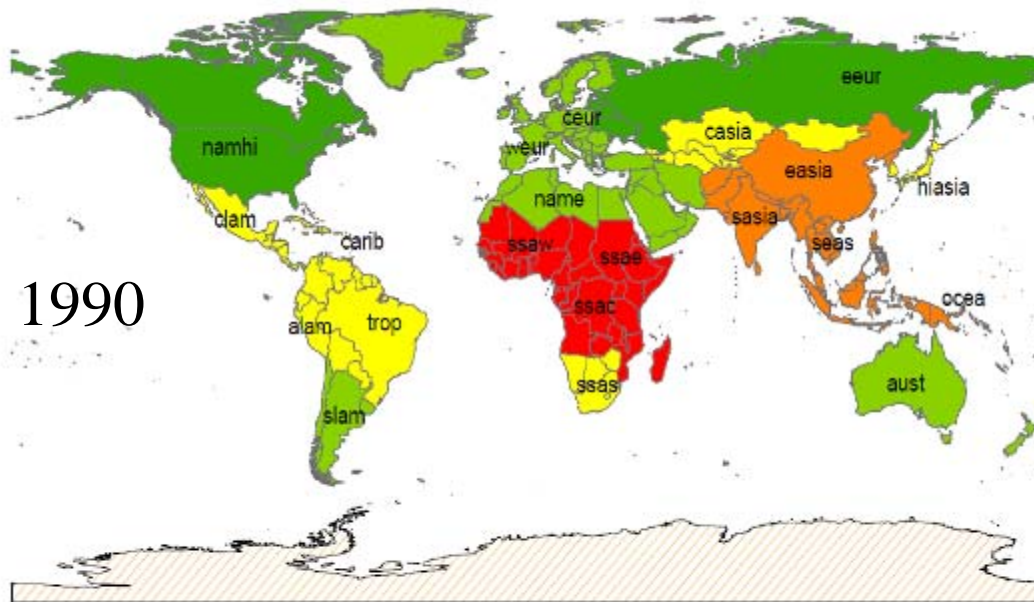
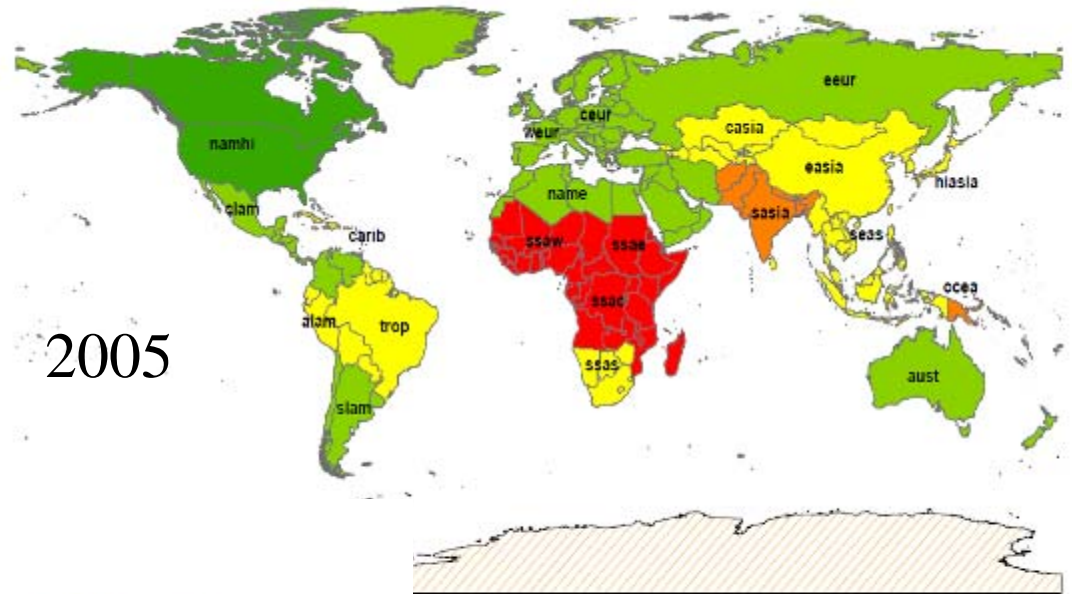
What NCD risk factor is shared by all everyone in the bottom two billion?

- Diet (fat, etc.)?
- Physical inactivity (obesity, etc.)?
- Smoking?
- Appropriate infectious agents?
- No, but there is one
- So ubiquitous, in fact, that it is one of the best quick indicators of poverty?

