Household air pollution and health: going up and going down

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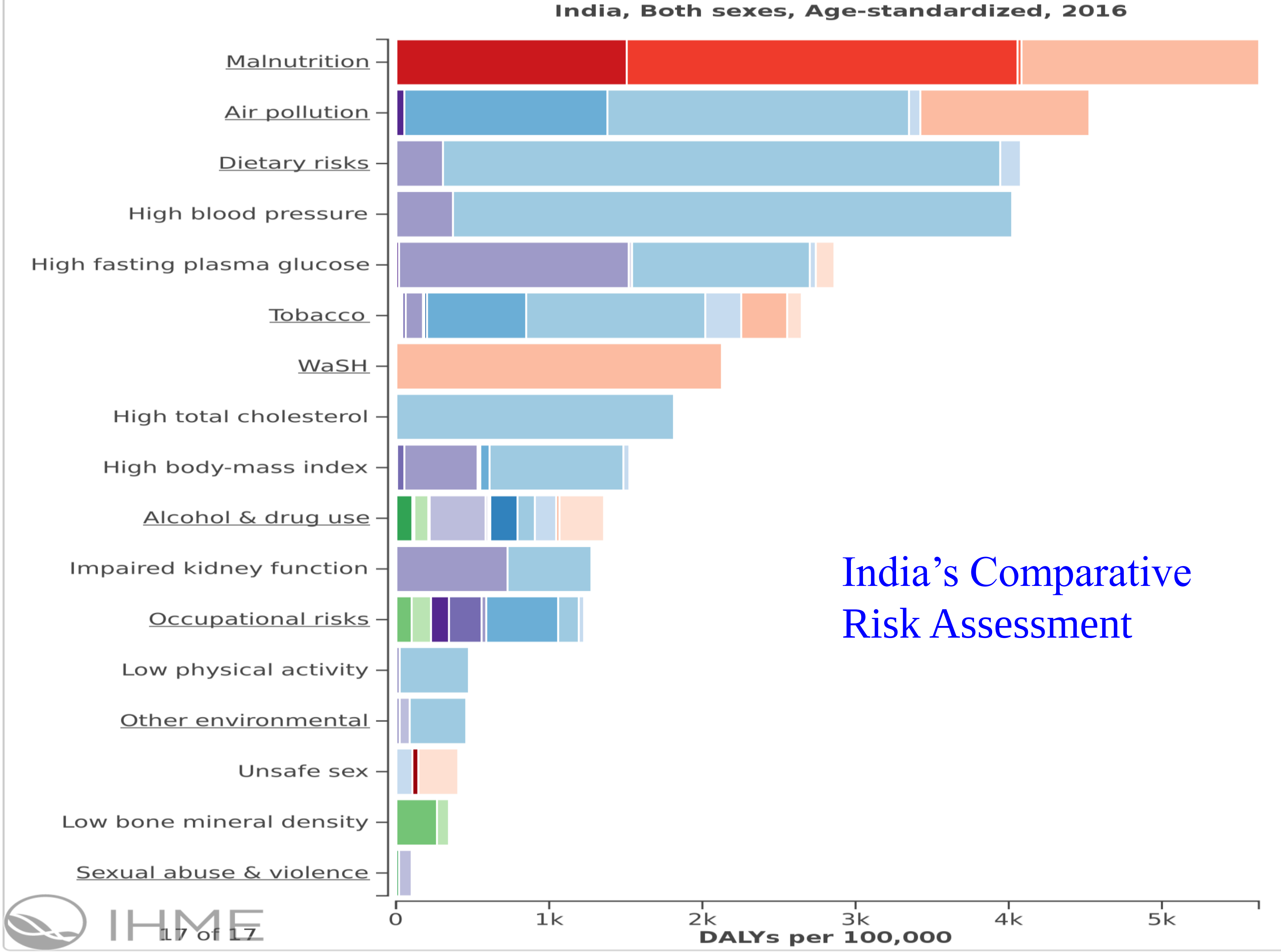
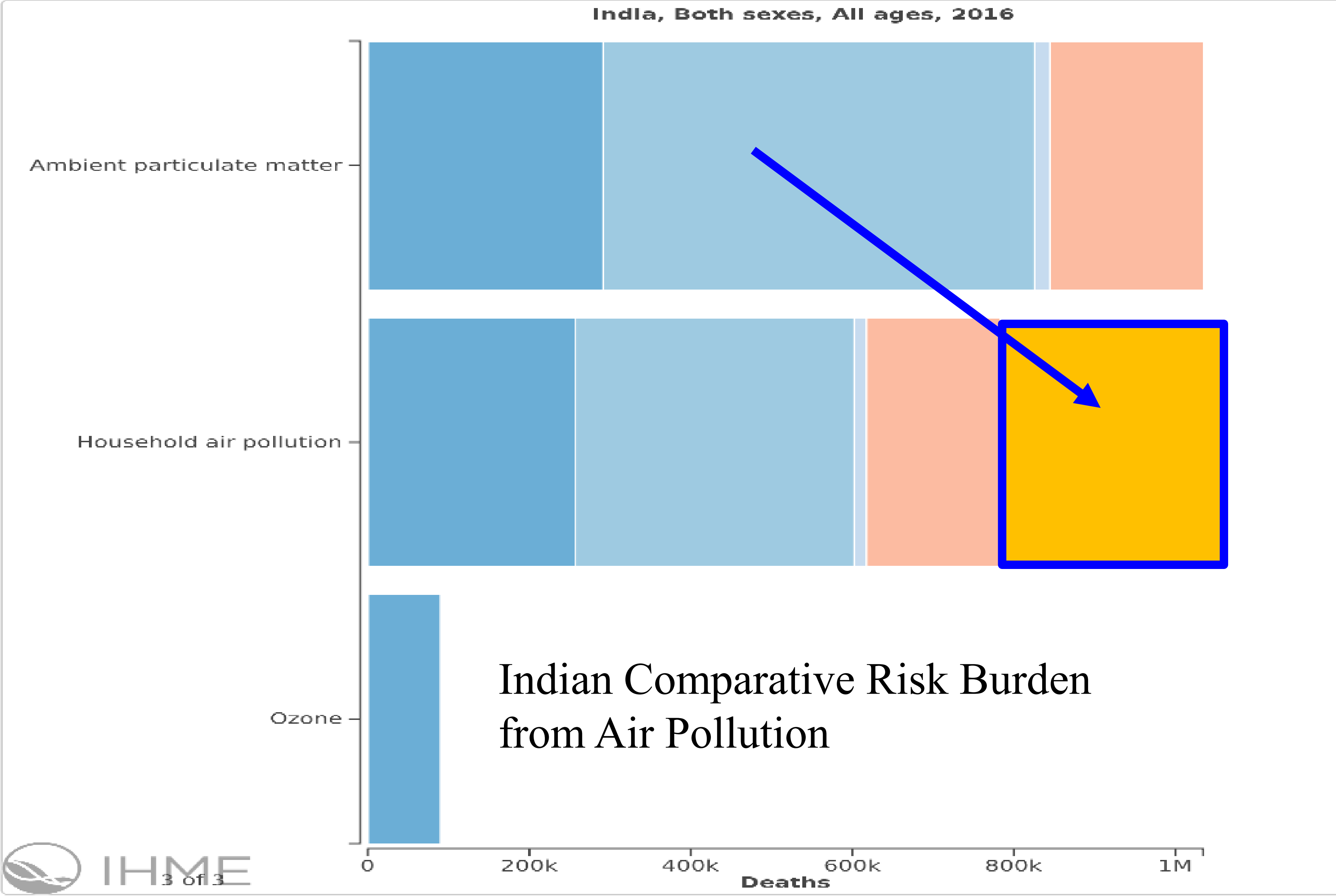
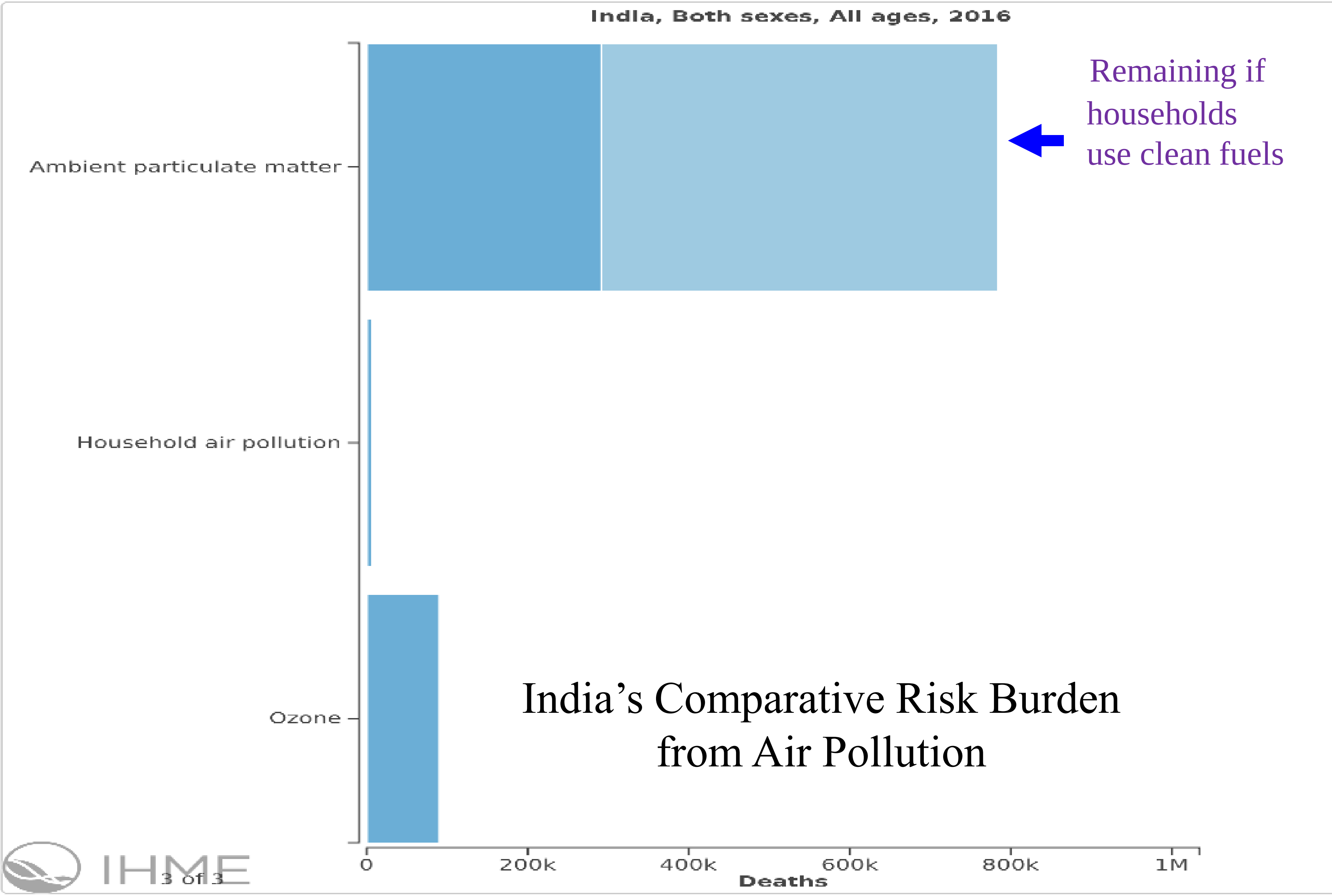
Avoidable risk is not always the same as attributable risk



