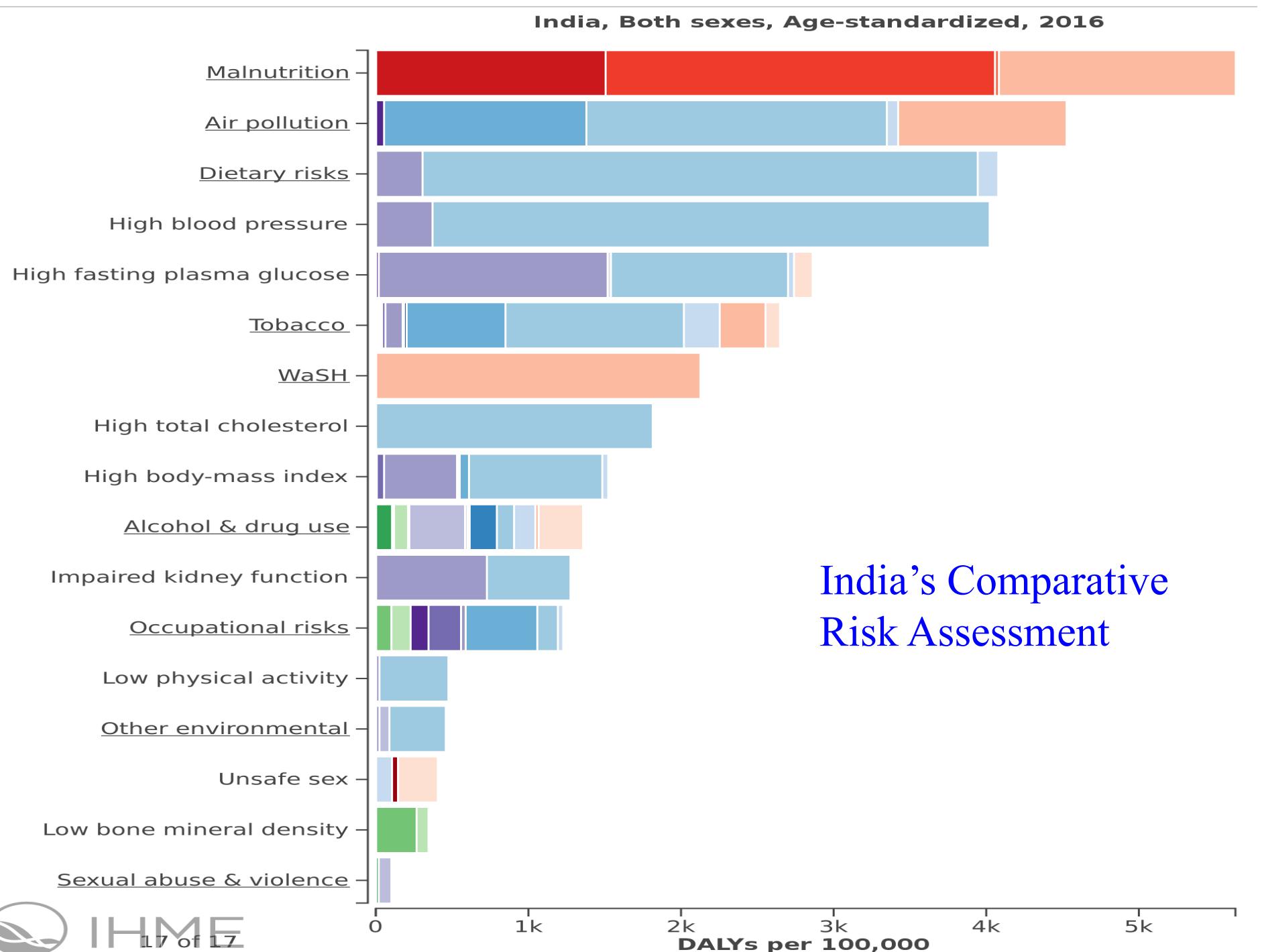


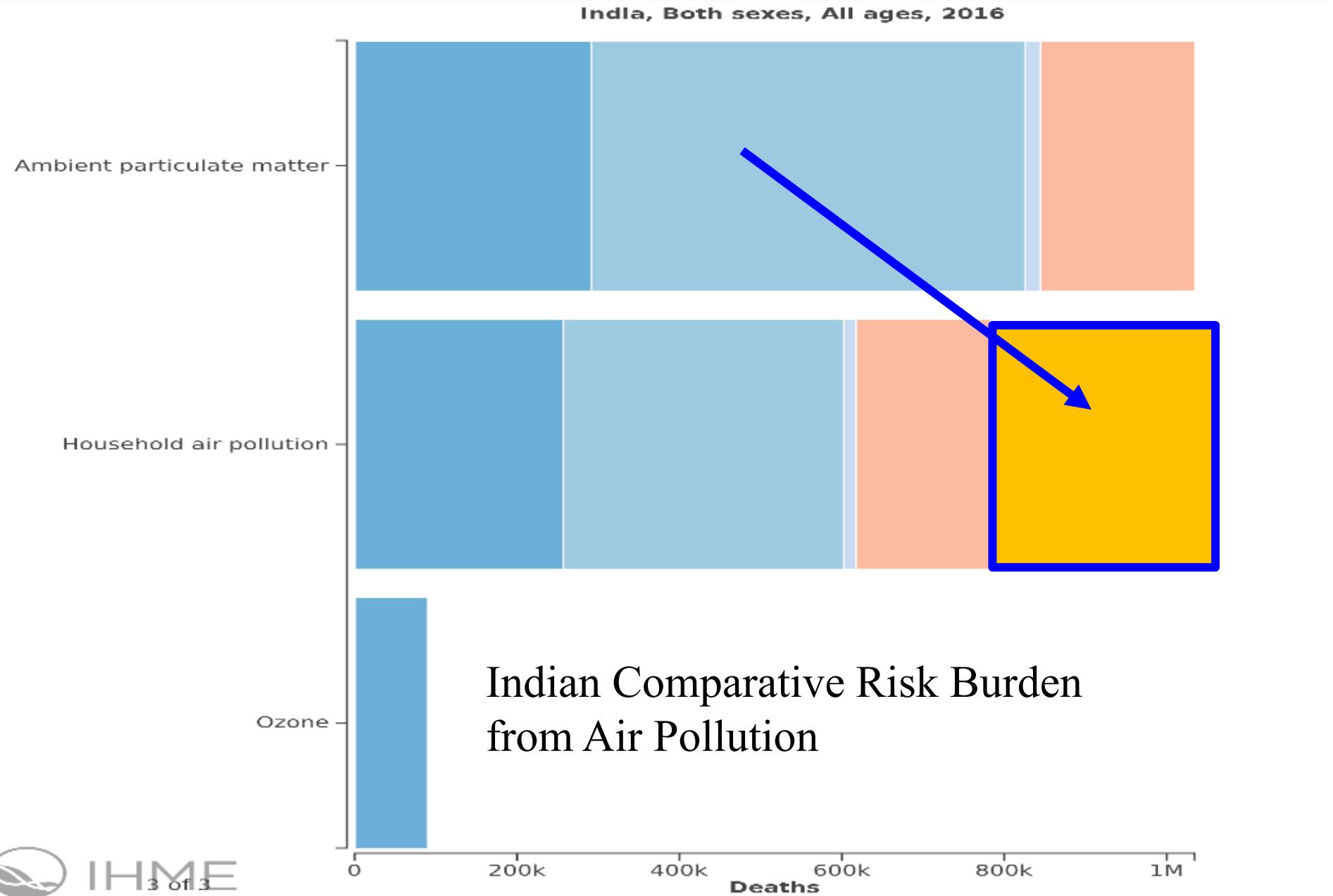
# Household air pollution and health: going up and going down

Kirk R. Smith, Professor of Global  
Environmental Health, UC Berkeley  
Director, Collaborative Clean Air Policy Centre  
New Delhi