Household solid fuel use



Households using biomass or coal to cook today

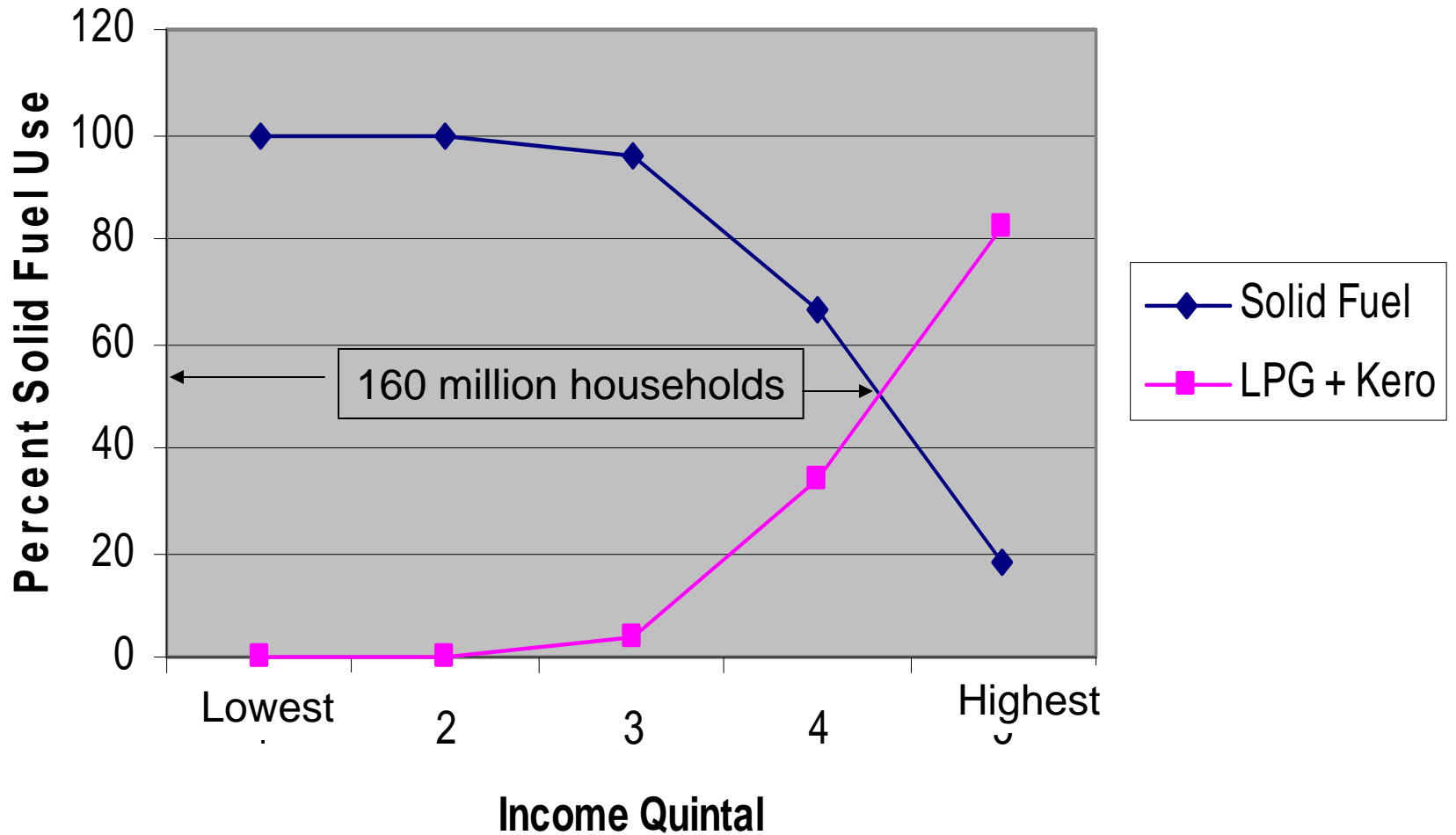


% of HH Exposed to HAP

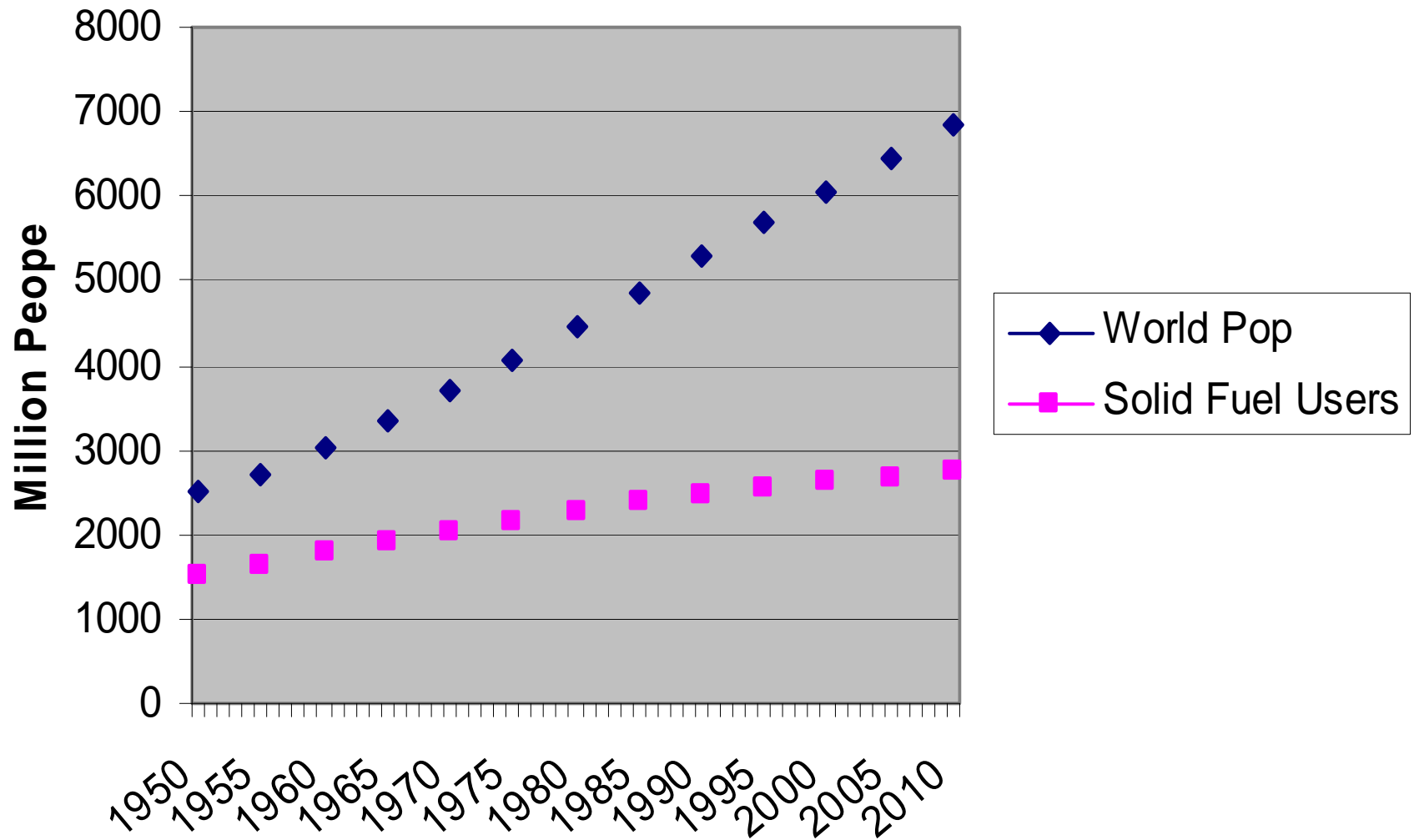


Comparative Risk Assessment (CRA)
2011- preliminary,

Distribution of Household Cooking Fuel by Income in India



World Population Using Solid Fuels



Biomass Cooking in History

- **Today, ~40% use solid fuels, about 2.7 billion people**
- **Although the percentage is dropping, the absolute number is still rising.**
- **Perhaps 10-15 million people a year are added to the total each year.**
- **Indeed, there are more people using solid fuels today for cooking than the total world population in 1950**
- **Or any year previously**

Road Map

- Intro – what’s wrong with biomass smoke?
- COPD – several new meta-analyses
- Lung cancer – new meta-analyses for both biomass and coal smoke [not further discussed].
- Cataracts/opacity – a major burden
- Cardiovascular disease – interpolation backed up by physiological evidence
- “Epidemiologic” transition – do NCD risks rise with development?

Toxic Pollutants in Biomass Fuel Smoke from Simple (poor) Combustion

Organics known to be mutagens, immune system suppressants, severe irritants, inflammation agents, central nervous system depressants, cilia toxins, endocrine disrupters, or neurotoxins.