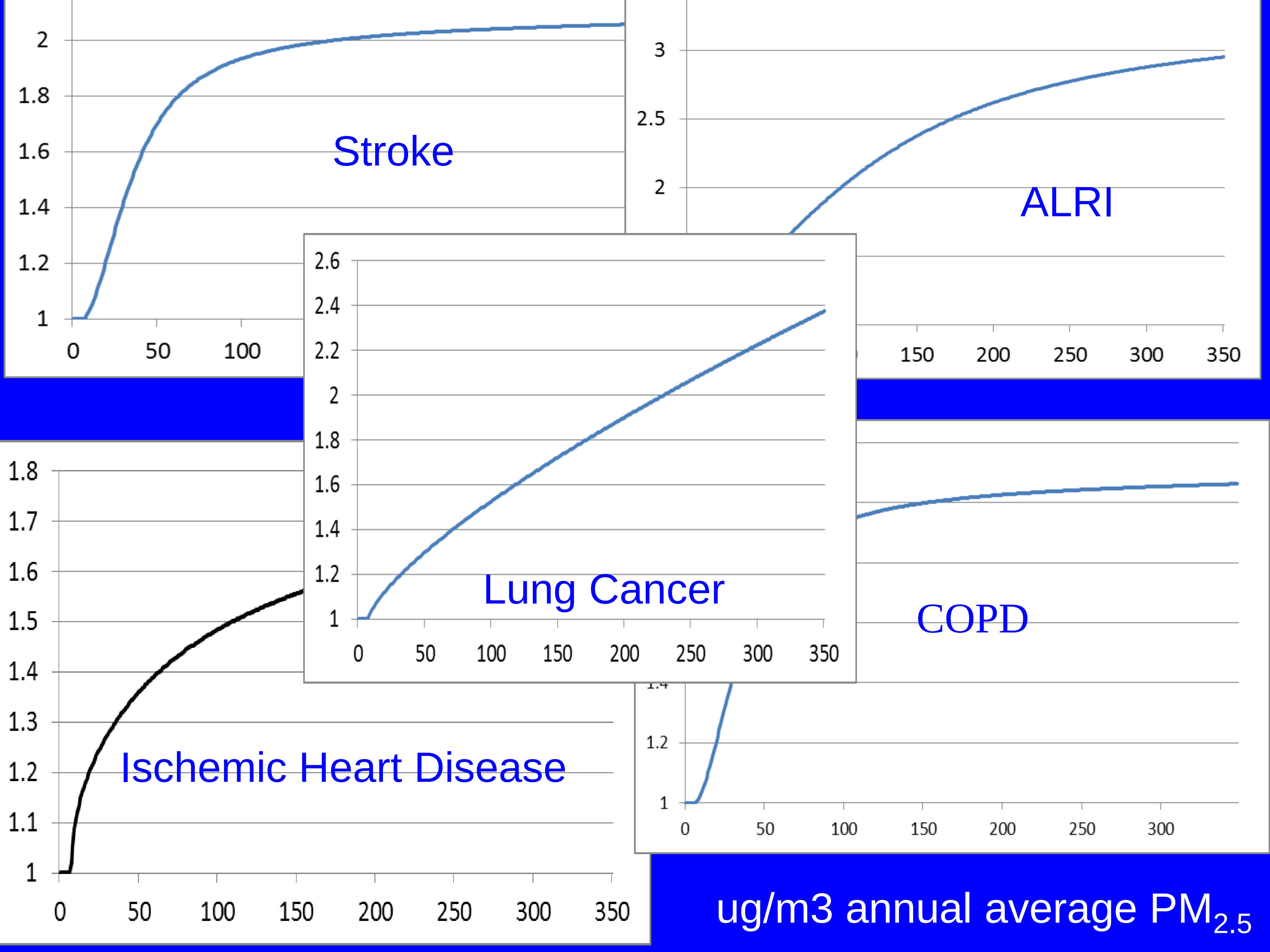
India's Comparative Risk Assessment



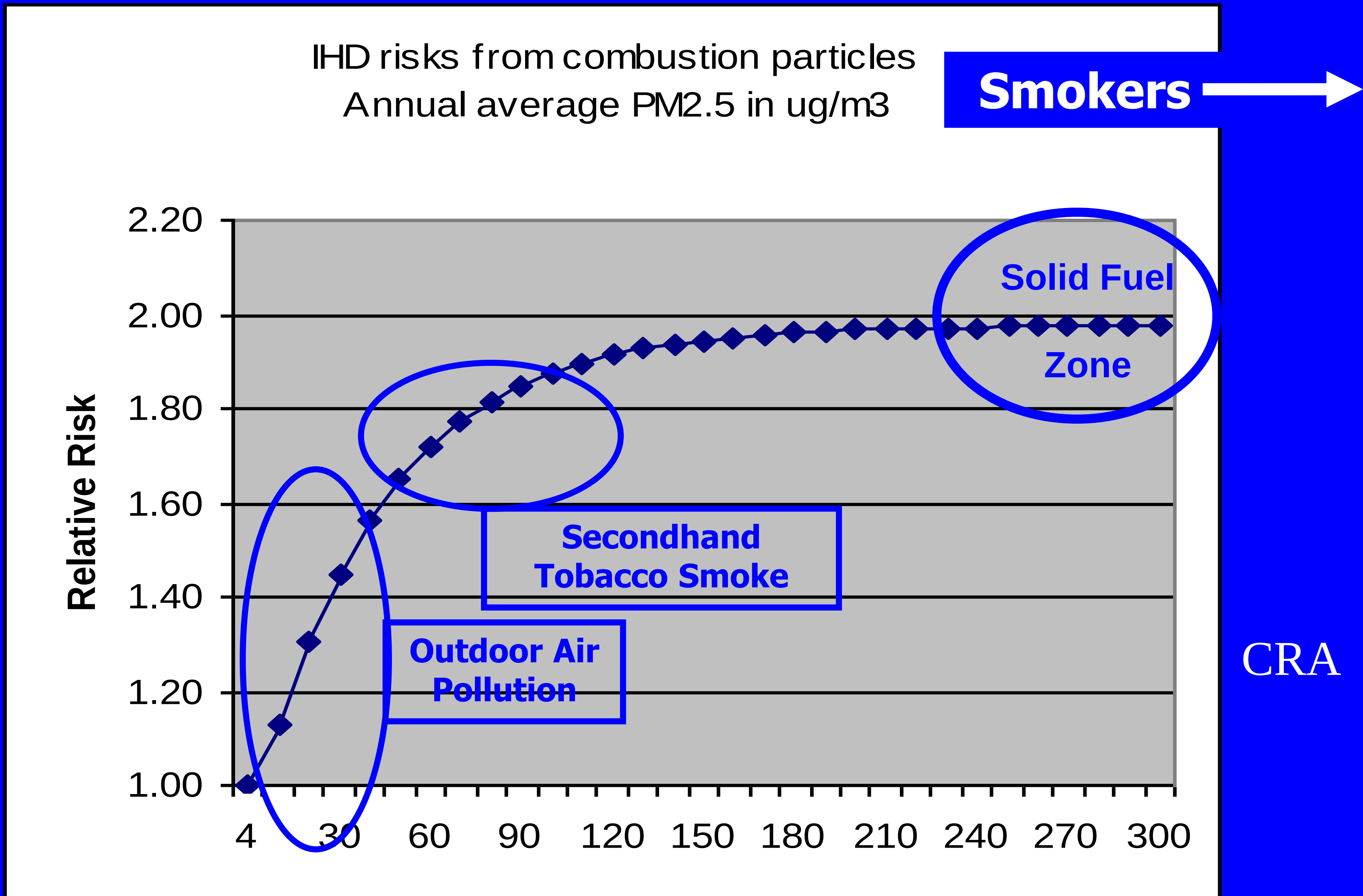
India, Both sexes, All ages, 2016
Ambient particulate matter
Household air pollution
Ozone
0
200k
400k
600k
800k
1M
Deaths
