Air pollution and global health

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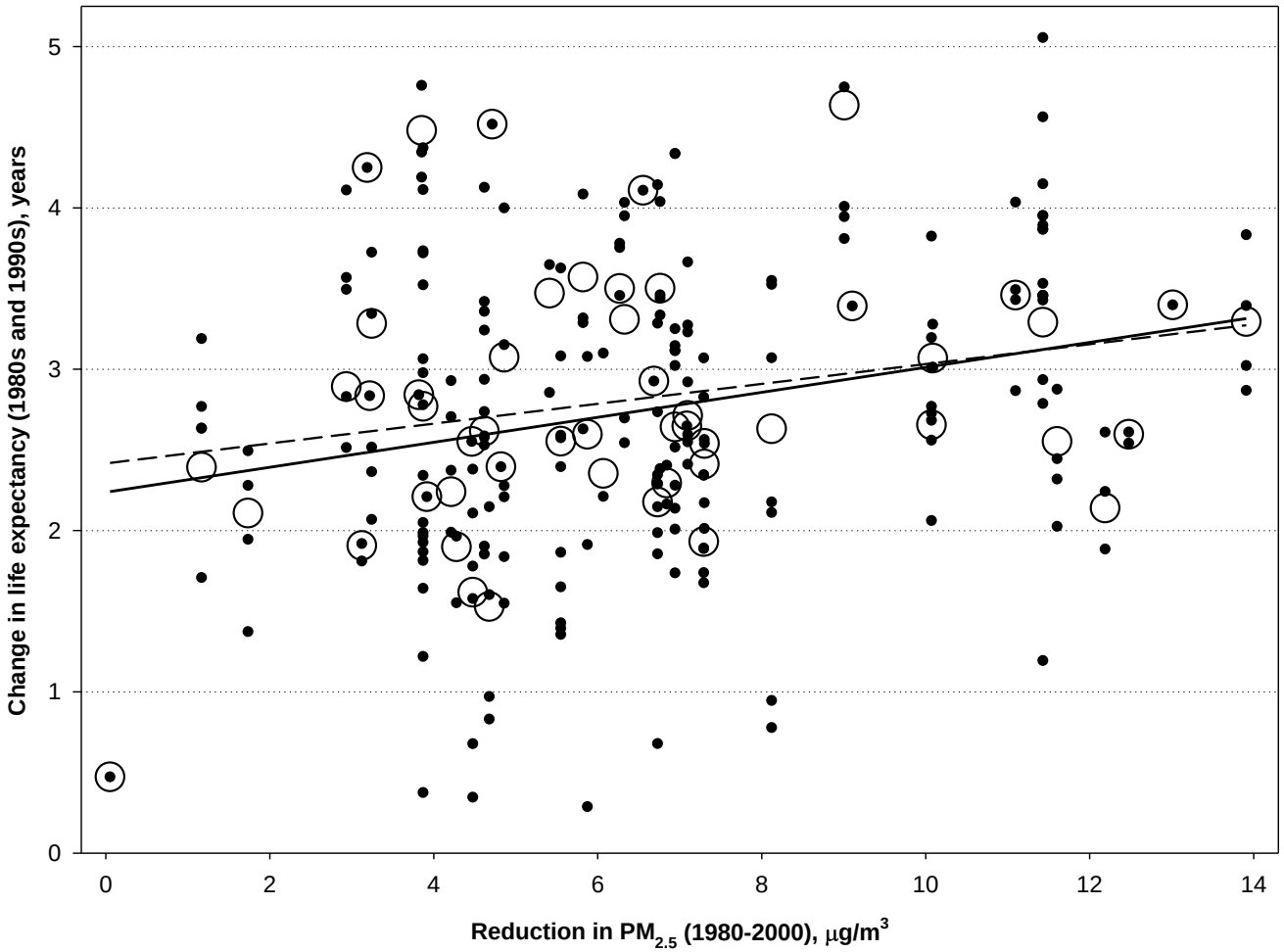
Session outline