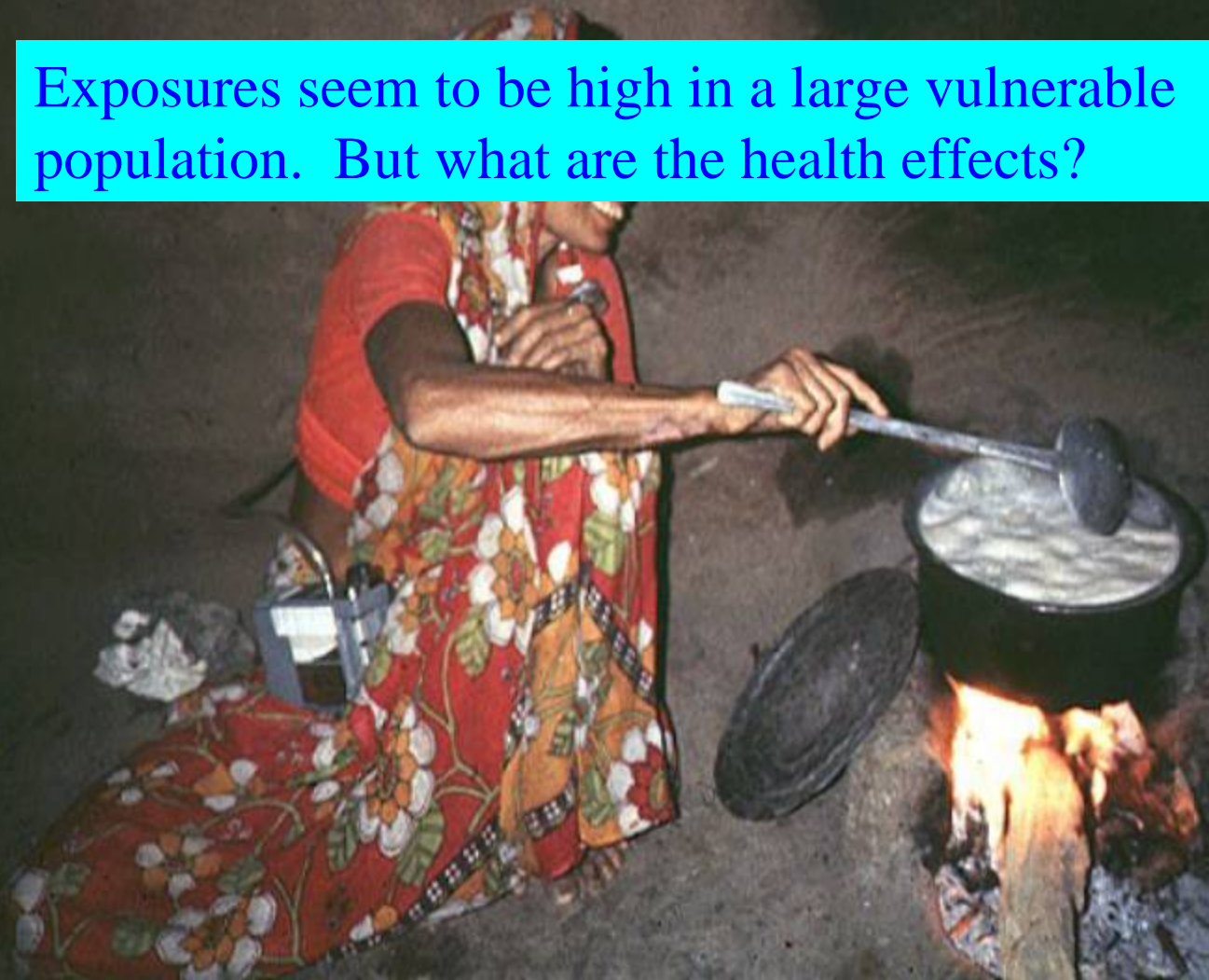
Several chemicals firmly established as human carcinogens.

Other toxic inorganic chemicals.

- 25+ alcohols and acids such as *methanol*
- 33+ phenols such as *catechol* & *cresol*
- Many quinones such as *hydroquinone*
- Semi-quinone-type and other radicals
- Chlorinated organics such as *methylene chloride* and *dioxin*

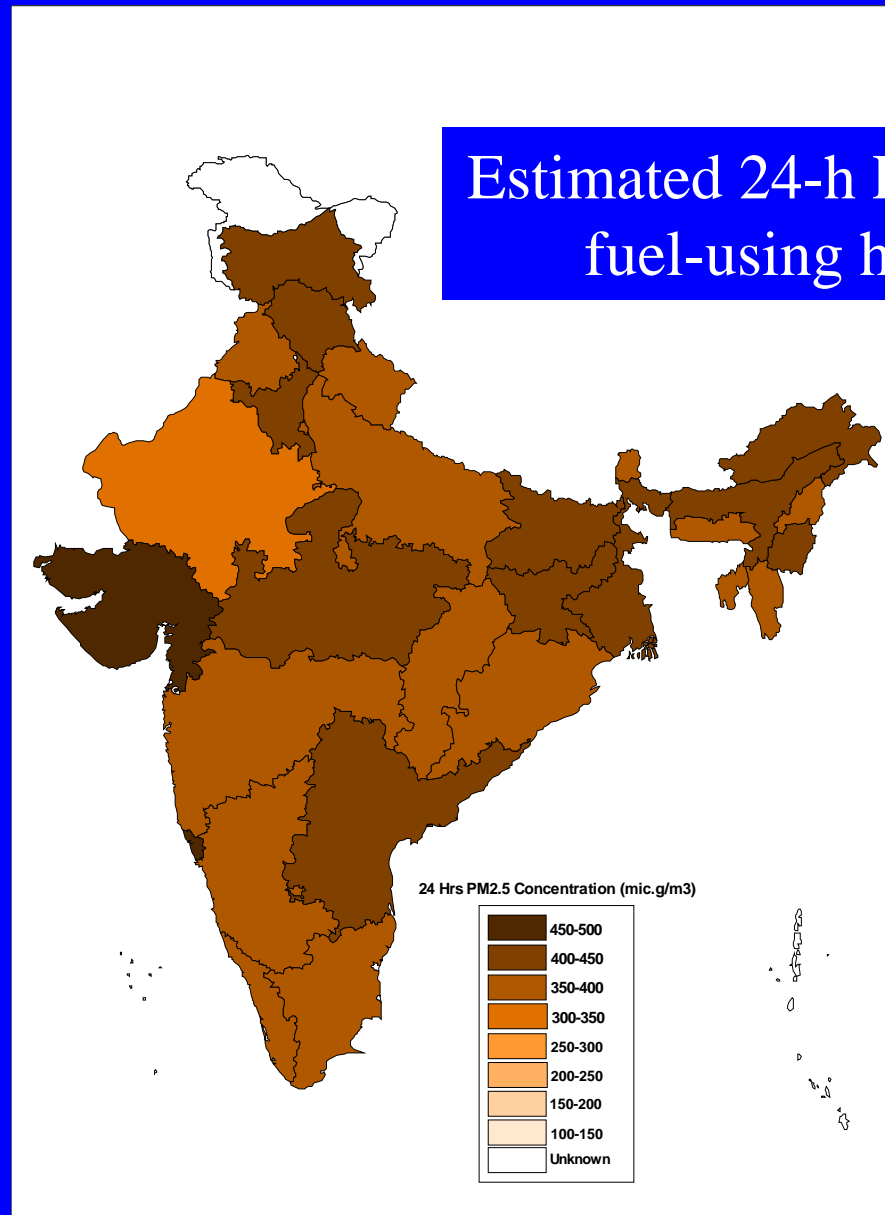
First person in human history to have her exposure measured doing the oldest task in human history

Exposures seem to be high in a large vulnerable population. But what are the health effects?



Kheda District
Gujarat, India
1981

Household Air Pollution Comparative Risk Assessment, 2011 Preliminary Estimates for India



Balakrishnan
et al.
forthcoming

~400 ug/m³ mean

EPA standard
= 15ug/m³
WHO AQG
= 10 ug/3

Diseases for which we have epidemiological studies - 2011



ALRI/
Pneumonia
(meningitis)

Low birth
weight

Stillbirth

Cognitive
Impairment?

Asthma?

Birth defects?

Chronic
obstructive
lung disease

Cancer
(lung, NP, cervical,
aero-digestive)

Blindness
(cataracts, opacity)

Tuberculosis?