Indian Comparative Risk Burden
from Air Pollution
IHME
3 of 3



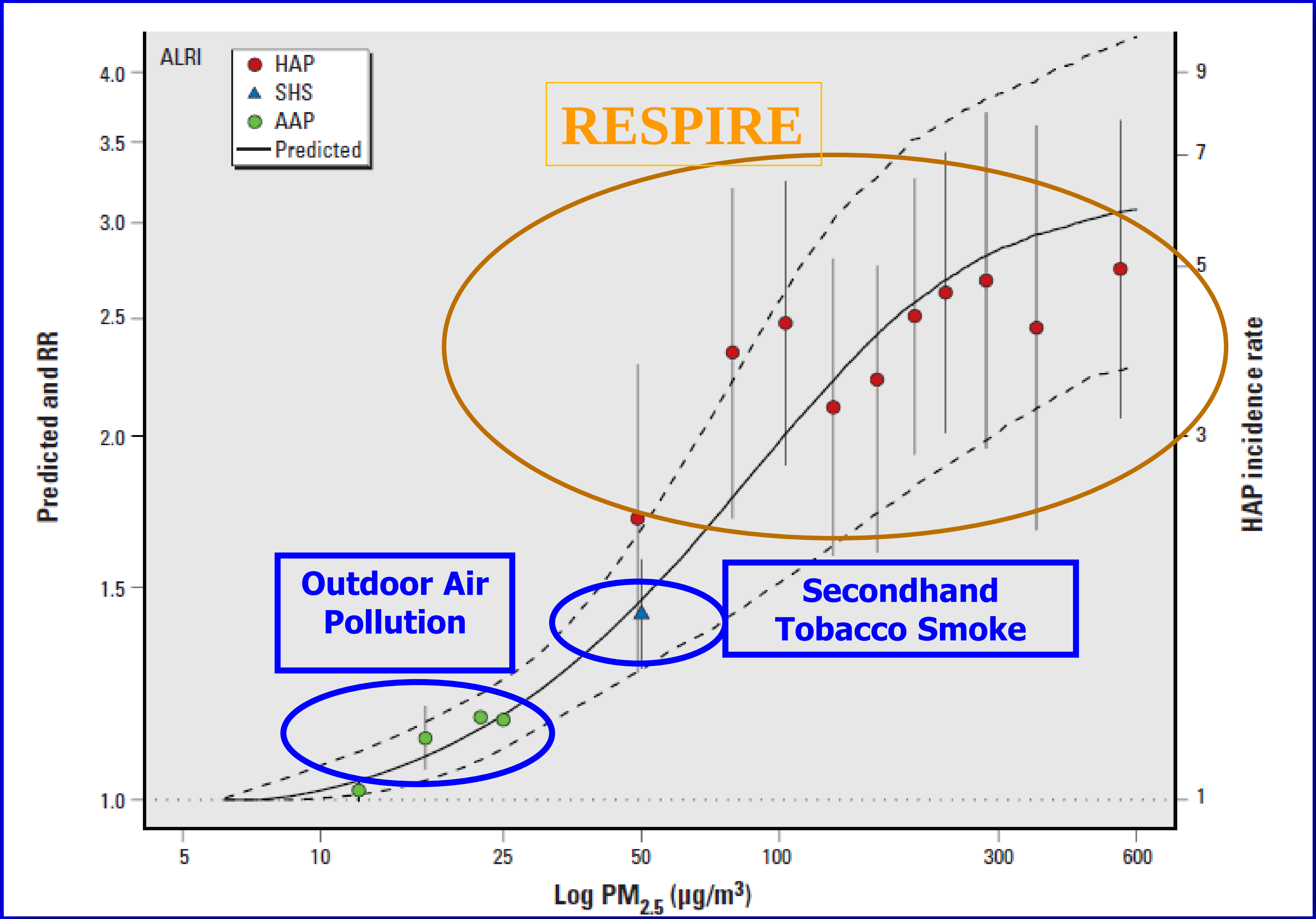
India's Comparative Risk Burden from Air Pollution


Stroke
ALRI
Lung Cancer
COPD
Ischemic Heart Disease
ug/m3 annual average $PM_{2.5}$