- Air pollution as a global health risk factor
- Household energy, indoor air pollution and child pneumonia
- Air pollution concentrations and sources in Accra neighborhoods
- Integrated management of lung disease in China

Major air pollution sources in industrialized cities

Los Angles: then (1953) and now

Crude association of change in $PM_{2.5}$ and change in county/metro life expectancy



Pope et al *NEJM* 2009

Biomass and coal as sources of air pollution

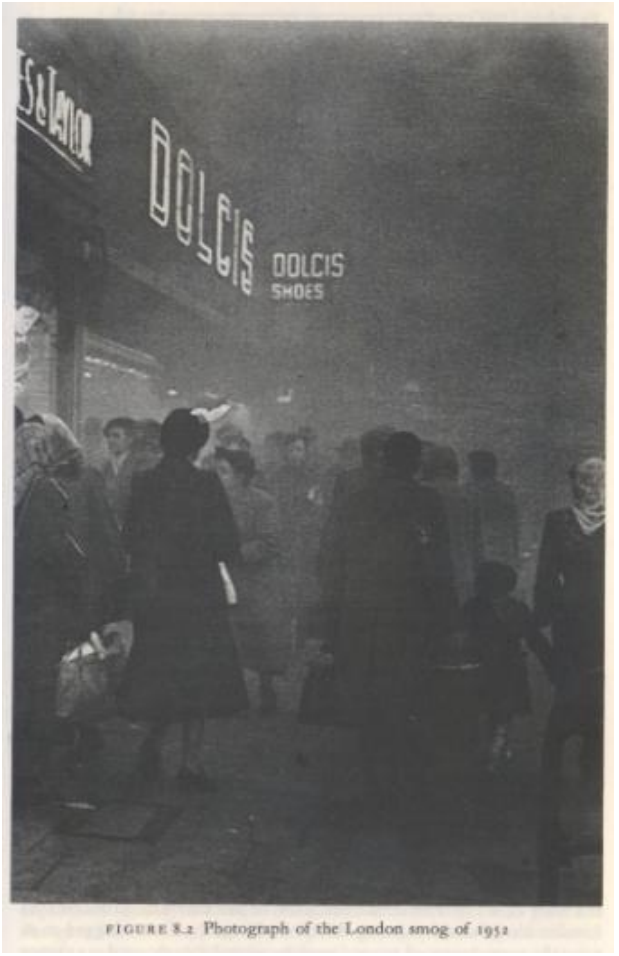
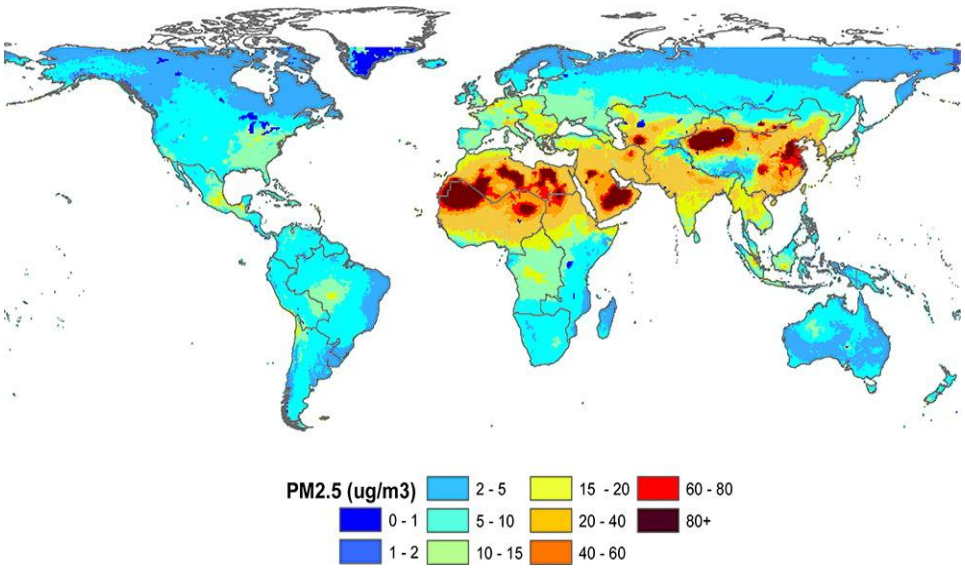