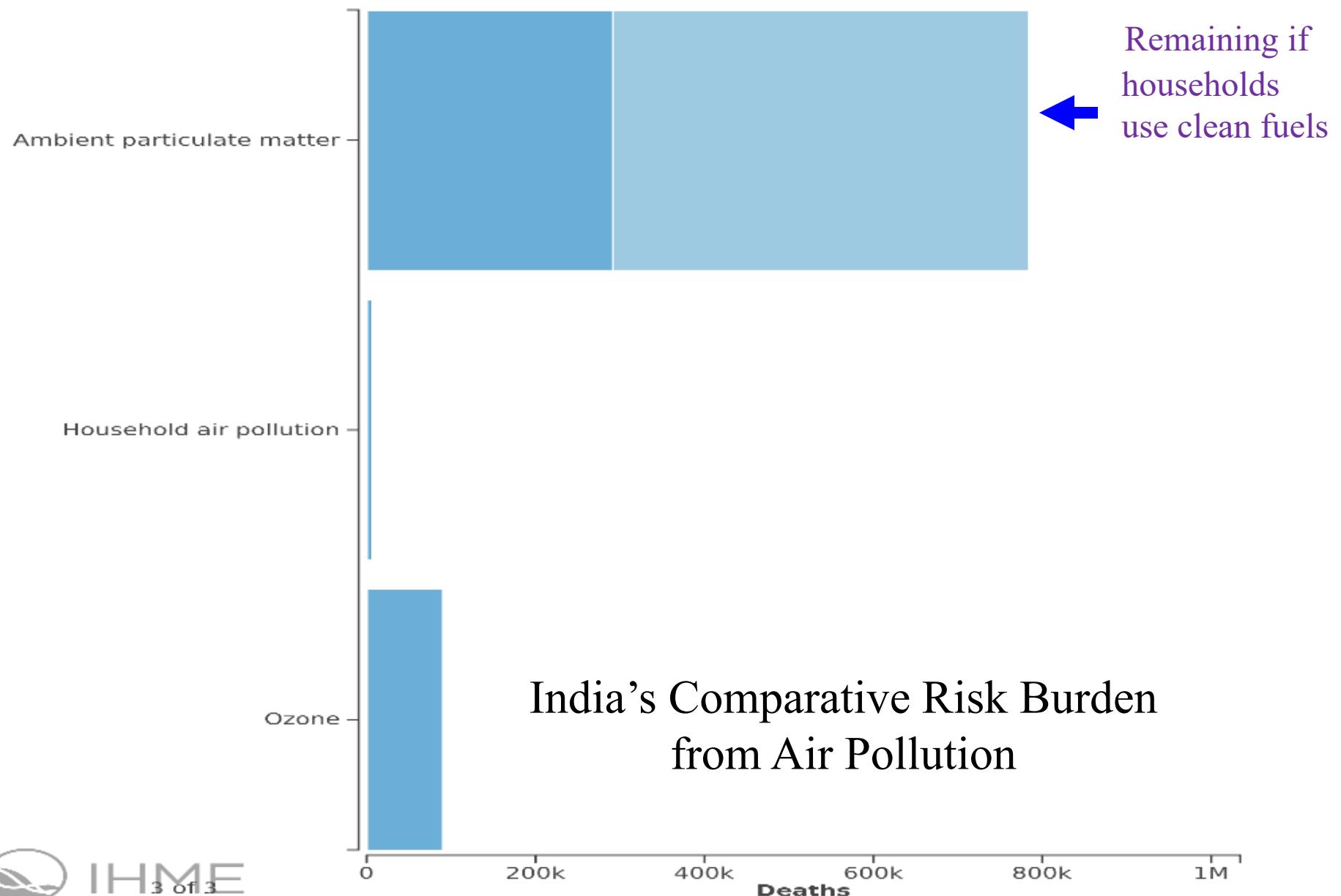
Prayas/CCAPC Meeting, New Delhi  
June 20, 2018

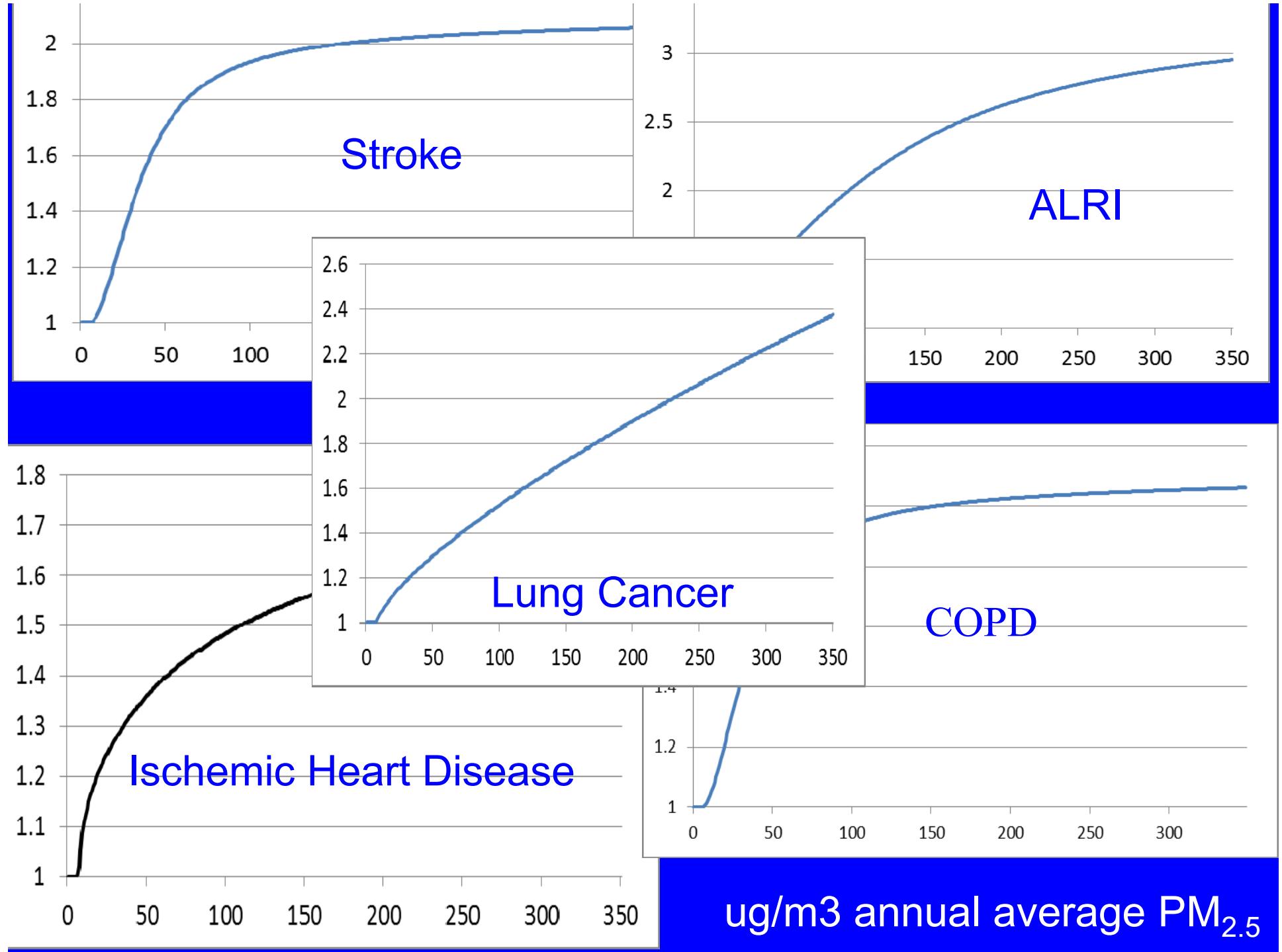
Avoidable risk is not always  
the same as attributable risk