Heart disease*
Blood pressure
ST-segment

*Interpolated

Biomass Smoke and COPD:

Meta-analysis

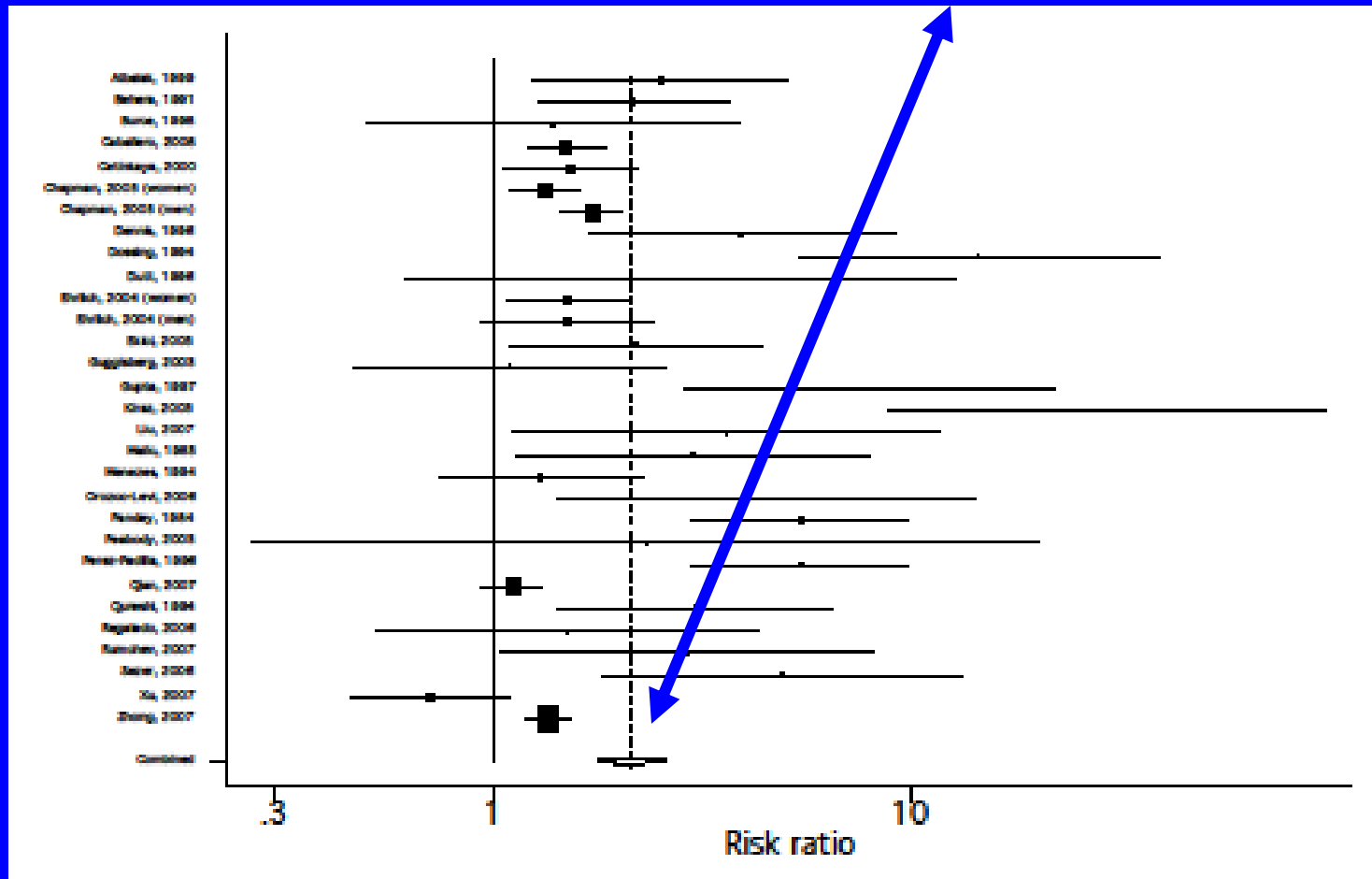
- Summary RR estimates calculated using both fixed effects and random effects models
- Heterogeneity among studies assessed using general variance-based methods
- Publication bias assessed using funnel plot, Eggers and Begg's tests

Exposure Assessment Used for Analysis	# of Final Studies
Fuel Type	19
<i>Coal Only</i>	7
<i>Wood Only</i>	6
Stove Type	2
Years Exposed	5
Urban v. Rural	2

Outcome Assessment	# of Final Studies
Chronic Bronchitis, clinical definition	20
COPD, FEV ₁ /FVC <0.70	4
Previous Physician Diagnosis	4

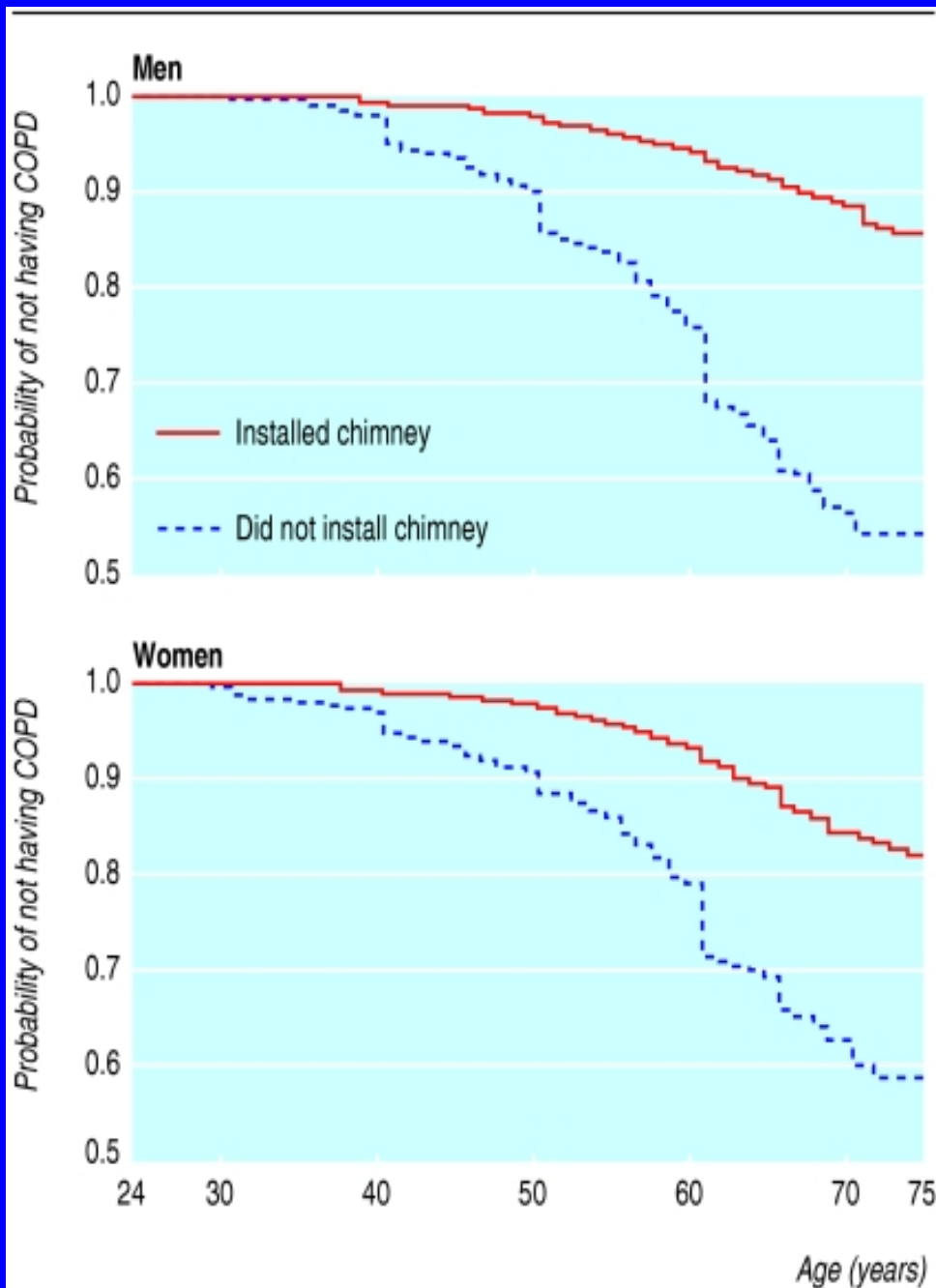
Forest Plot for All Studies Included in Meta-analysis