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



CRA

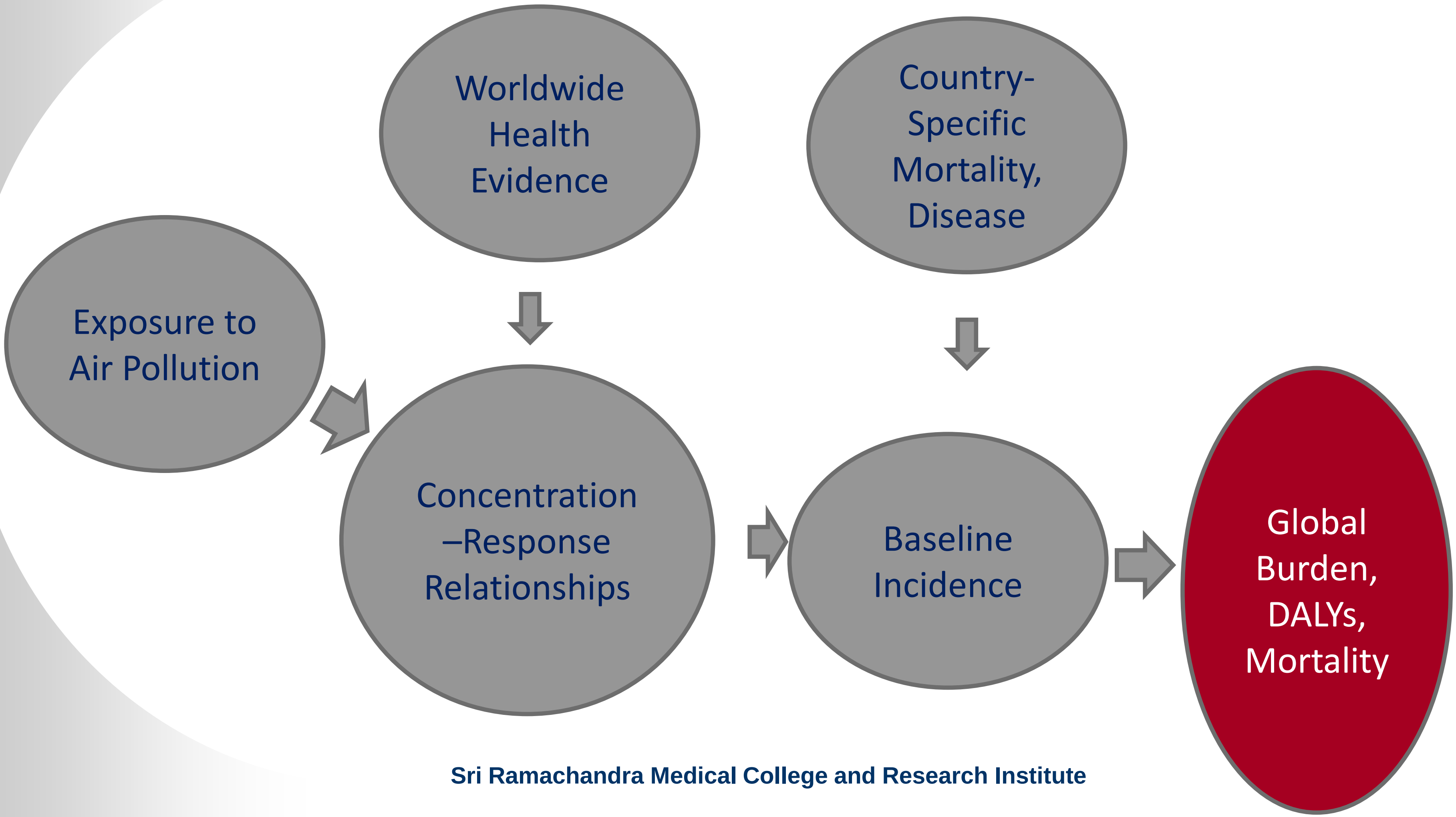


Burnett et al., EHP. 2014, Integrated Exposure-Response Functions

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.

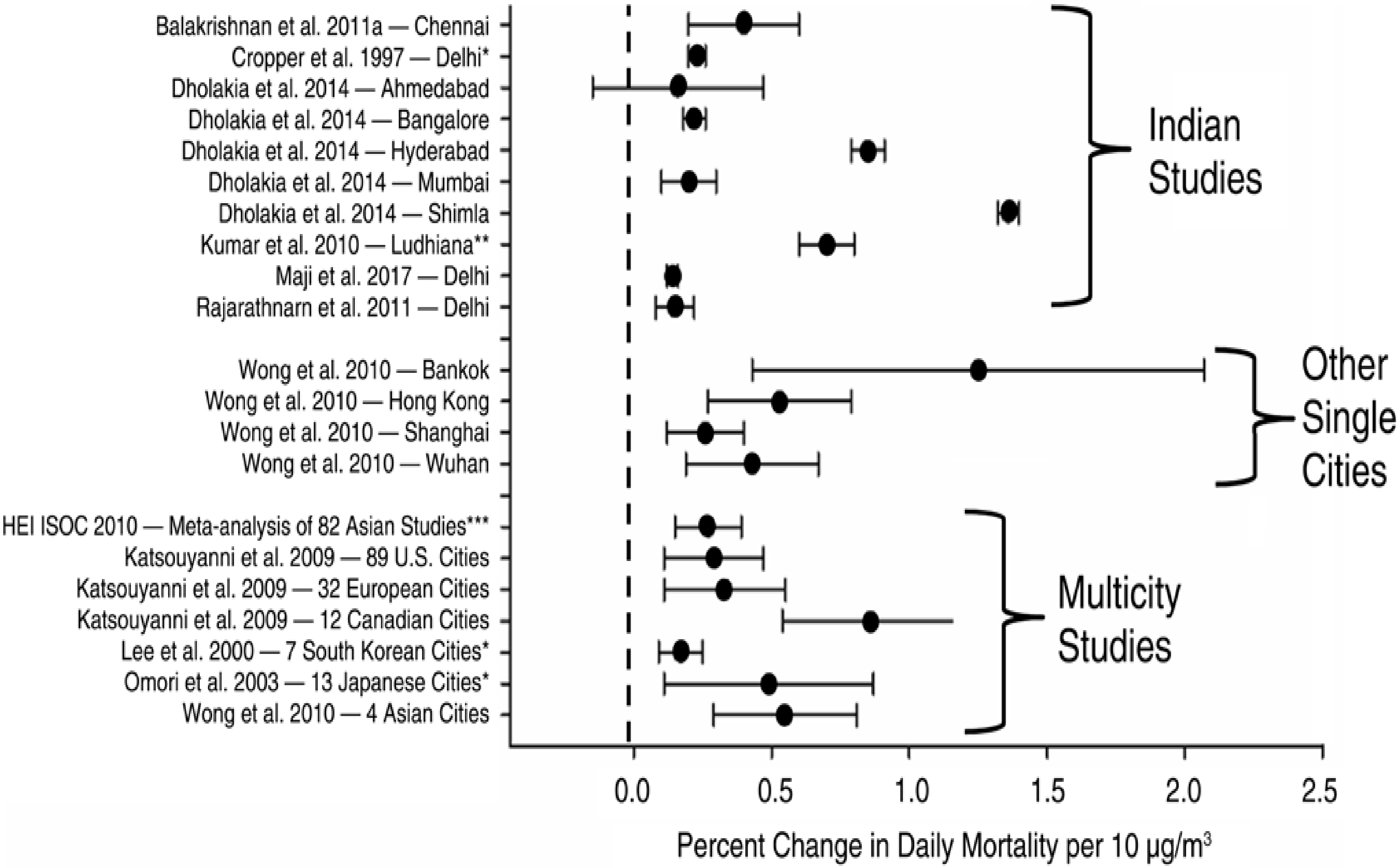
Estimating the Burden of Disease due to Air Pollution – what if exposures had not occurred in the past



First difficulty discussed here

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

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

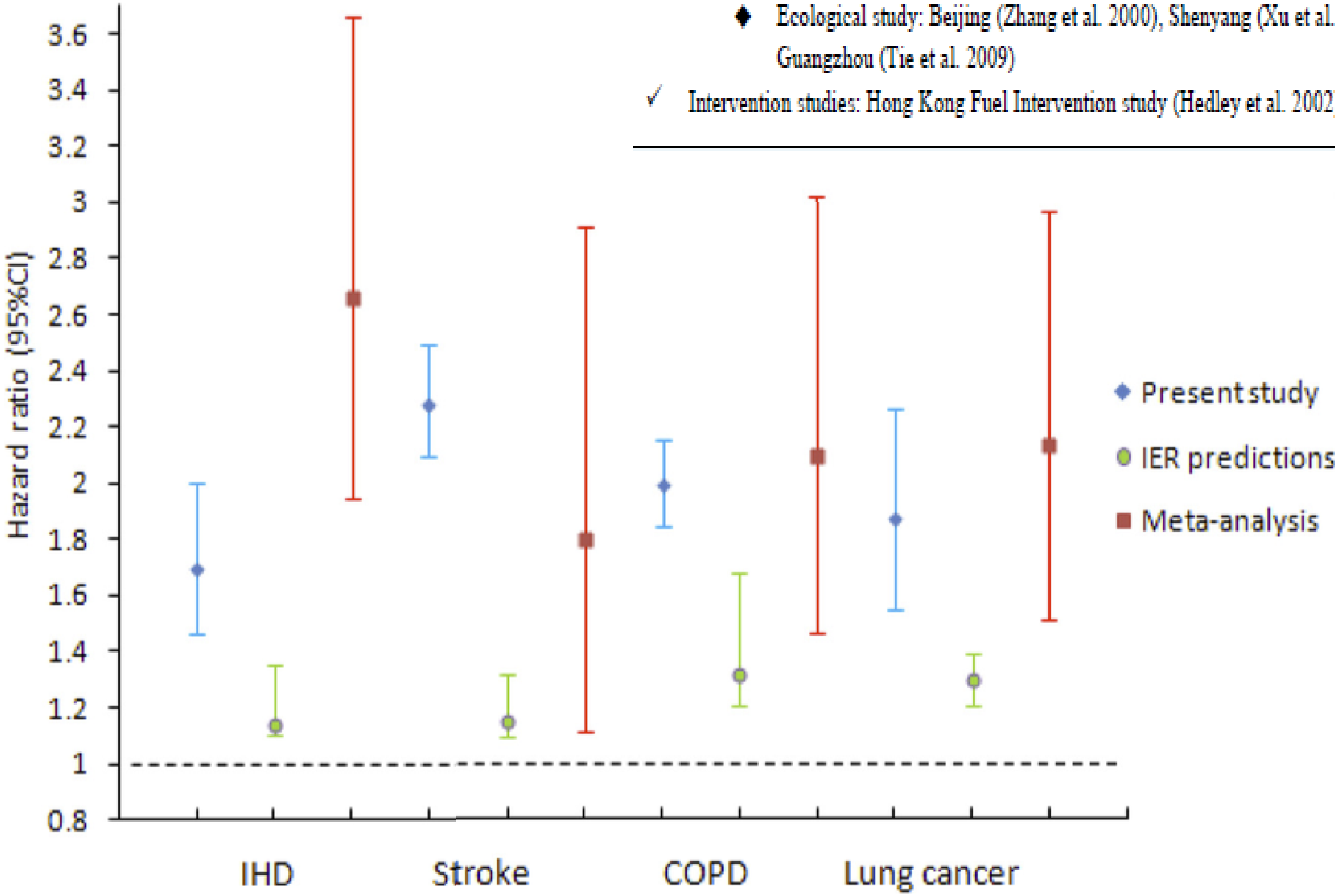


Comparability of Effects Estimates from HAP studies from the region (GBD health end-points)