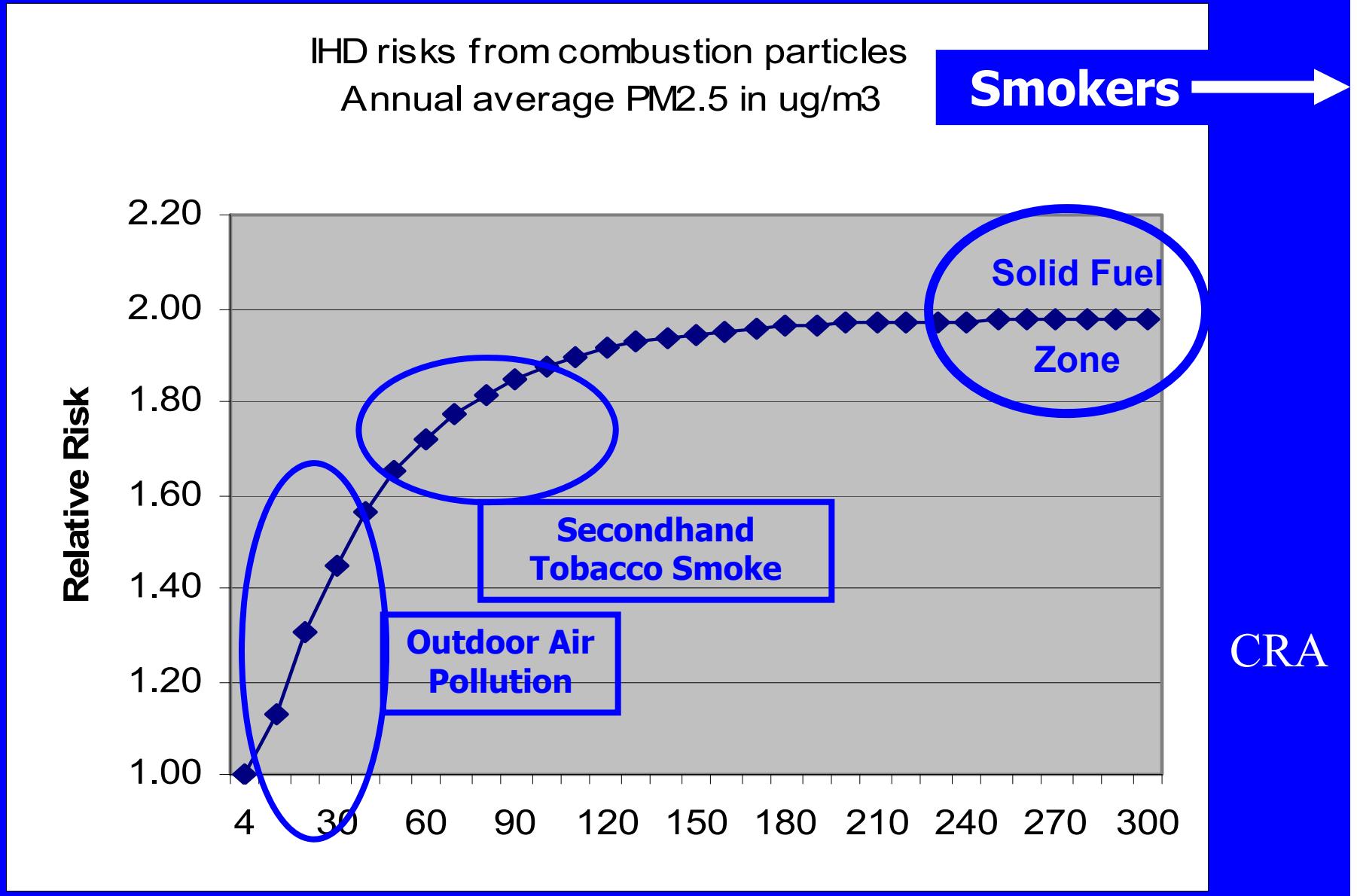


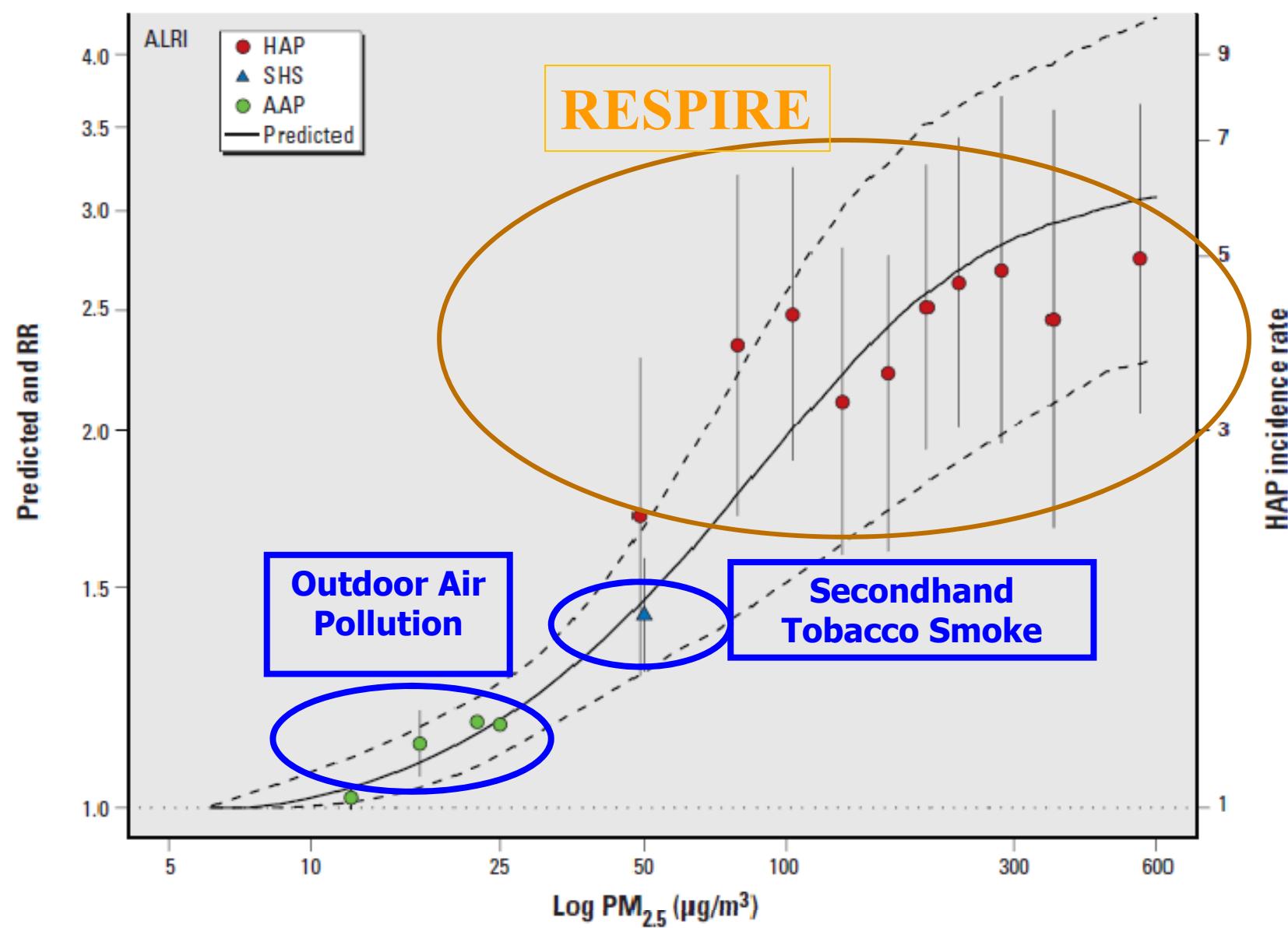
India, Both sexes, All ages, 2016





# Integrated Exposure-Response: Outdoor Air, SHS, and Smoking



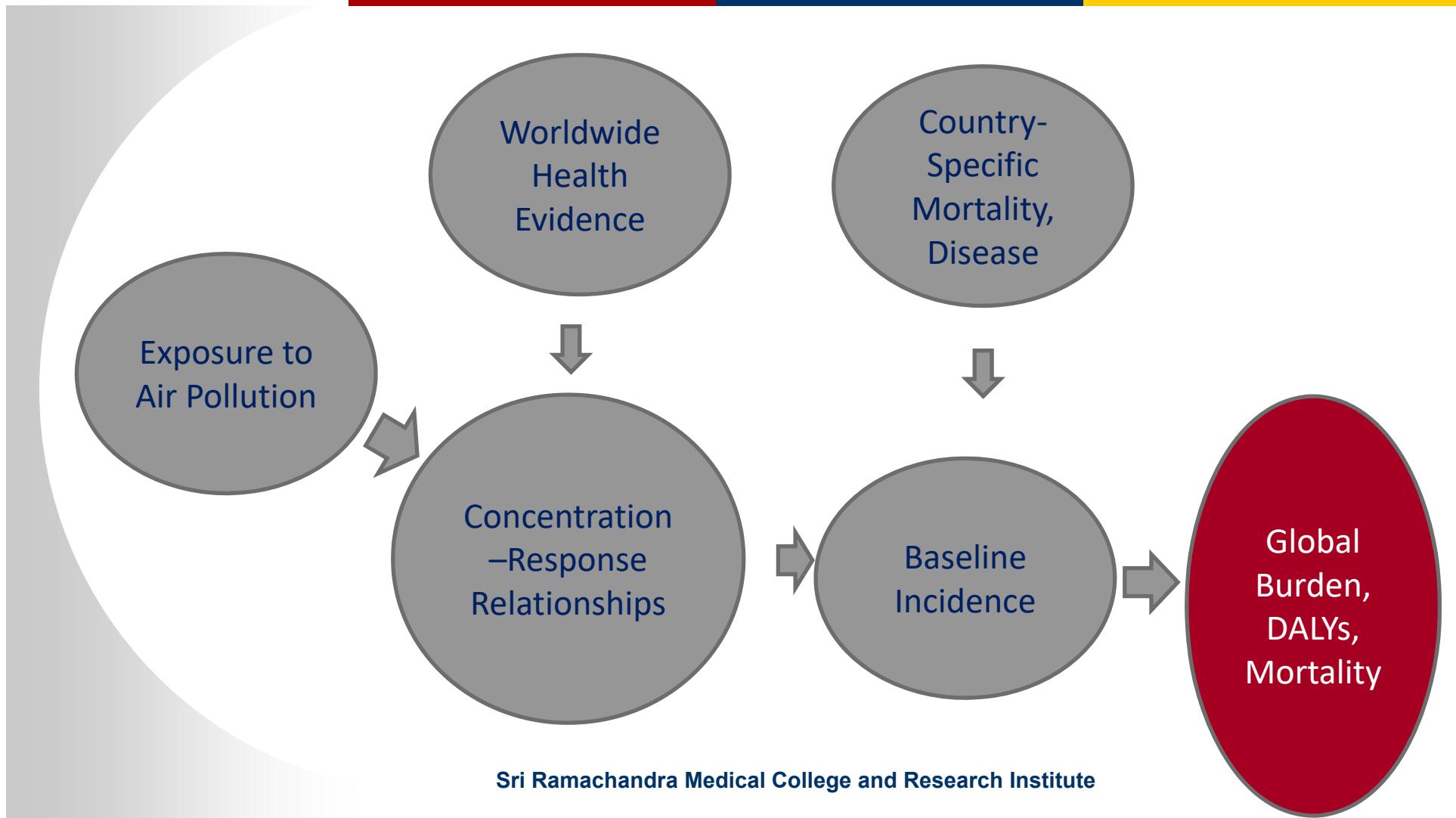


Burnett et al., EHP, 2014, Integrated Exposure-Response Functions

# GBD/CRA is our best estimate of what disease comes today from past exposures

- Is not necessarily the same as what will happen if going forward with controls
- Partly because of difficulties of estimating the future in specific populations
  - Age structure, background disease conditions, competing risks, etc.