FIGURE 8.2 Photograph of the London smog of 1952

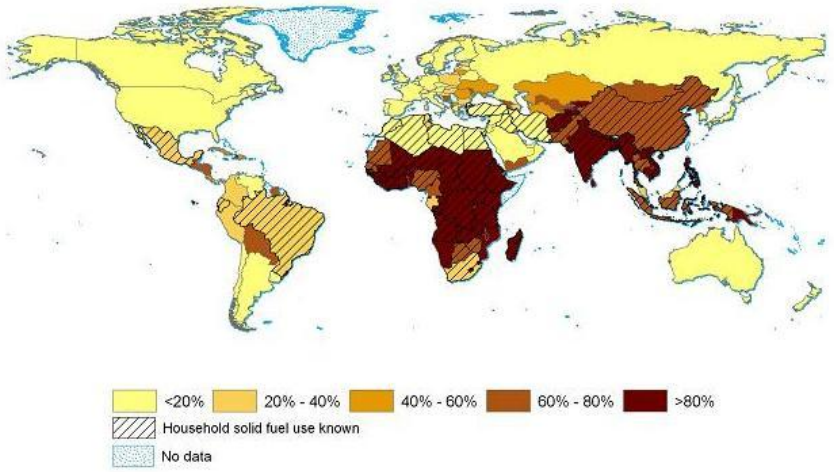
Biomass and coal and household air pollution

Global distributions of urban PM pollution and household biomass/coal use

Ambient PM pollution (2005)



Household biomass/coal use (2000)