Health Outcome		India studies	Reported ORs	Meta-analysis estimate	
COPD	HAP	Behera et al (1991)	3.04 (2.15-4.31)	Kurmi et al Hu et al PO et al Smith et al 2014	2.80 (1.85–4.0) 2.44(1.9-3.33) 2.4(1.47-3.93) 1.93(1.61-2.92)
		Qureshi et al (1994)	2.10 (1.50 to 2.94)		
		Dutt et al (1996)	2.8(0.61-12.85)		
		Malik et al(1985)	2.95(1.6-5.44)		
		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) Smith et al(2014)	1.78 (1.45–2.18)
		Mishra et al (2004)	2.2(1.16-4.18)		
		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) Bruce (2015)	2.15(1.61-2.89) 1.17 (1.01 to 1.37)

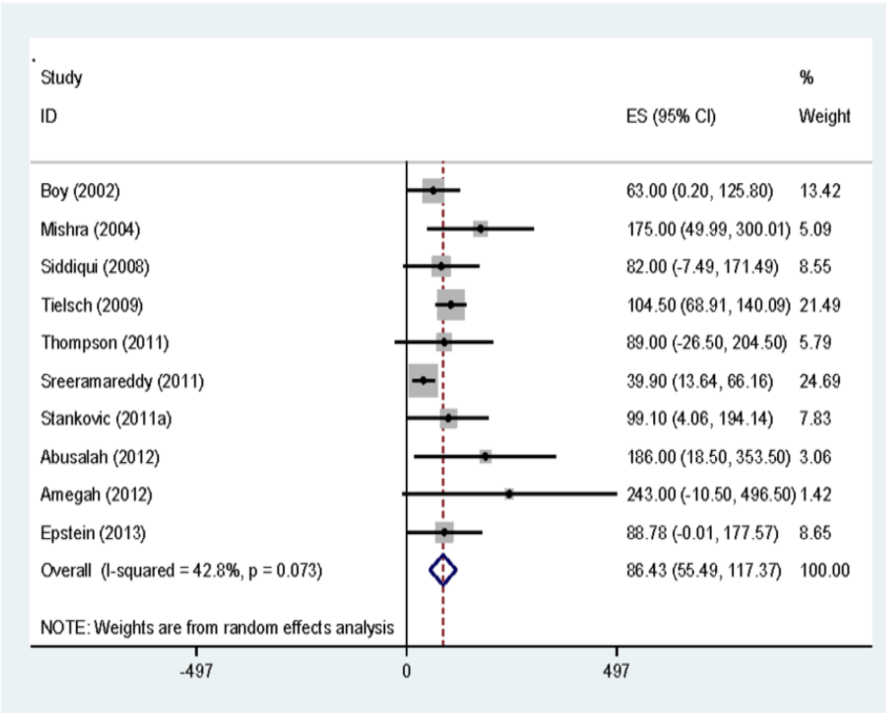
Comparability of Effects Estimates from Ambient studies from the region

- Long-term exposure studies:
  - Cohort study: China National Hypertension Survey and its follow-up study (Cao et al. 2011), Chinese Men Cohort (Zhou et al. 2014), Four Northern Chinese Cities Cohort (Zhang et al. 2014), Shenyang Cohort (Dong et al. 2012; Zhang et al. 2011)
  - Ecological study: Beijing (Zhang et al. 2000), Shenyang (Xu et al. 1996), Guangzhou (Tie et al. 2009)
- ✓ Intervention studies: Hong Kong Fuel Intervention study (Hedley et al. 2002)

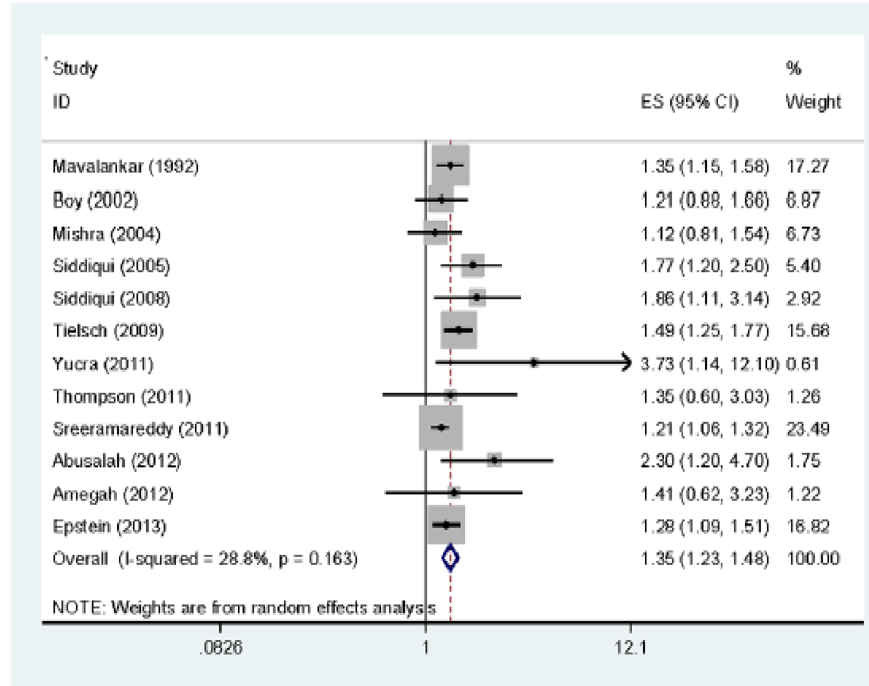


HAP Studies on health end points not currently included in GBD assessments : Birthweight/Low Birthweight