- Random effects model was used to account for significant heterogeneity between studies $X^2=150.33, df=29 (p=0.000)$
- Overall effect measure for all studies, OR=2.14 (1.78, 2.58)



Risk of COPD: Vented vs. unvented coal stoves

Xuan Wei County
China,
retrospective cohort,
1976-1992,
20,453 subjects
81% added chimneys



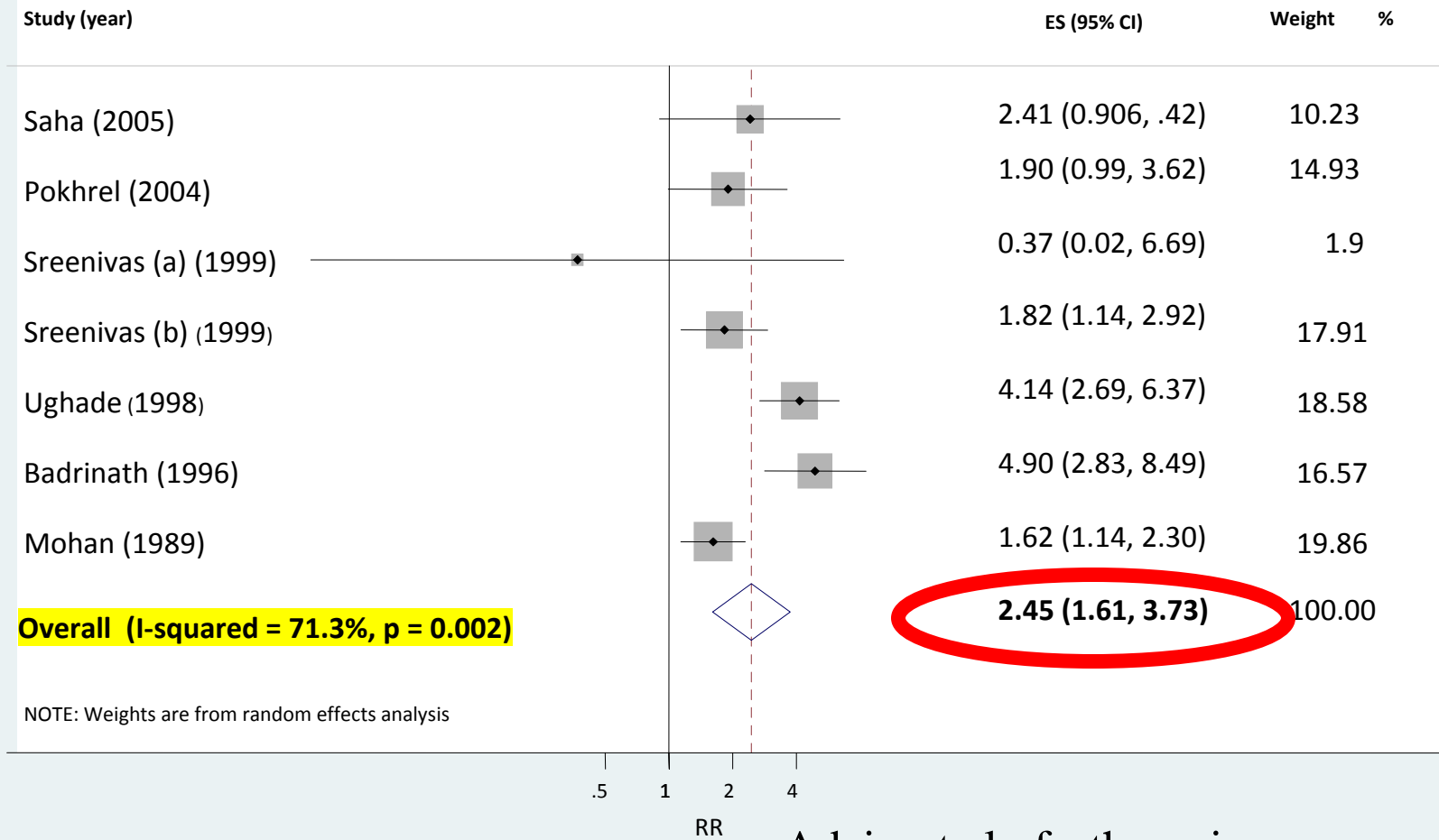
Chapman et al. **Br Med J**
2005; 331: 1050.

Cataracts

- Major burden of disease in developing countries
- In South Asia, 2.8% of total DALYs in 2005
- Half that of ischaemic heart disease
- Roughly same as TB or stroke
- Greater than COPD or maternal conditions
- Women suffer 40% more than men