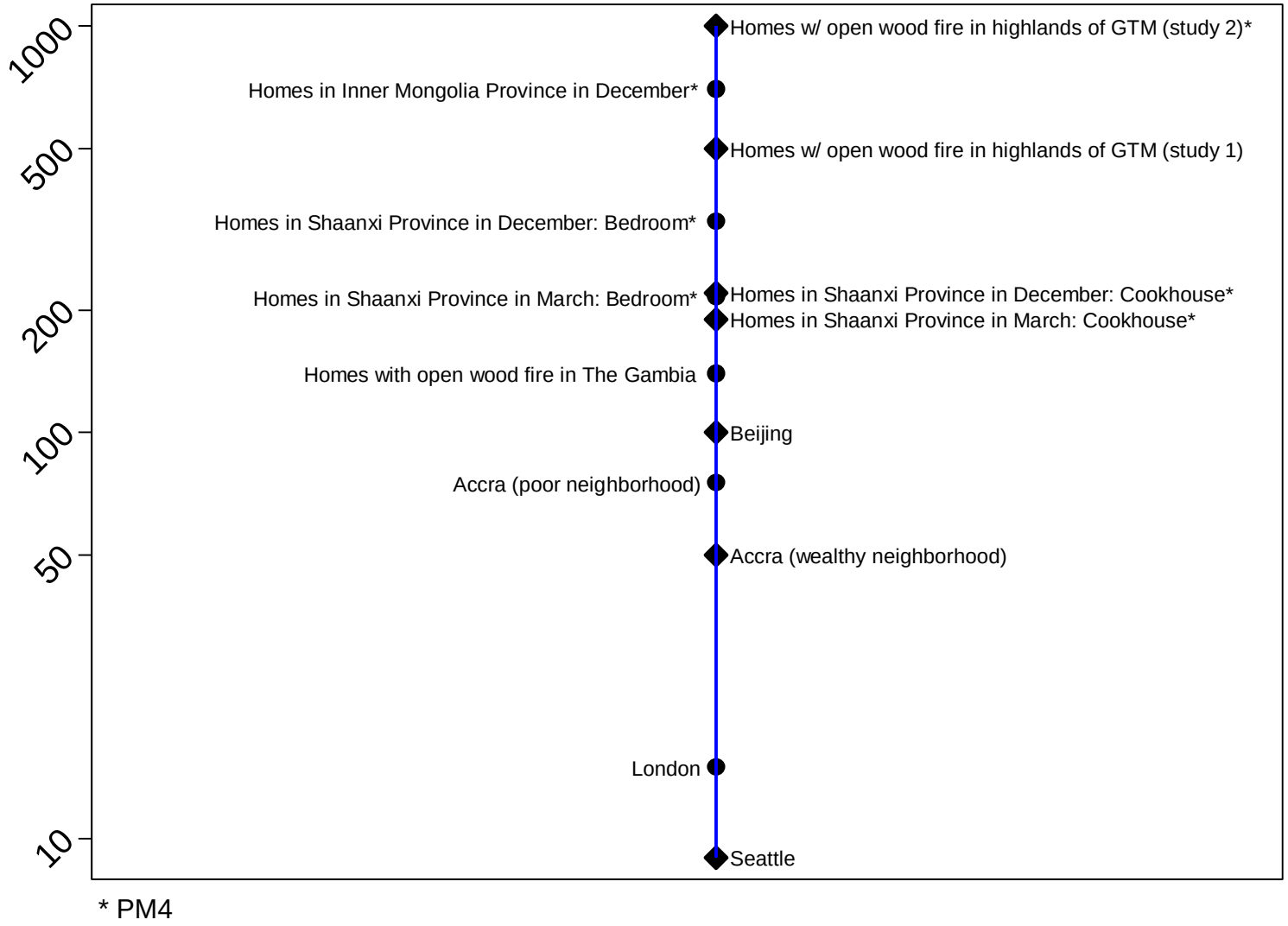


Brauer et al *Environmental Science and Technology* 2012 and Smith et al in *Comparative Quantification of Health Risks* 2004

Health effects of air pollution

- Mixture of hundreds of solid and gaseous pollutants including
  - Particulate matter (PM)
  - Carbon monoxide (CO)
  - Particle-bound or gaseous organic and inorganic compounds
- Health outcomes affected by air pollution
  - Strong or convincing evidence: pneumonia in children under five years of age, cardiovascular outcomes, COPD, lung cancer, cataracts (for biomass smoke)
  - Limited evidence: prematurity and/or IUGR, TB, (and cognition and other developmental outcomes)
- PM has been consistently, independently, and coherently related to diseases affected by air pollution