A



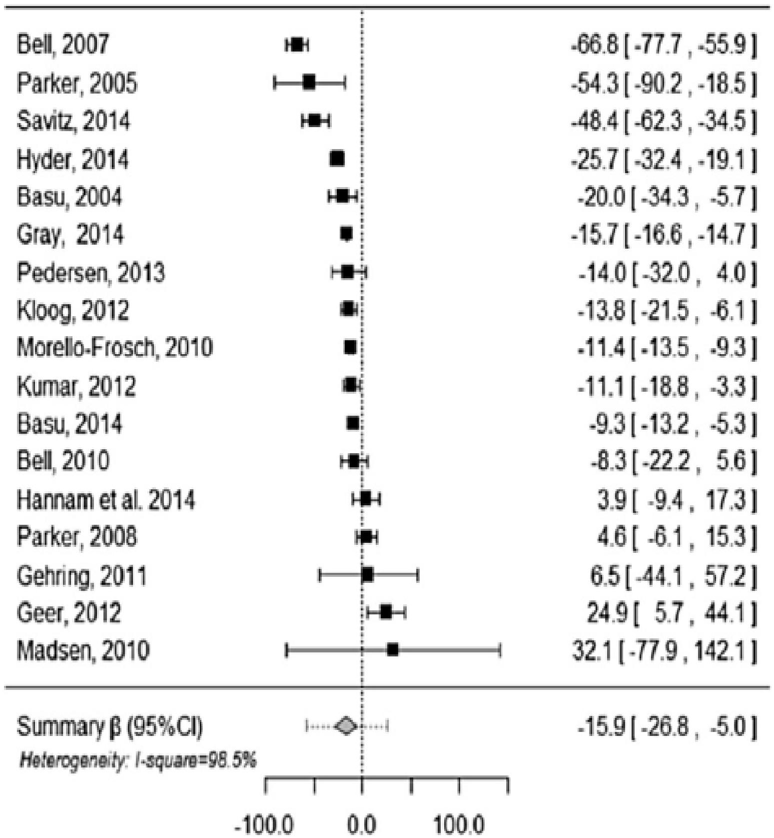
B

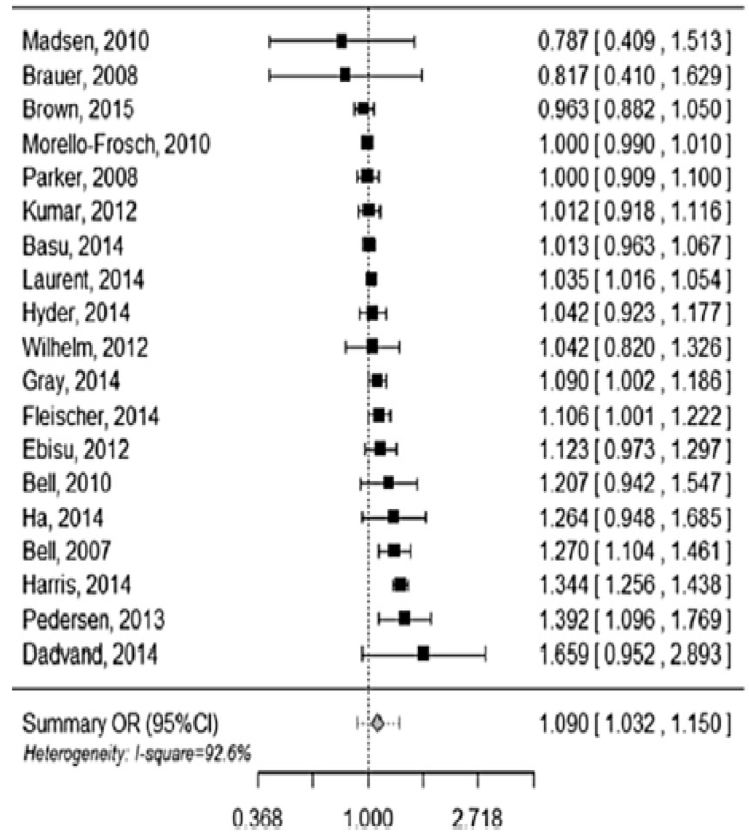


Exposure to HAP associated with 86 g (95%CI: 55.0, 117) reduction in birthweight and a 35% increased odds of low birthweight (OR: 1.35, 95%CI: 1.15, 1.5) *(Amegah et al 2014)*

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



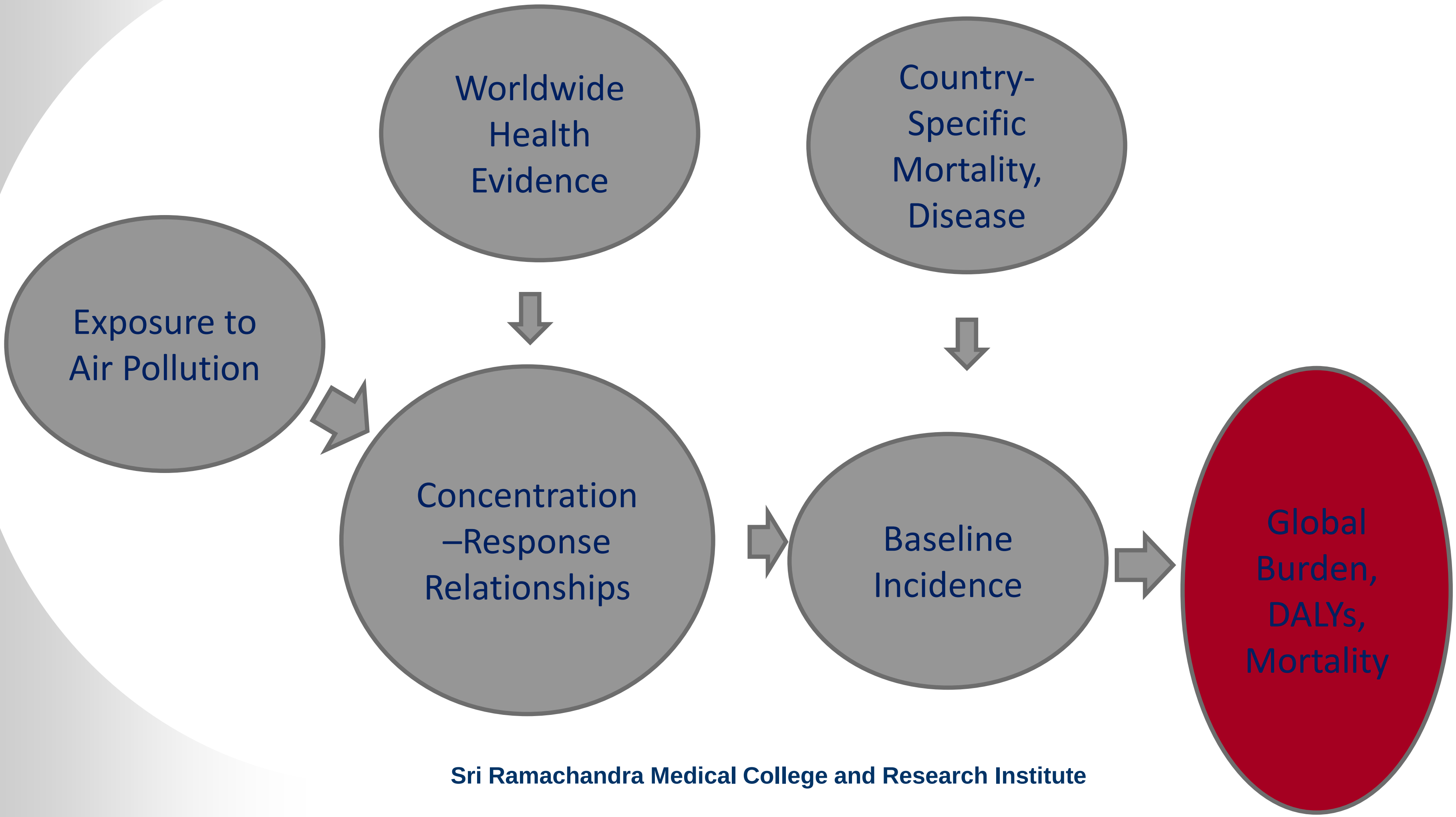


Exposure to AAP associated with 15.9 g (95%CI: 5.0, 26.8) reduction in birthweight and a 9% increased odds of low birthweight (OR: 1.09, 95%CI: 1.03, 1.15) (Sun et al 2015)

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-µg/m3 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