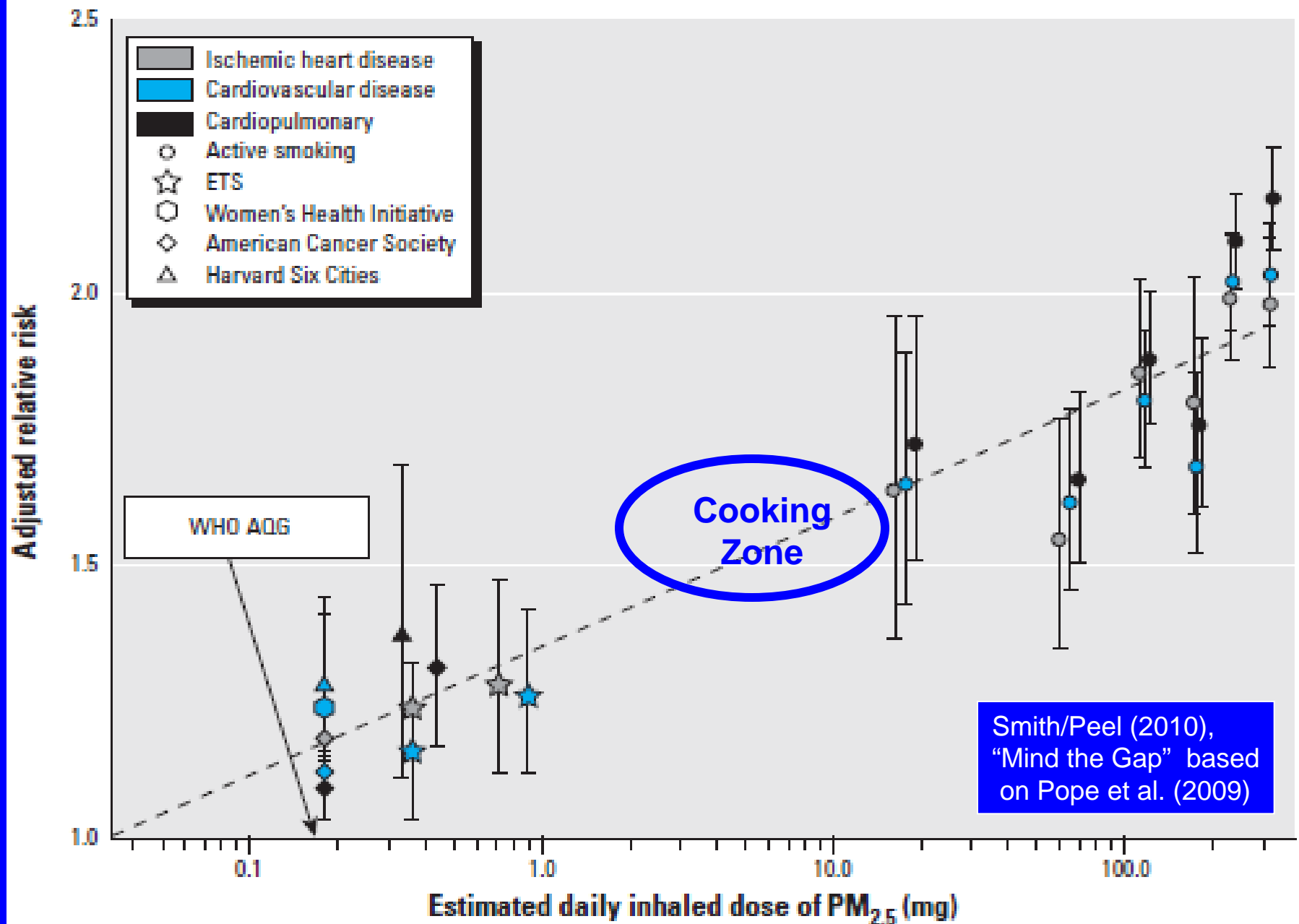
Summary of 7 (of 9 total) studies

Studies adjusted for smoking (*random effects*)



Adair, et al., forthcoming

Heart Disease and Combustion Particle Doses



Argument from consistency across combustion particle exposures for CVD

- Fine combustion particles are best measure of risk in each setting and seem to have similar effects per unit mass across the four source types
- Remarkable consistency across 3 orders of magnitude of dose measured in mg/day of $PM_{2.5}$
- Where household air pollution has no direct epi data, seems reasonable to interpolate for outcomes where there are well established effects at both lower and higher doses.

Indian National Biomass Cookstove Initiative – Dec 2, 2009

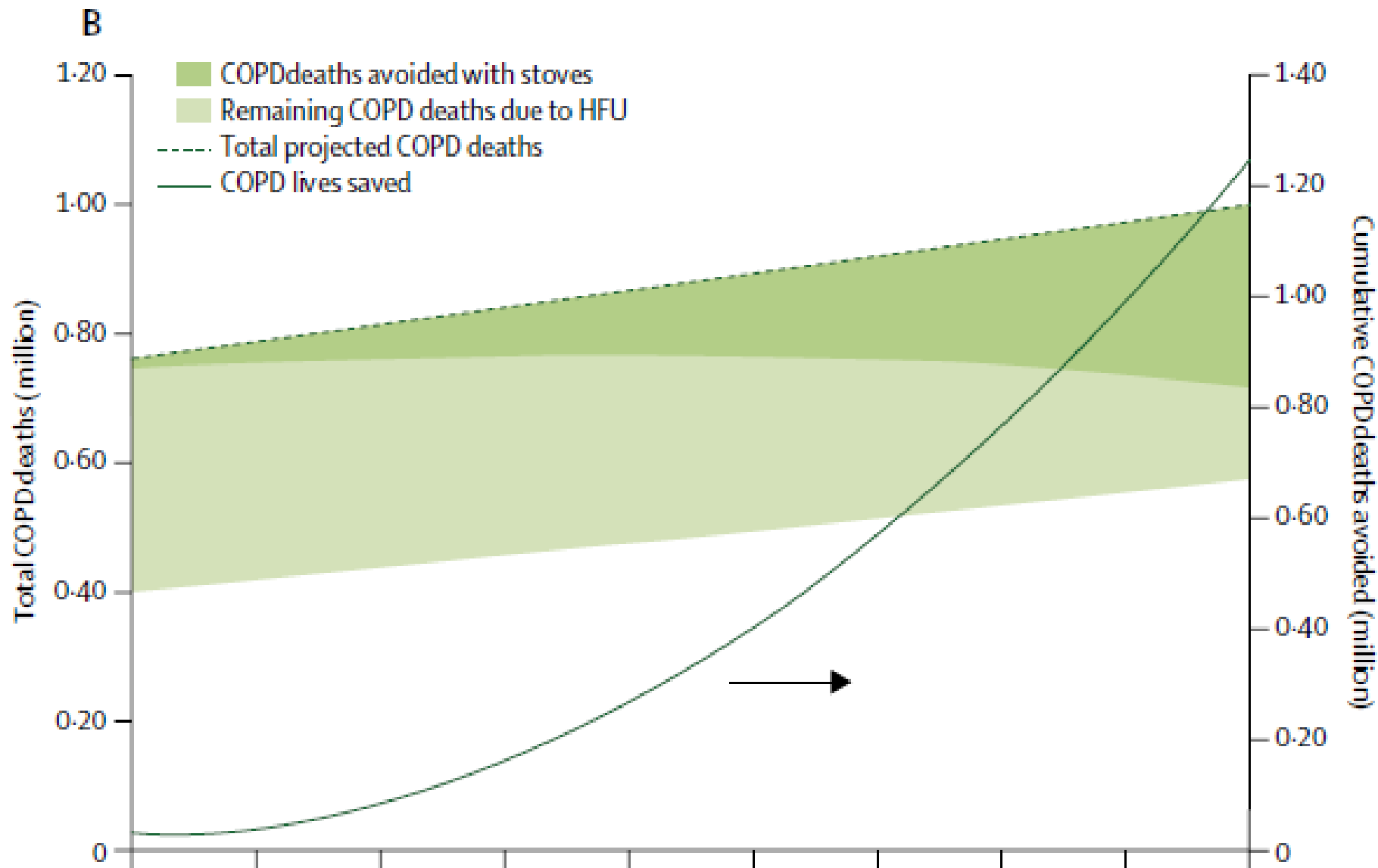
- *“Our aim is to achieve the quality of energy services from cookstoves [for all Indian households] comparable to that from other clean energy sources such as LPG.”*

Analysis of total health benefits of 150 million advanced stoves introduced over 10 years in India