## Estimating the Burden of Disease due to Air Pollution – what if exposures had not occurred in the past

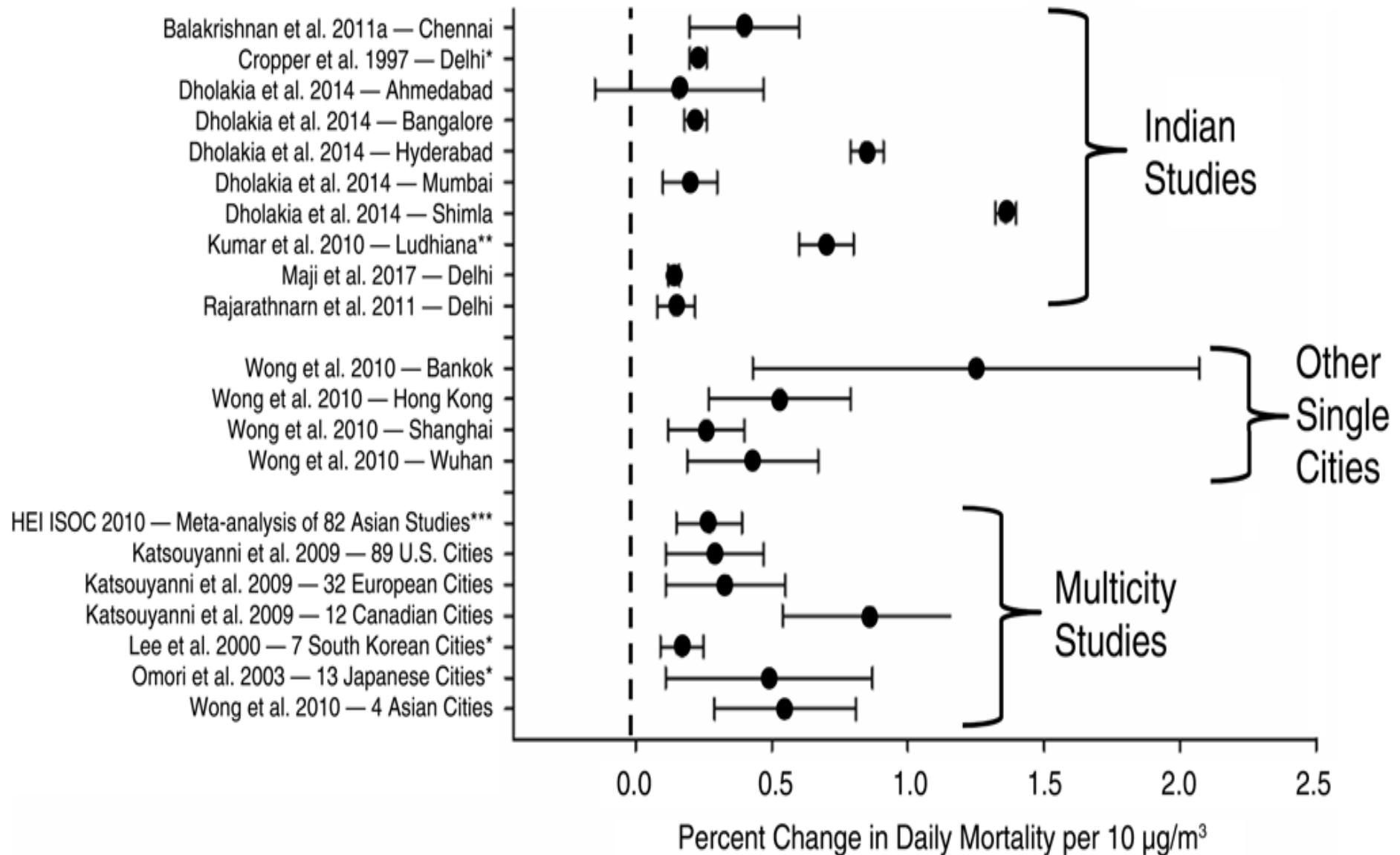


# First difficulty discussed here

- Are health impacts different among Indians/Asians compared to the populations where the studies have been done?

Following few slides courtesy  
of Kalpana Balakrishnan

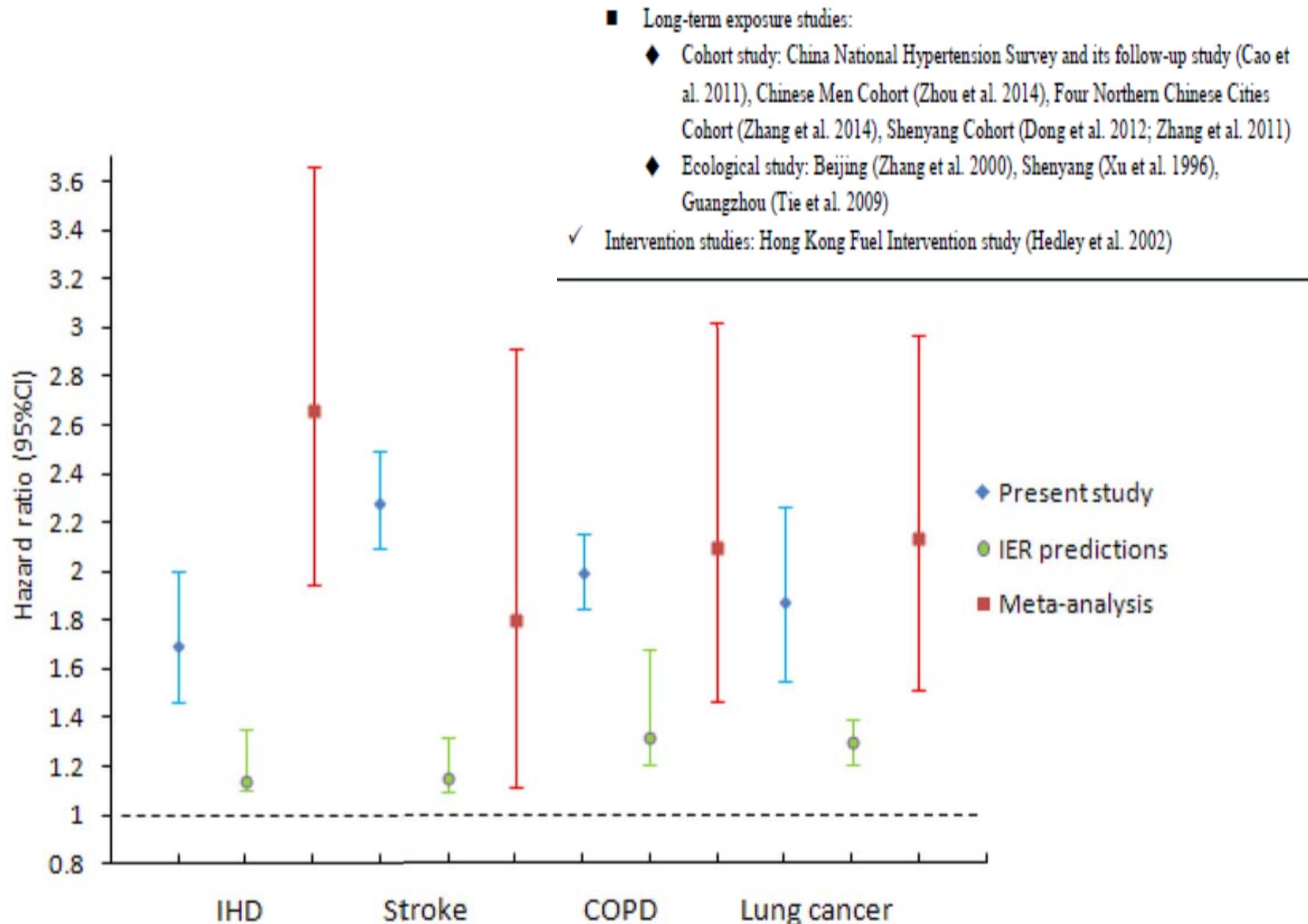
## Comparability of Effects Estimates from AAP studies from the region (Short-term effects : GBD related health endpoints)