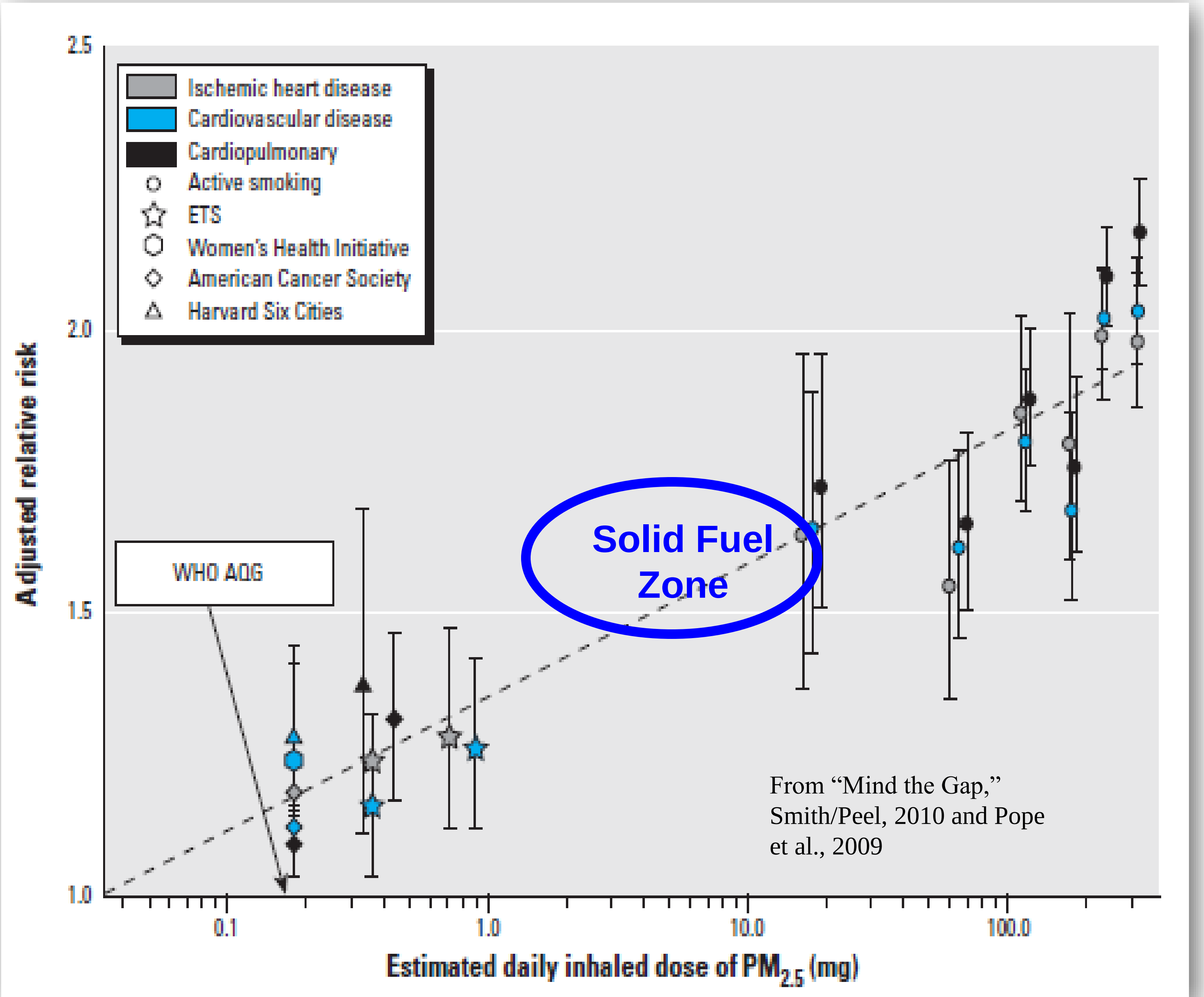


Table 2. Adjusted relative risk estimates[a] for various increments of exposure from cigarette smoking (versus never smokers), second hand cigarette smoke, and ambient air pollution from the present analysis and selected comparison studies.

Source of risk estimate	Increments of Exposure	Adjusted RR (95% CI) Lung Cancer	IHD	CVD	CPD	Estimated Daily Dose $PM_{2.5}$ (mg)[b]
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 $\mu g/m^3$ ambient $PM_{2.5}$	-----	-----	-----	1.31(1.17-1.46)	0.44
ACS-air pol. extend.	10 $\mu g/m^3$ 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 $\mu g/m^3$ ambient $PM_{2.5}$	-----	-----	-----	1.37(1.11-1.68)	0.33
HSC-air pol. extend.	10 $\mu g/m^3$ ambient $PM_{2.5}$	1.21(0.92-1.69)	-----	1.28(1.13-1.44)	-----	0.18
WHI-air pol.	10 $\mu g/m^3$ 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

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,[1,2] Kirk R. Smith,[2] Peter Stone,[3] Anaité Díaz,[4] Byron Arana,[4] and Joel Schwartz[1]

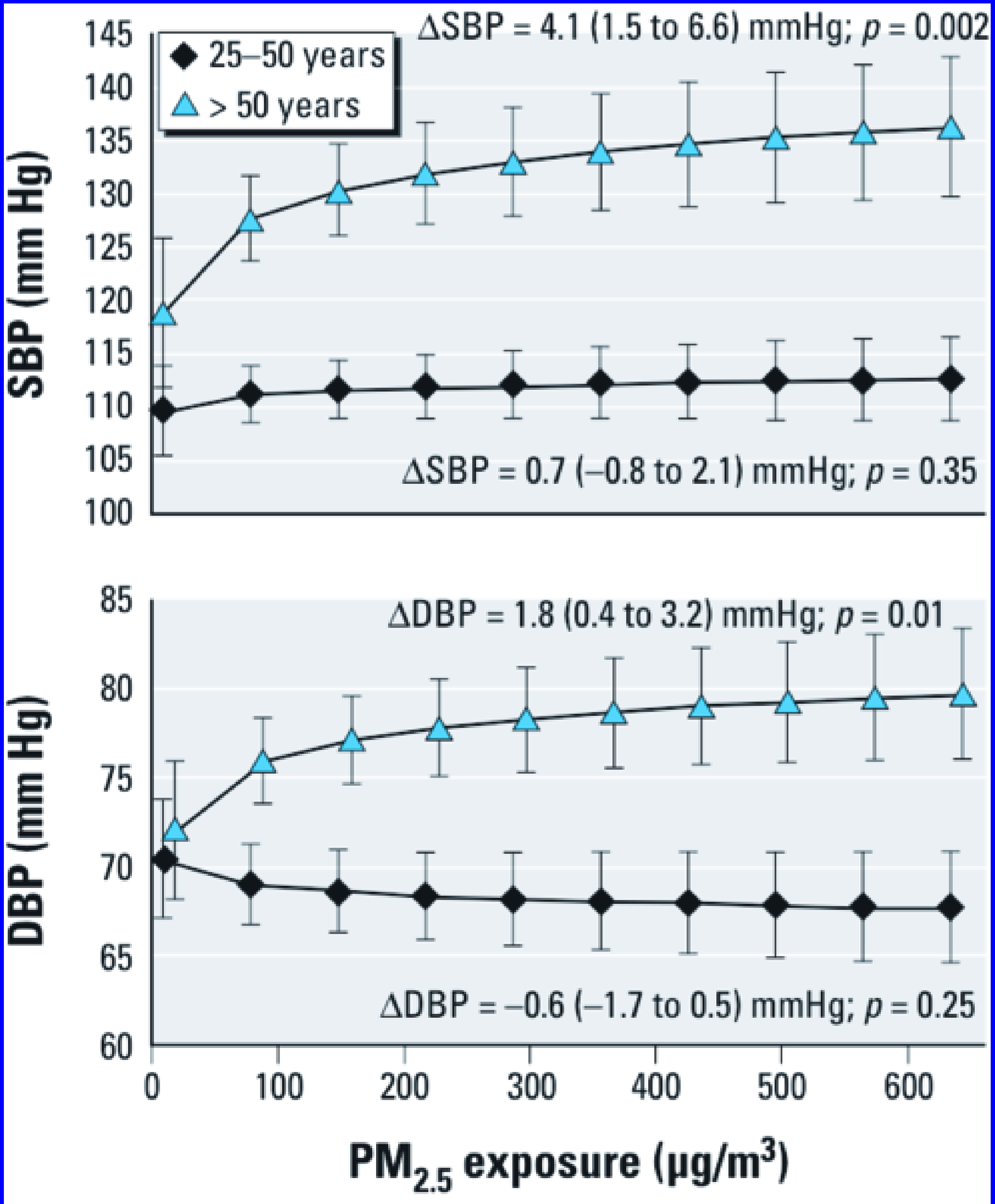
[1]Department of Environmental Health, Harvard School of Public Health, Boston, Massachusetts, USA; [2]Environmental Sciences Division, University of California, Berkeley, California, USA; [3]Brigham and Women's Hospital, Boston, Massachusetts, USA; [4]Center for Health Studies, Universidad del Valle,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

EHP Nov, 2011

Table 3. Odds ratios (ORs) for nonspecific ST-segment depression (30-min average ≤ –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 OR (95% CI)	Crude *p*-Value	Adjusted OR (95% CI)	Adjusted *p*-Value
Between-groups	0.34 (0.15, 0.81)	0.015	0.26 (0.08, 0.90)[a]	0.033
Before-and-after (only control group)	0.41 (0.24, 0.70)	0.001	0.28 (0.12, 0.63)[b]	0.002

[a]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). [b]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

JAMA | Original Investigation

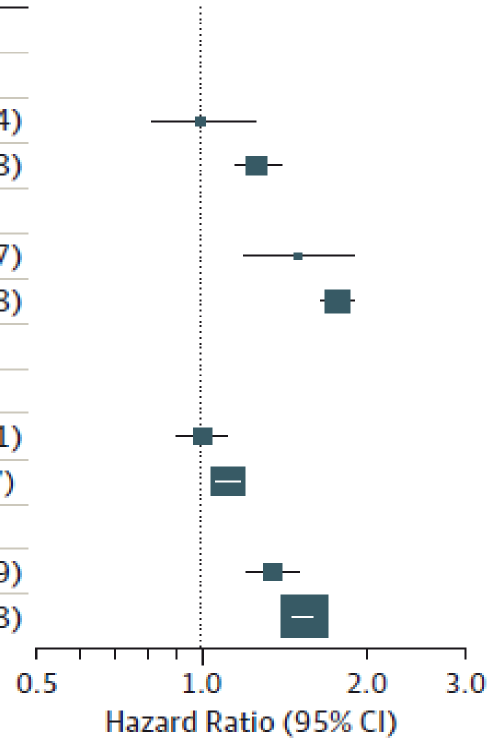
Association of Solid Fuel Use With Risk of Cardiovascular and All-Cause Mortality in Rural China