Wilkinson, Smith, et al., the Lancet 374:1917-29, 2009

Chronic Obstructive Pulmonary Disease

THE LANCET

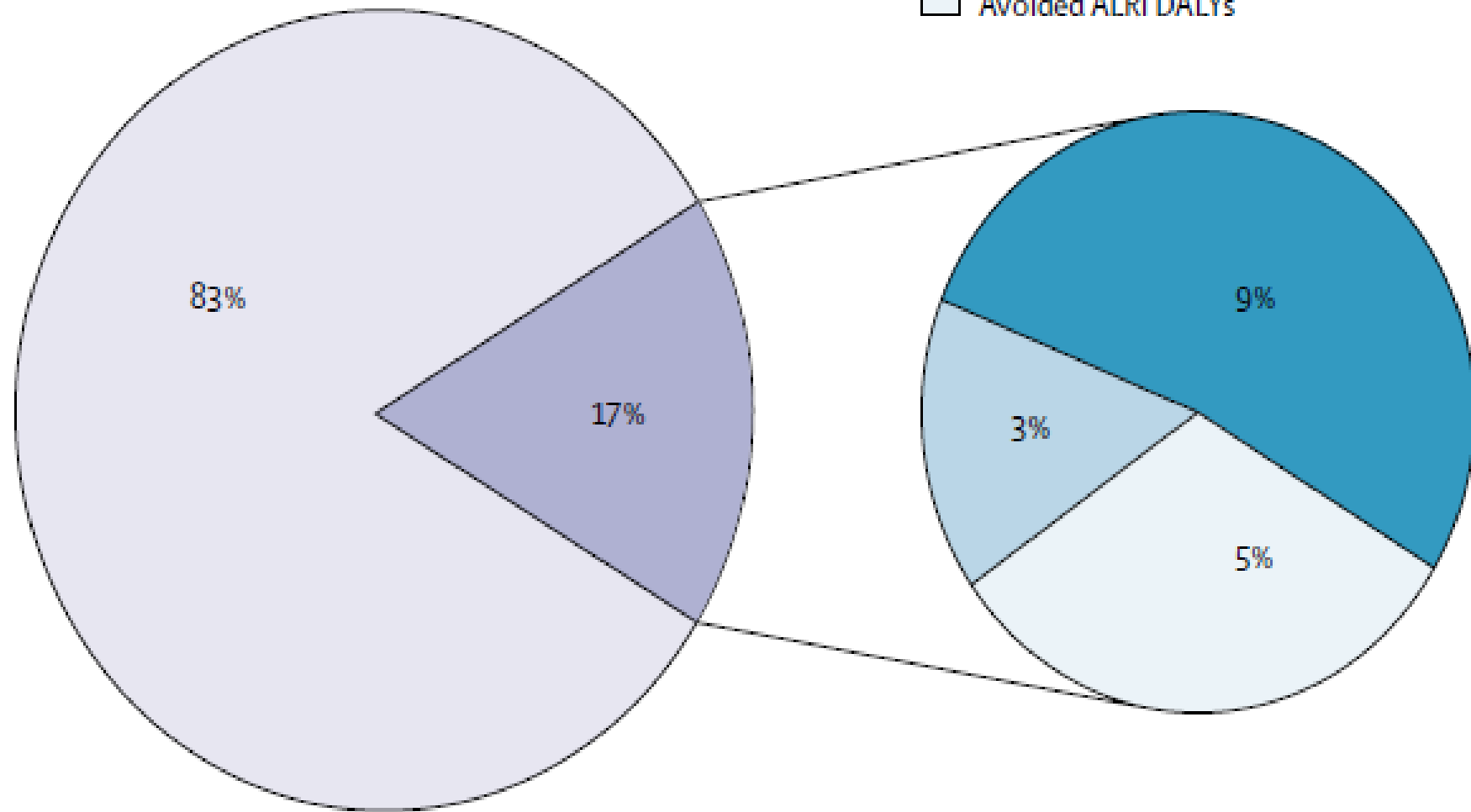


Health Benefits Upon Completion, 2020

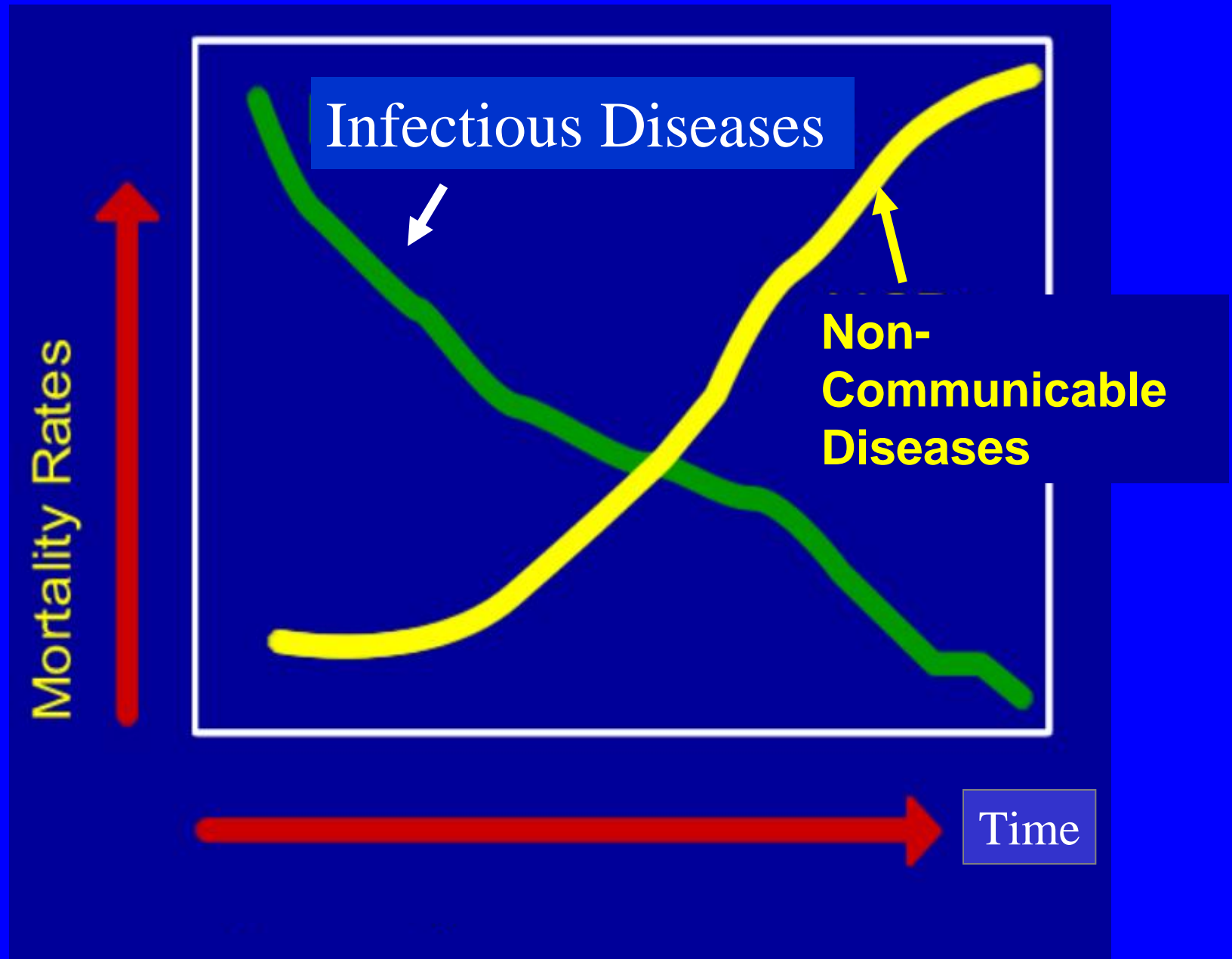
THE LANCET

Remaining ALRI, IHD, COPD DALYs in 2020
Avoided DALYs

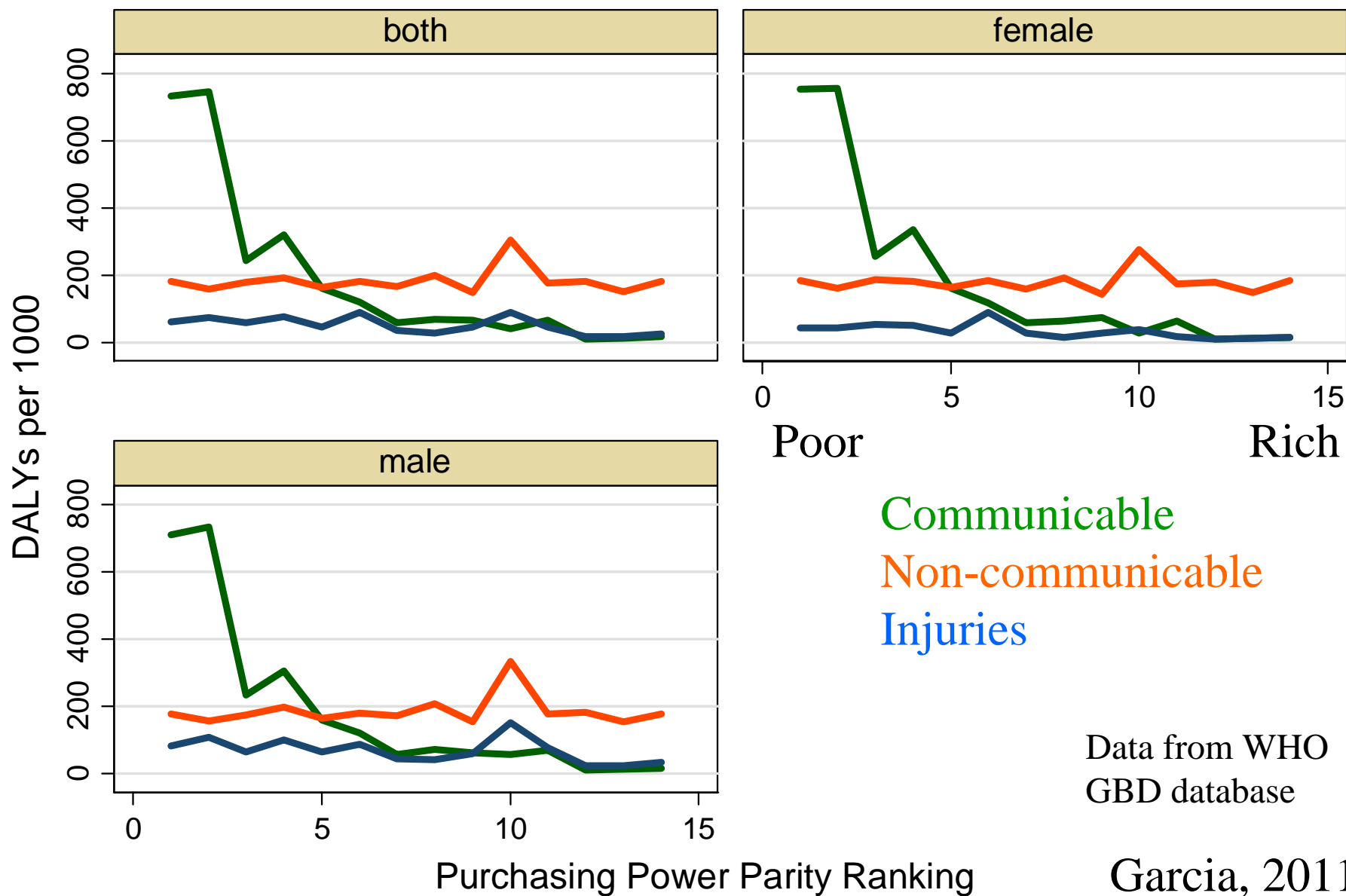
Avoided COPD DALYs
Avoided IHD DALYs