Comparison of PM levels in different environments



* PM4

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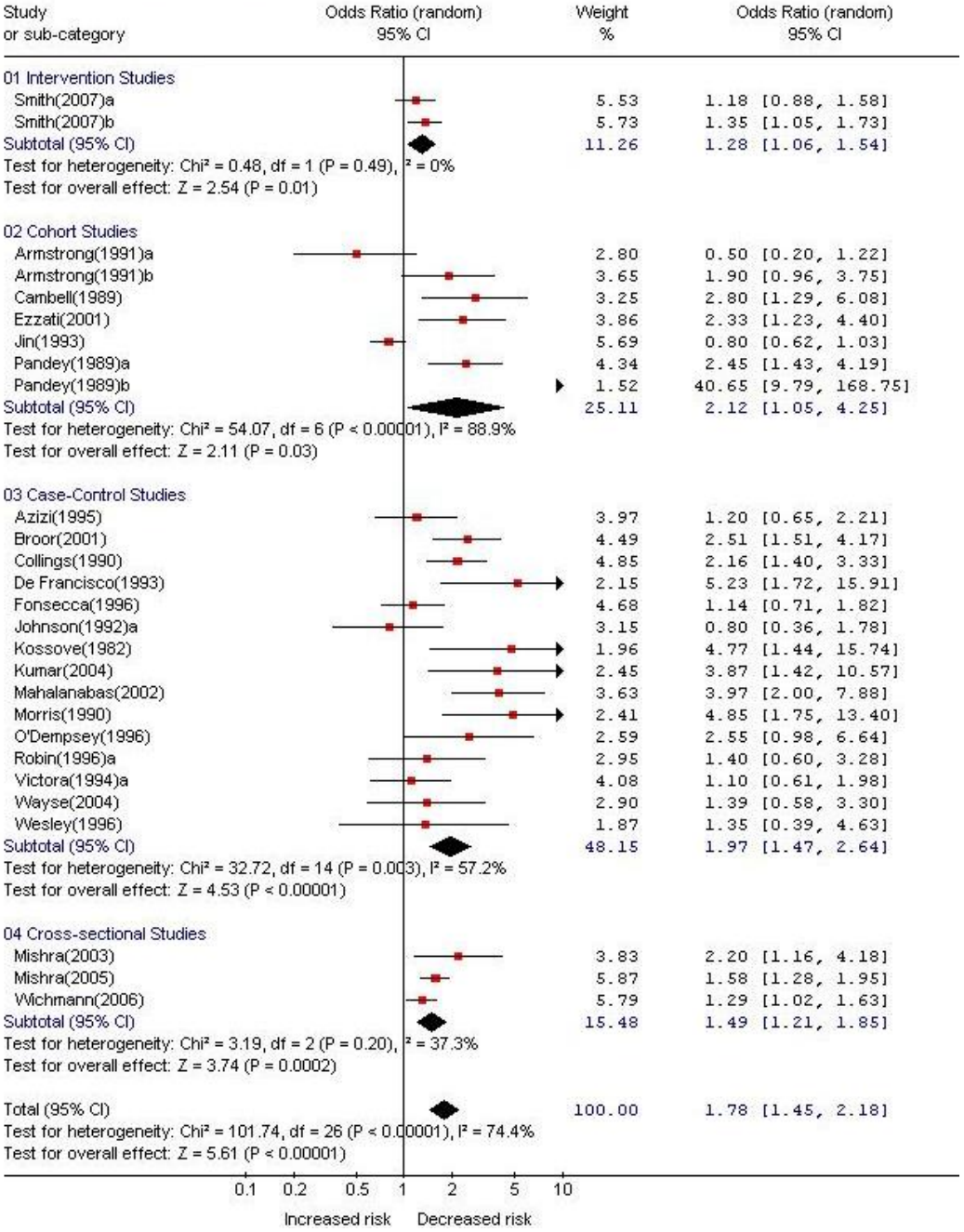
Biomass/coal smoke and pneumonia meta-analysis

- All but one study used a categorical exposure variable, e.g. type of fuel, location of cooking, or child carried on mother's back when cooking
- Comparison groups have low but not no exposure