## Comparability of Effects Estimates from HAP studies from the region (GBD health end-points )

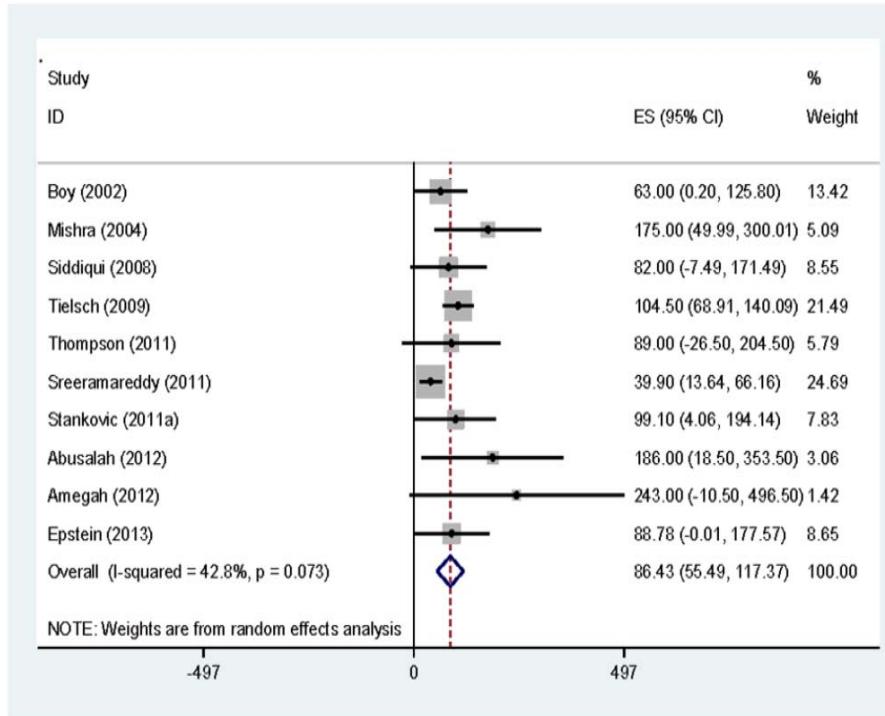
Health Outcome		India studies	Reported ORs	Meta-analysis estimate	
COPD	HAP	Behera et al (1991)	3.04 (2.15-4.31)	Kurmi et al	2.80 (1.85–4.0)
		Qureshi et al (1994)	2.10 (1.50 to 2.94)	Hu et al	2.44(1.9-3.33)
		Dutt et al (1996)	2.8(0.61-12.85)	PO et al	2.4(1.47-3.93)
		Malik et al(1985)	2.95(1.6-5.44)	Smith et al 2014	1.93(1.61-2.92)
		Pandey et al(1984)	4.05(3.23- 4.16)		
		Jindal et al(2006)	1(0.79-1.27)		
Child ALRI	HAP	Pandey et al (1989)	2.45(1.43-4.19)	Dherani et al(2008)	
		Mishra et al (2004)	2.2(1.16-4.18)	Smith et al(2014)	1.78 ( 1.45–2.18)
		Kumar et al (2004)	3.67(1.42-10.57)		
		Mishra et al (2005)	1.58 (1.28–1.95)		
Lung Cancer (Biomass)	HAP	Gupta et al (2000)	1.52 (0.33–6.98)	Smith et al (2014)	1.18(1.03-1.35)
		Sapkota et al(2008)	3.76 (1.64–8.63)		
		Behera et al (2005)	3.59(1.08-11.67)		
Cataracts	HAP	Mohan et al (1989)	1.61 (1.02–2.50)	Smith et al (2014)	2.46(1.74-3.5)
		Badrinath(1996)	4.91(2.82-8.55)		
		Sreenivas(1999)	1.82(1.13-2.93)		
		Saha(2005)	2.4(0.9-6.38)		
		Zodpey et al (1999)	2.37 (1.44–4.13)		
Lung Cancer(Coal)	HAP	Not available		Hosgood et al (2011)	2.15(1.61-2.89)
				Bruce (2015)	1.17 (1.01 to 1.37)

## Comparability of Effects Estimates from Ambient studies from the region

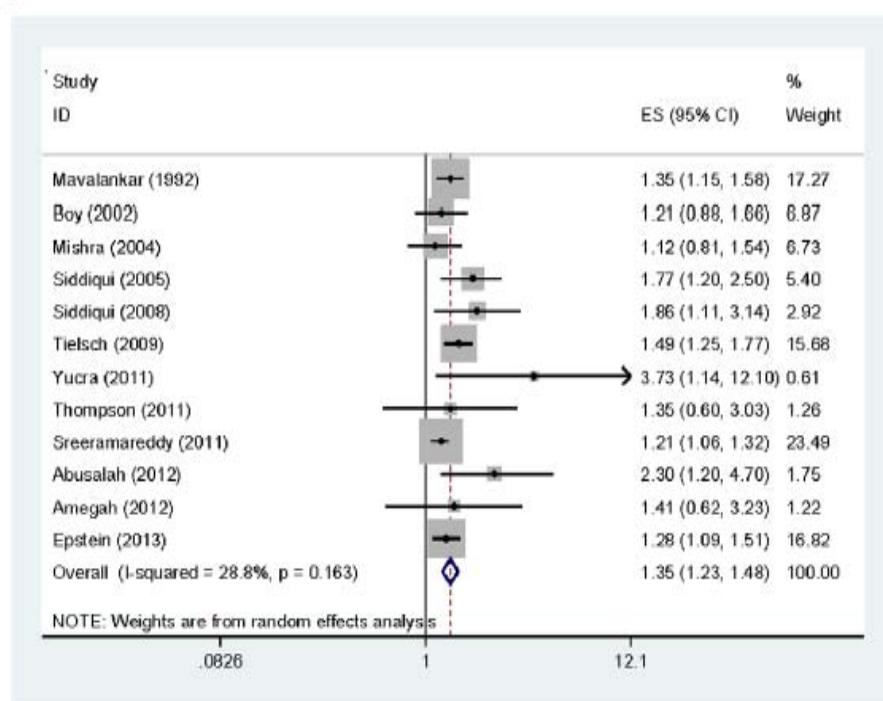


# HAP Studies on health end points not currently included in GBD assessments : Birthweight/Low Birthweight

A



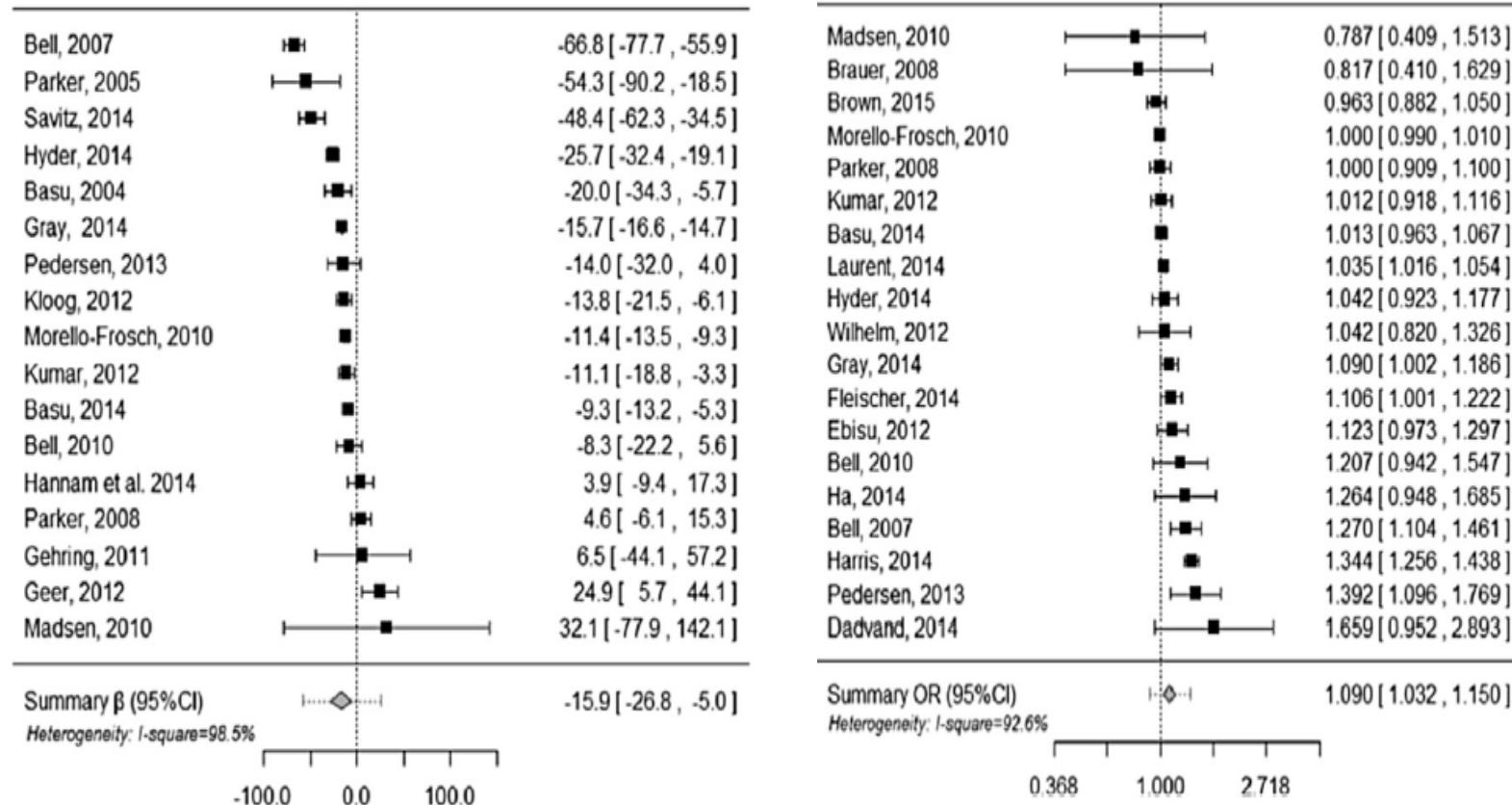
B



Exposure to HAP associated with 86 g (95%CI: 55.0, 117) reduction in birthweight and a 35% increased odds of low birthweight (OR: 1.35, 95%CI: 1.15, 1.5)  
(Amegah *et al* 2014)