Avoided ALRI DALYs



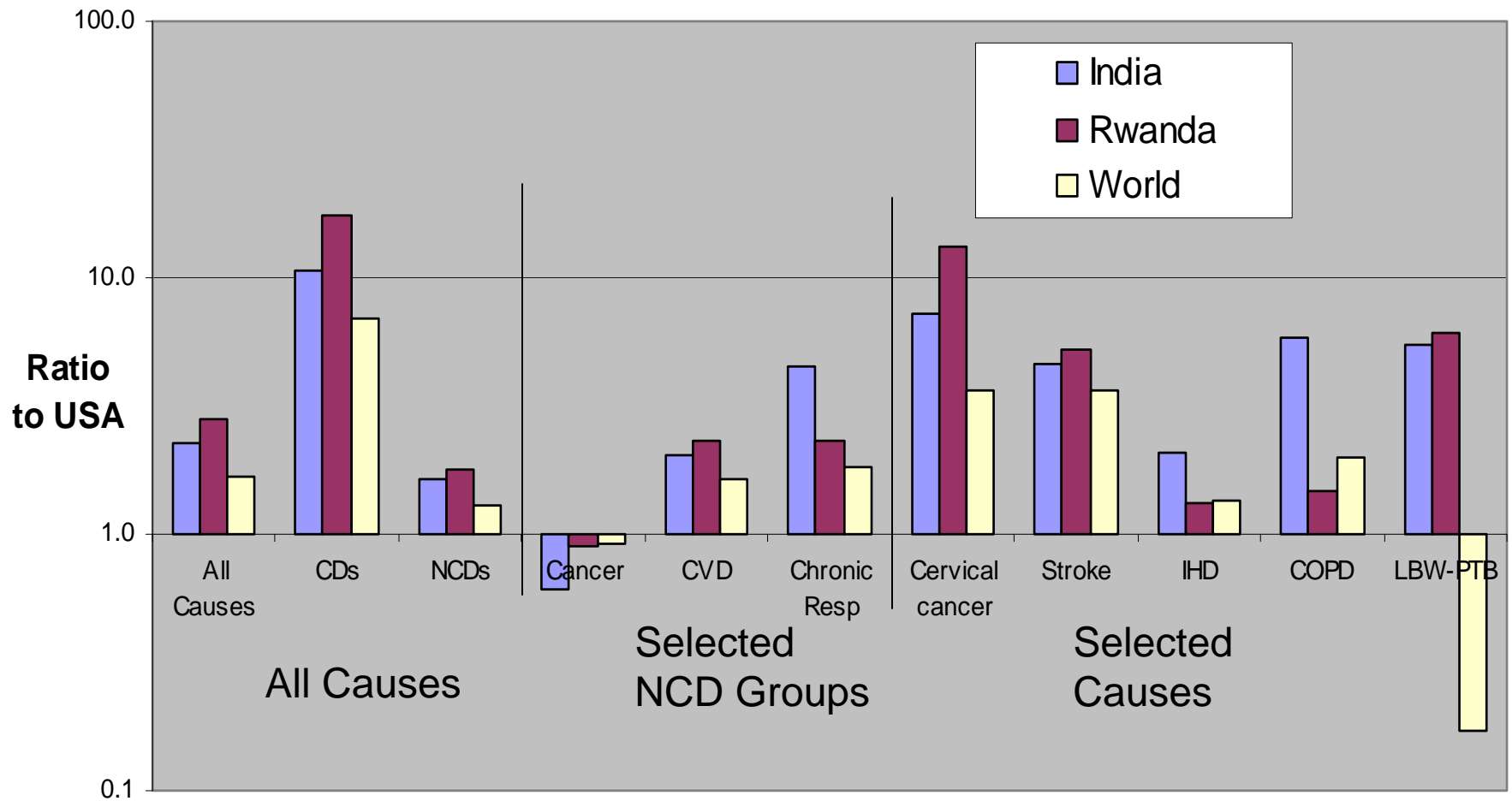
The Classic Epidemiological Transition



Epidemiological Transition: All Ages



Age-Adjusted Death Rates Compared to USA - 2008



CDs include communicable, maternal, and perinatal causes

Many thanks

Publications and presentations available at my website:

<http://ehs.sph.berkeley.edu/krsmith/>

Or just Google “Kirk R. Smith”