Dherani et al. *Bulletin of WHO* 2008

Effects of household air pollution from biomass fuels and coal on child LRI

Ezzati and Kammen *Lancet* 2001

Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study

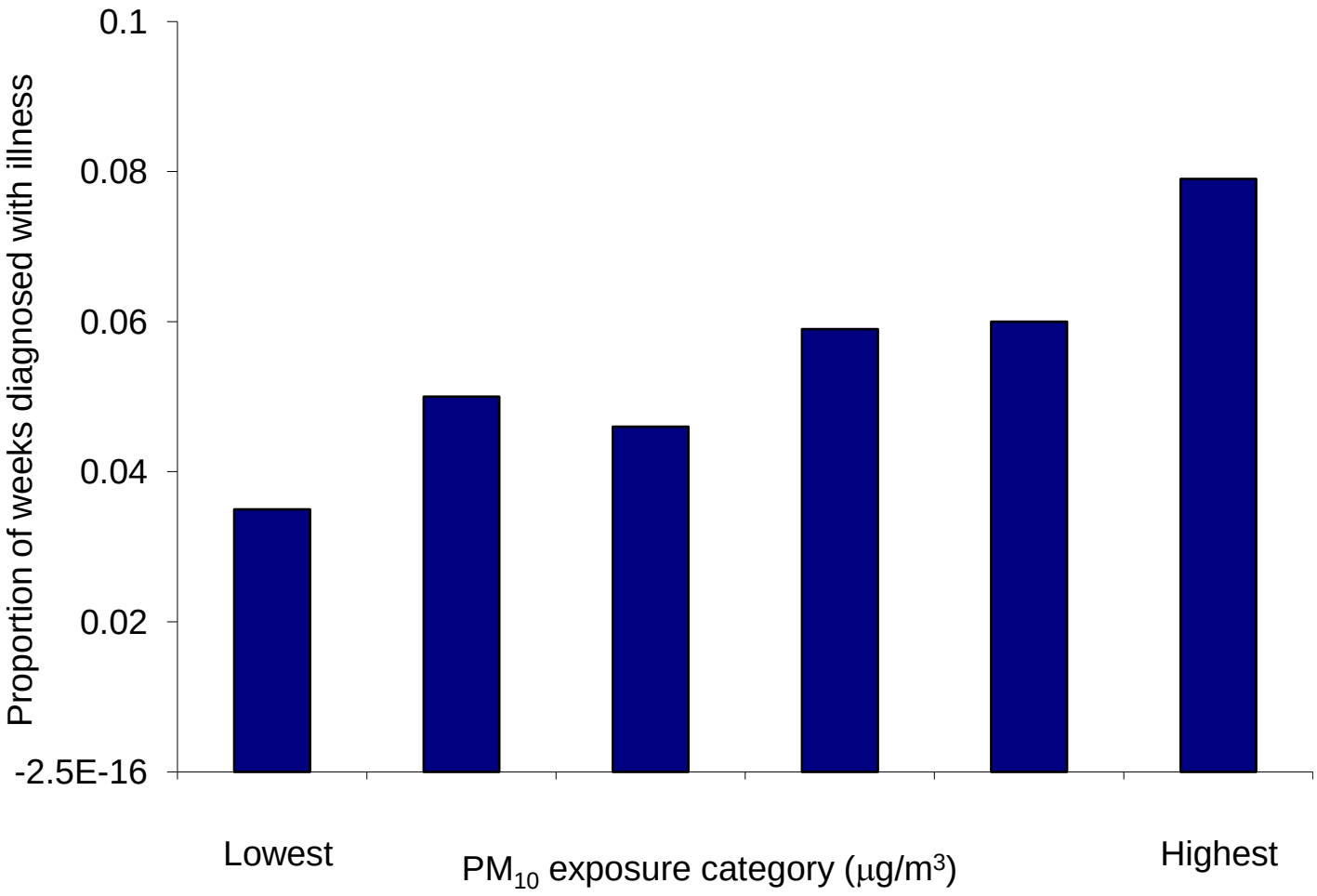
Majid Ezzati, Daniel M Kammen

Smith et al. *Lancet* 2011

Effect of reduction in household air pollution on childhood pneumonia in Guatemala (RESPIRE): a randomised controlled trial

Kirk R Smith, John P McCracken, Martin W Weber, Alan Hubbard, Alisa Jenny, Lisa M Thompson, John Balmes, Anaité Diaz, Byron Arana, Nigel Bruce

PM_{10} exposure and clinical diagnosis of pneumonia in children ≤ 5 years in Central Kenya