Results from the TAPHE cohort in India estimate a 72 gm change associated with biomass use when compared to LPG (Balakrishnan *et al* 2018)

# Ambient Studies on health end points not currently included in GBD assessments : Birthweight/Low Birthweight

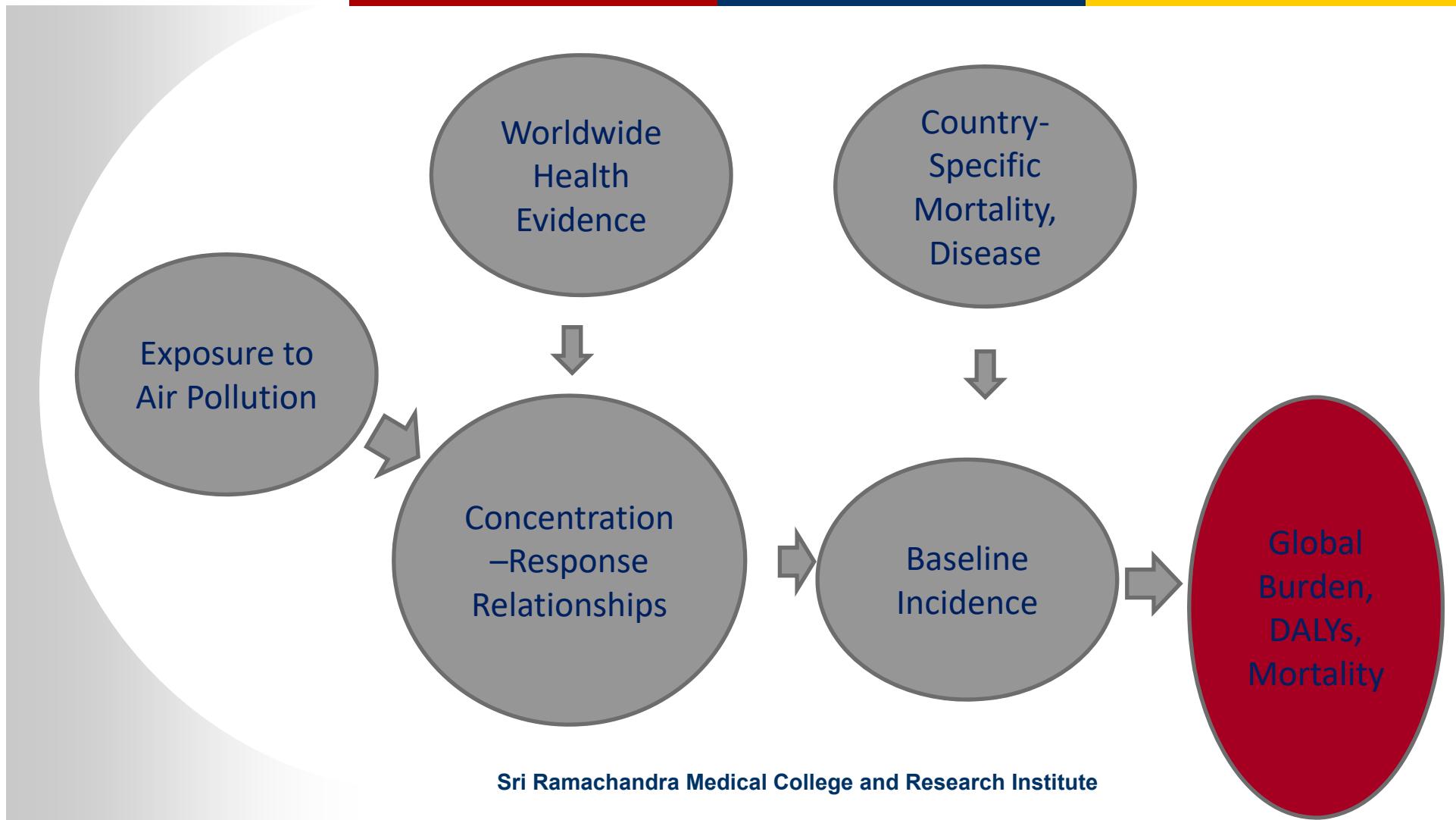


Exposure to AAP associated with 15.9 g (95%CI: 5.0, 26.8) reduction in birthweight and a 9% increased odds of low birthweight (OR: 1.09, 95%CI: 1.03, 1.15) (Sun et al 2015)

Results from the TAPHE cohort in India estimate a, 4 g (95% CI:1.08 g, 6.76 g) decrease in birthweight and 2% increase in prevalence of low birthweight [odds ratio (OR) = 1.02; 95% CI:1.005,1.041 per 10- $\mu\text{g}/\text{m}^3$  increase in pregnancy period PM2.5 exposures (Balakrishnan 2018)].

ETS associated with a 40 gm reduction and smoking with a ~200gm reduction in birthweight among pregnant women

## Estimating the Burden of Disease due to Air Pollution – what if exposures had not occurred in the past



## Second difficulty discussed here

- IERs have been created without direct studies of heart disease and HAP

# Heart Disease and Combustion Particle Doses

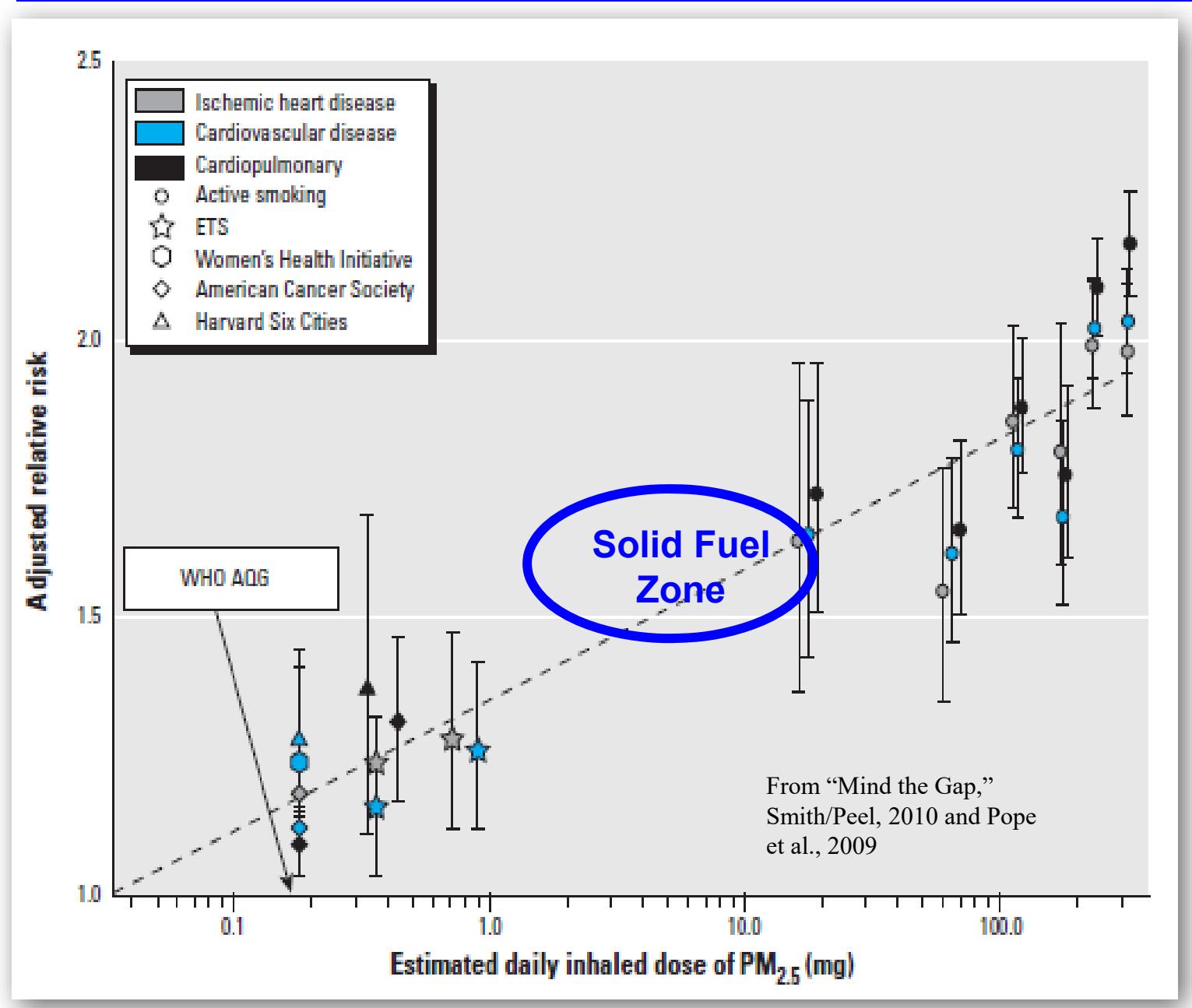


Table 2. Adjusted relative risk estimates<sup>a</sup> for various increments of exposure from cigarette smoking (versus never smokers), second hand cigarette smoke, and ambient air pollution from the present analysis and selected comparison studies.