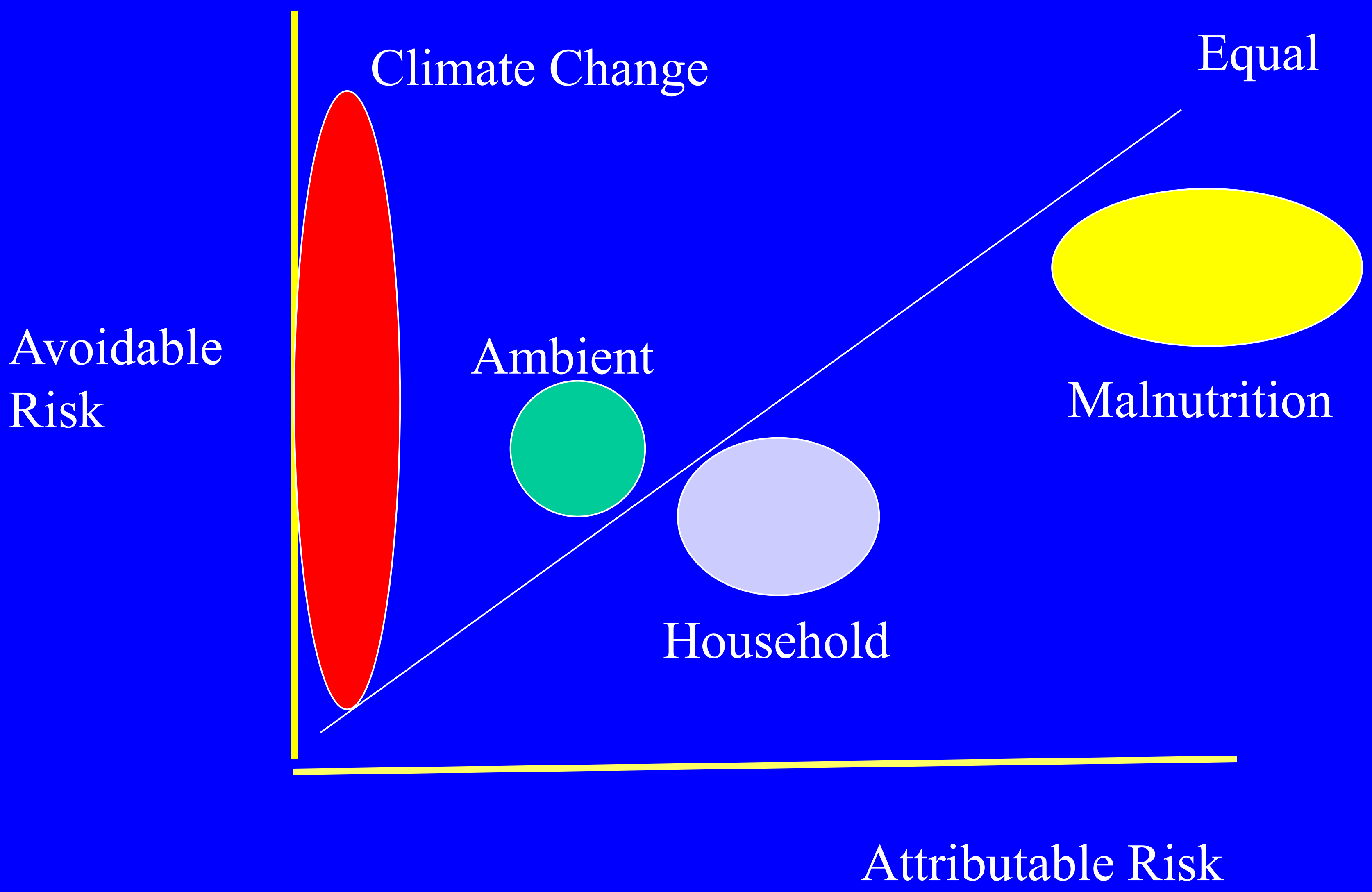
Kuai Yu, MD; Gaokun Qiu, MD, PhD; Ka-Hung Chan, MSc; Kin-Bong Hubert Lam, PhD; Om P. Kurmi, PhD; Derrick A. Bennett, PhD; Canqing Yu, MD, PhD; An Pan, PhD; Jun Lv, MD, PhD; Yu Guo, MSc; Zheng Bian, MSc; Ling Yang, PhD; Yiping Chen, DPhil; Frank B. Hu, MD, PhD; Zhengming Chen, DPhil; Liming Li, MD, MPH;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

April 3, 2018

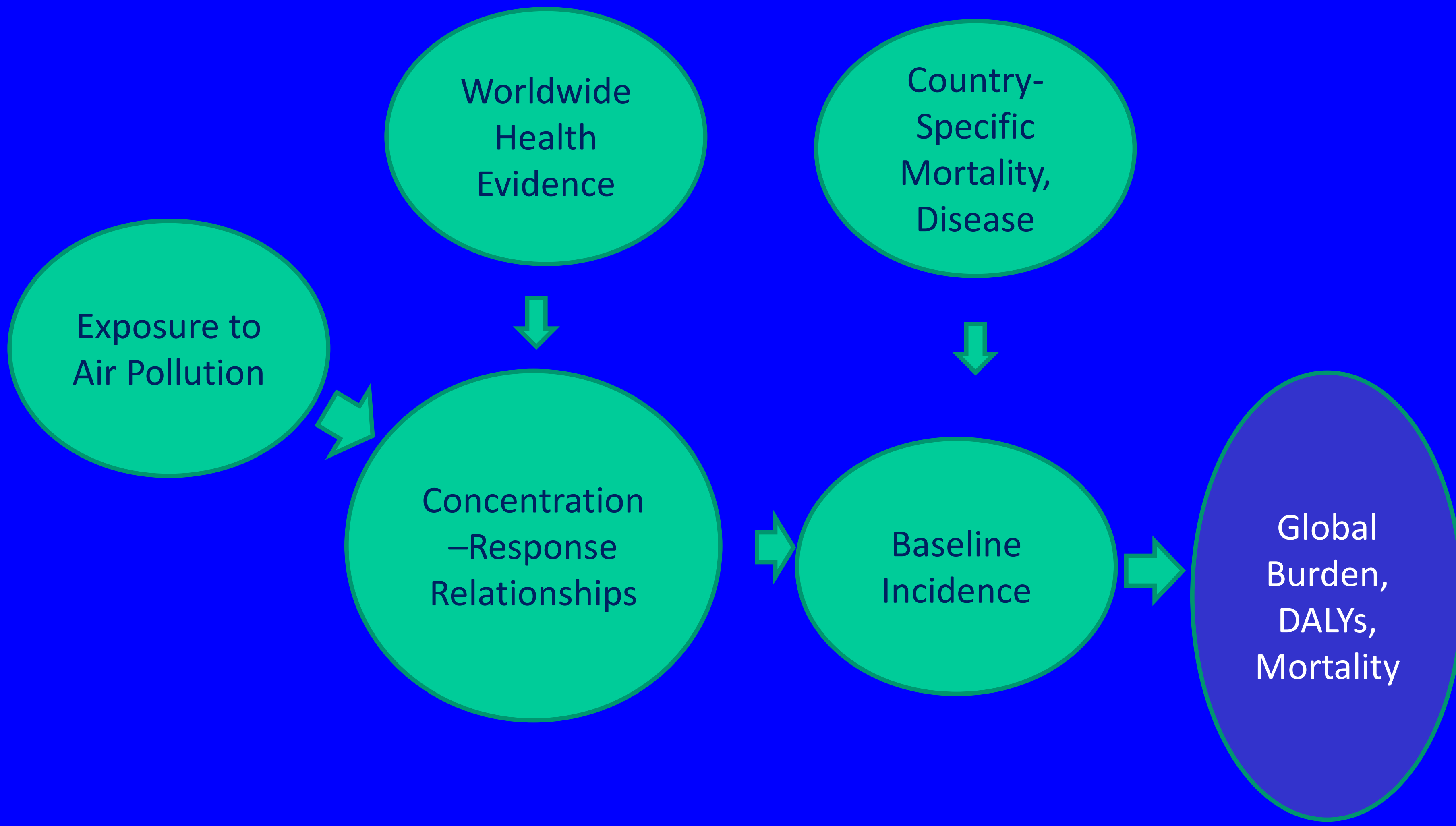
A Cooking fuel

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)
Cardiovascular mortality				
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)
All-cause mortality				
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)




Climate Change
Equal
Avoidable
Risk
Ambient
Malnutrition
Household
Attributable Risk

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

Many thanks

For publications
& presentations:
Just "Google"
Kirk R. Smith