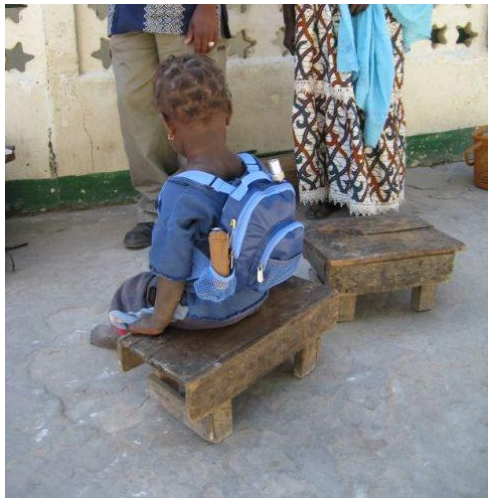


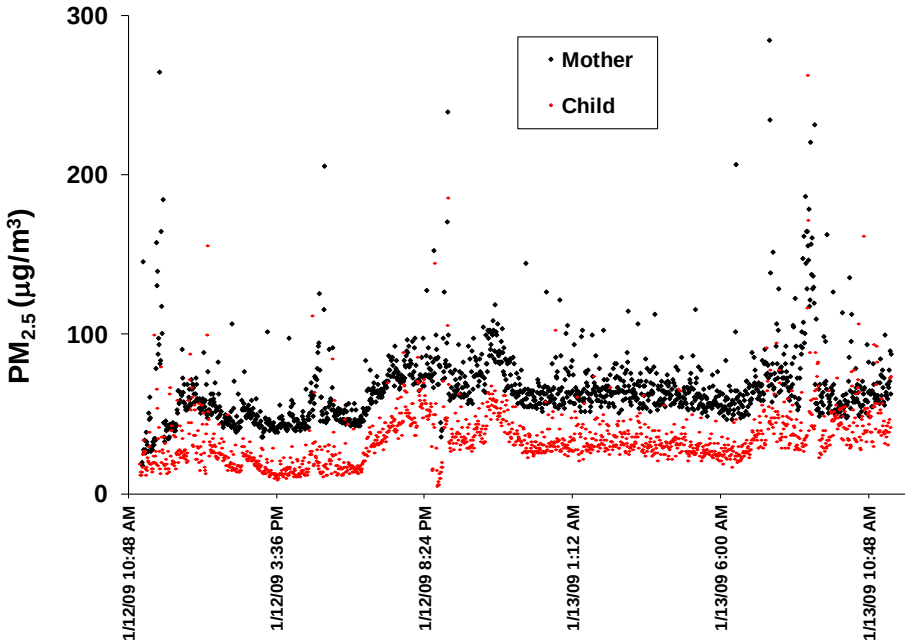
Adjusted ORs for different categories: 1.4-2.9