Source of risk estimate	Increments of Exposure	Adjusted RR (95% CI)				Estimated Daily Dose PM <sub>2.5</sub> (mg) <sup>b</sup>
		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 <sup>3</sup> ambient PM <sub>2.5</sub>	---	---	---	1.31(1.17-1.46)	0.44
ACS-air pol. extend.	10 µg/m <sup>3</sup> ambient PM <sub>2.5</sub>	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 <sup>3</sup> ambient PM <sub>2.5</sub>	---	---	---	1.37(1.11-1.68)	0.33
HSC-air pol. extend.	10 µg/m <sup>3</sup> ambient PM <sub>2.5</sub>	1.21(0.92-1.69)	---	1.28(1.13-1.44)	---	0.18
WHI-air pol.	10 µg/m <sup>3</sup> ambient PM <sub>2.5</sub>	---	---	1.24(1.09-1.41) <sup>c</sup>	---	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) <sup>d</sup>	---	---	0.36
INTERHEART	Live with smoking spouse	---	1.28(1.12-1.47) <sup>d</sup>	---	---	0.54

Pope et al.  
Environmental Health  
Perspectives  
2011, in press

# Intervention to Lower Household Wood Smoke Exposure in Guatemala Reduces ST-Segment Depression on Electrocardiograms

John McCracken,<sup>1,2</sup> Kirk R. Smith,<sup>2</sup> Peter Stone,<sup>3</sup> Anaité Diaz,<sup>4</sup> Byron Arana,<sup>4</sup> and Joel Schwartz<sup>1</sup>

<sup>1</sup>Department of Environmental Health, Harvard School of Public Health, Boston, Massachusetts, USA; <sup>2</sup>Environmental Sciences Division, University of California, Berkeley, California, USA; <sup>3</sup>Brigham and Women's Hospital, Boston, Massachusetts, USA; <sup>4</sup>Center for Health Studies, Universidad del Valle, Guatemala City, Guatemala

EHP Nov, 2011

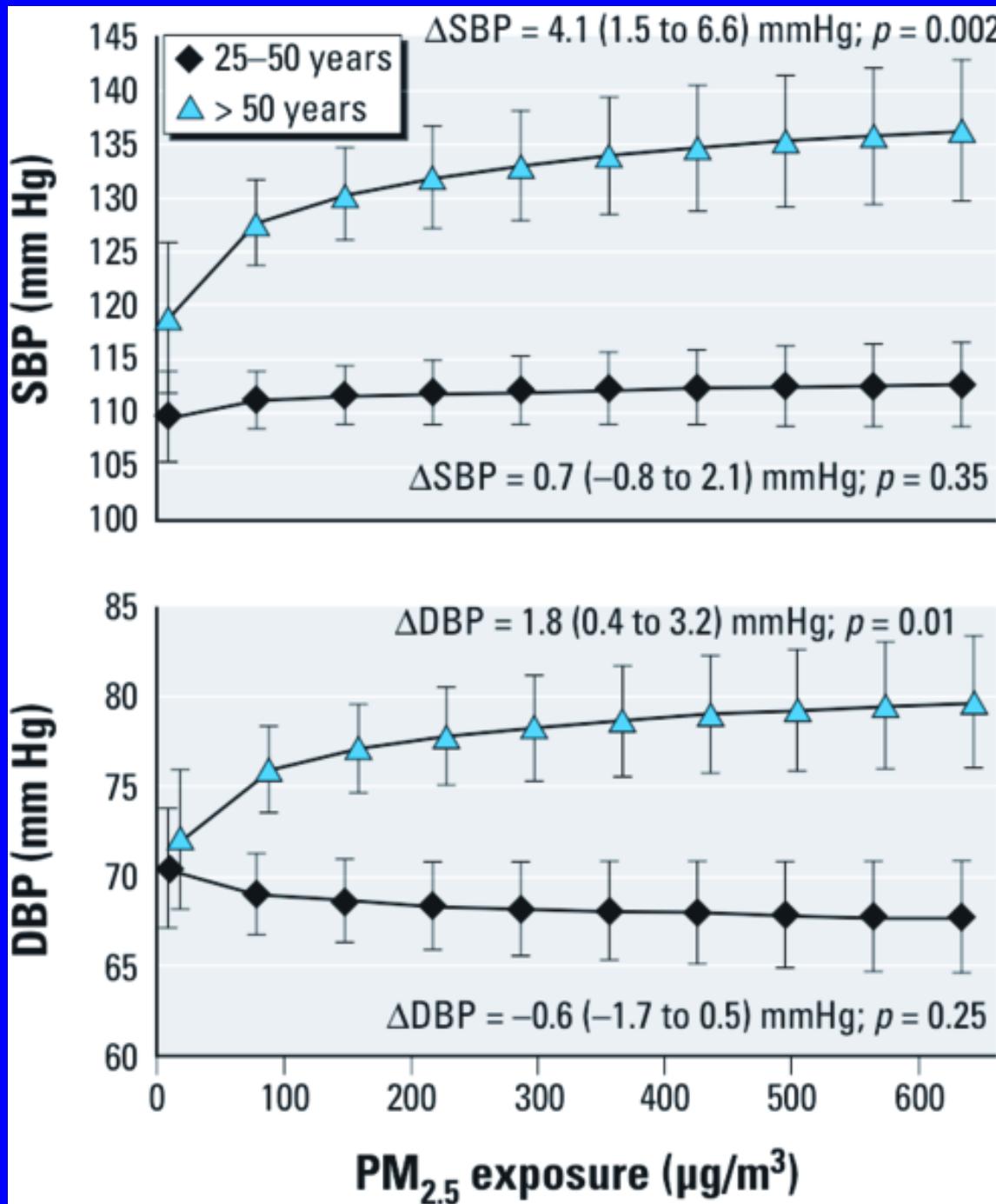
**Table 3.** Odds ratios (ORs) for nonspecific ST-segment depression (30-min average  $\leq -1$  mm, regardless of slope) associated with chimney-stove intervention compared with open fire from two study designs: between-groups and before-and-after analyses.

Comparison	Crude		Adjusted	
	OR (95% CI)	p-Value	OR (95% CI)	p-Value
Between-groups	0.34 (0.15, 0.81)	0.015	0.26 (0.08, 0.90) <sup>a</sup>	0.033
Before-and-after (only control group)	0.41 (0.24, 0.70)	0.001	0.28 (0.12, 0.63) <sup>b</sup>	0.002

<sup>a</sup>Adjusted for age (quadratic), BMI (quadratic), asset index category, ever smoking, SHS, owning a wood-fired sauna, recent use of wood-fired sauna, and time of day (natural spline with 5 degrees of freedom). <sup>b</sup>Adjusted for age (quadratic), day of week, season (wet/dry), daily average temperature and relative humidity, daily rainfall, interactions of weather variables with season, recent use of wood-fired sauna, and time of day (natural spline with 5 degrees of freedom).

# Household Air Pollution and Blood Pressure

In Yunnan



Baumgartner et al.  
Environmental Health  
Perspectives 2011

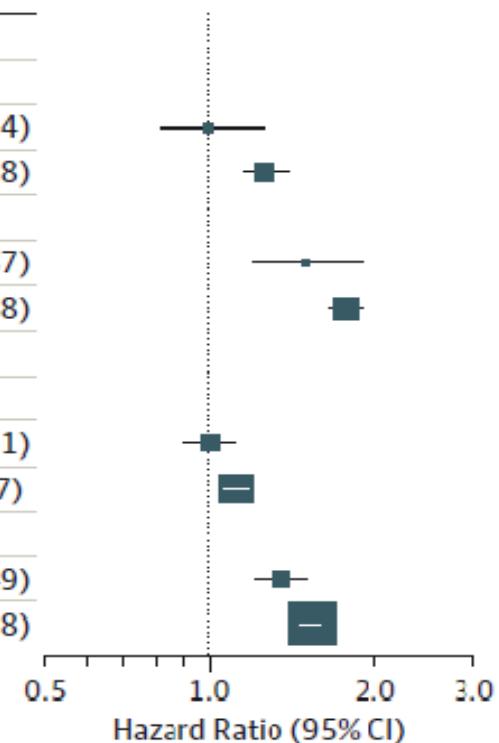
# Association of Solid Fuel Use With Risk of Cardiovascular and All-Cause Mortality in Rural China

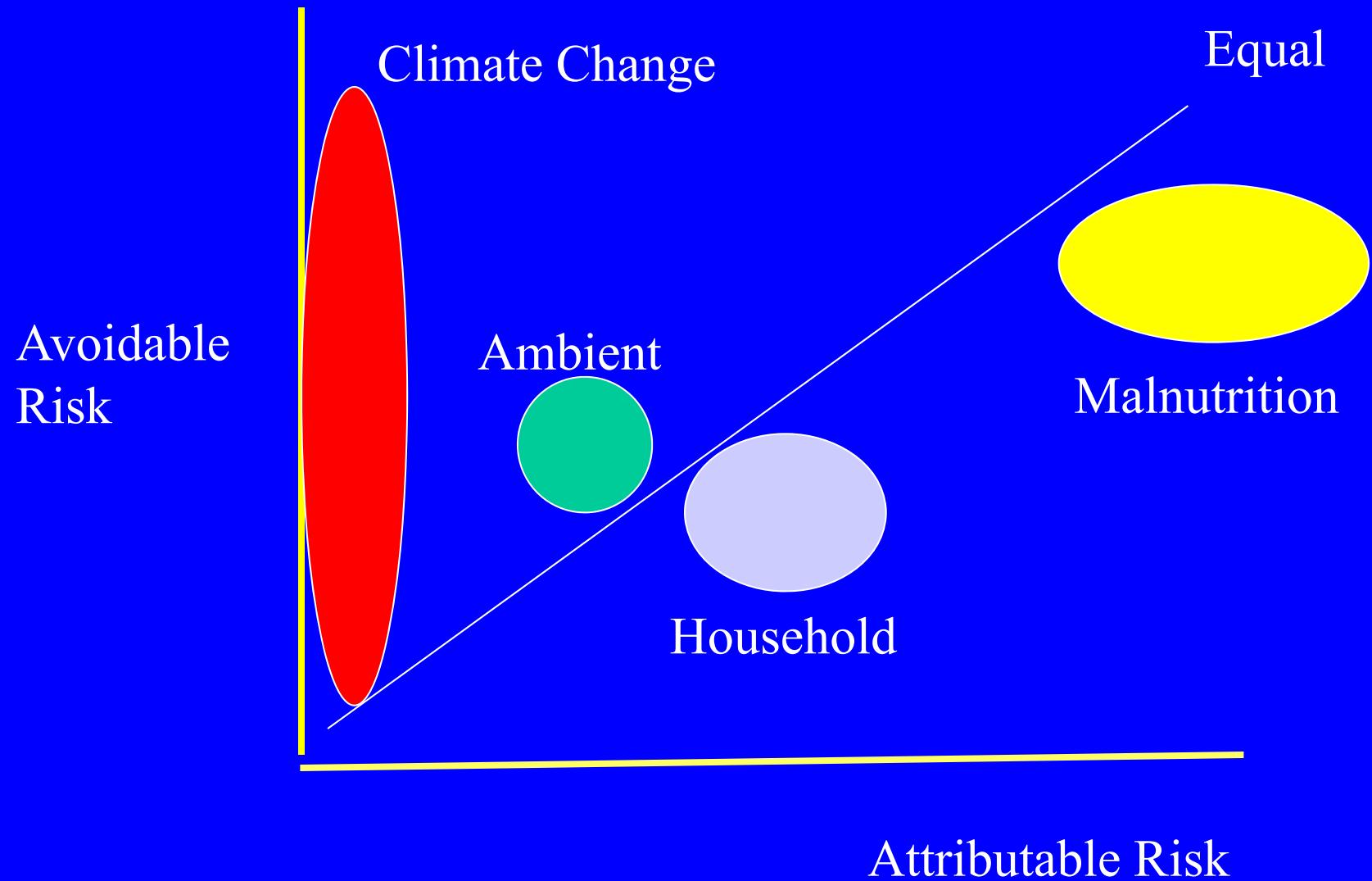
Kuai Yu, MD; Gaokun Qiu, MD, PhD; Ka-Hung Chan, MSc; Kin-Bong Hubert Lam, PhD; Om P. Kurmi, PhD; Derrick A. Bennett, PhD; Canqing Yu, MD, PhD; An Pan, PhD; Jun Lv, MD, PhD; Yu Guo, MSc; Zheng Bian, MSc; Ling Yang, PhD; Yiping Chen, DPhil; Frank B. Hu, MD, PhD; Zhengming Chen, DPhil; Liming Li, MD, MPH; Tangchun Wu, MD, PhD

April 3, 2018

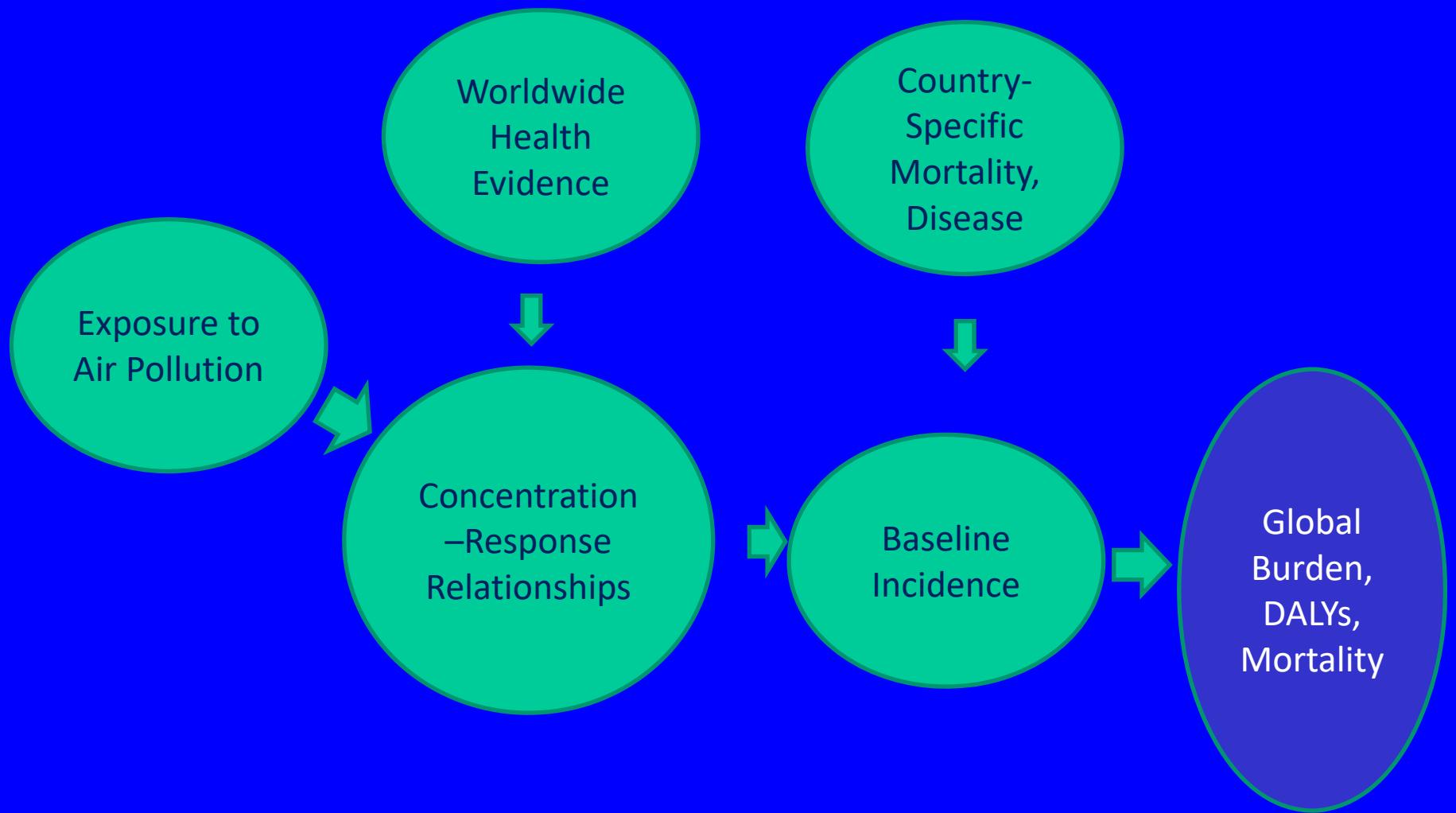
## A Cooking fuel

Smoking Status and Fuel Type	No. of Deaths	Mortality Rate per 100 000 Person-Years	Rate Difference per 100 000 Person-Years (95% CI)	Hazard Ratio (95% CI)
<b>Cardiovascular mortality</b>				
Never smoker				
Clean fuels	101	132	[Reference]	1.00 (0.81 to 1.24)
Solid fuels	2149	306	174 (105 to 243)	1.25 (1.14 to 1.38)
Ever smoker				
Clean fuels	79	156	24 (-58 to 106)	1.49 (1.19 to 1.87)
Solid fuels	808	402	270 (181 to 359)	1.76 (1.64 to 1.88)
<b>All-cause mortality</b>				
Never smoker				
Clean fuels	489	418	[Reference]	1.00 (0.90 to 1.11)
Solid fuels	5362	808	390 (283 to 497)	1.11 (1.05 to 1.17)
Ever smoker				
Clean fuels	366	547	129 (-15 to 273)	1.34 (1.20 to 1.49)
Solid fuels	2593	1109	691 (540 to 842)	1.52 (1.46 to 1.58)





## Estimating the Burden of Disease due to Air Pollution for future interventions – uncertainty across the board



Avoidable burden is not  
always the same as  
attributable burden

Indeed, usually it is not

# Many thanks

For publications  
& presentations:  
Just “Google”  
Kirk R. Smith