The exposure-response relationship seemed steeper at lower levels

Ezzati and Kammen *Lancet* 2001

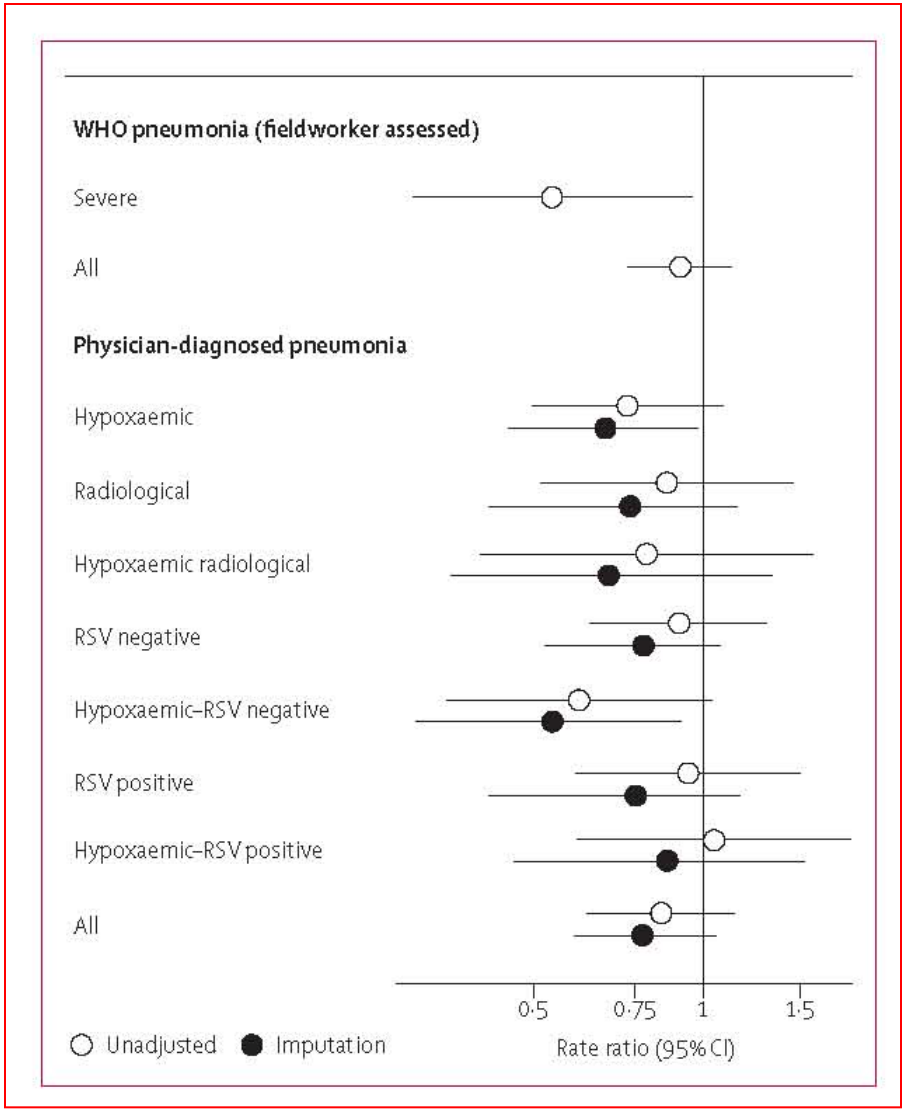
Pilot measurement of personal PM exposure in The Gambia

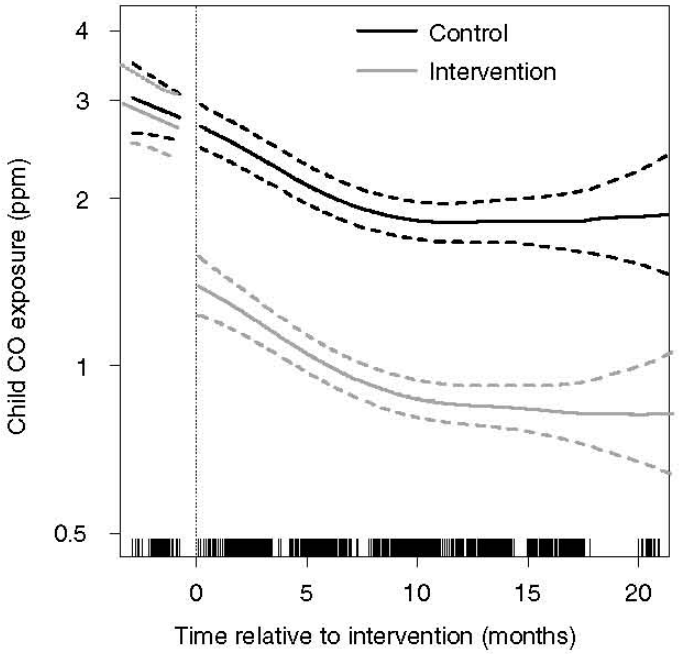




Dionisio et al *Environmental Science and Technology* 2012

The effect of stove intervention on child pneumonia in Guatemala

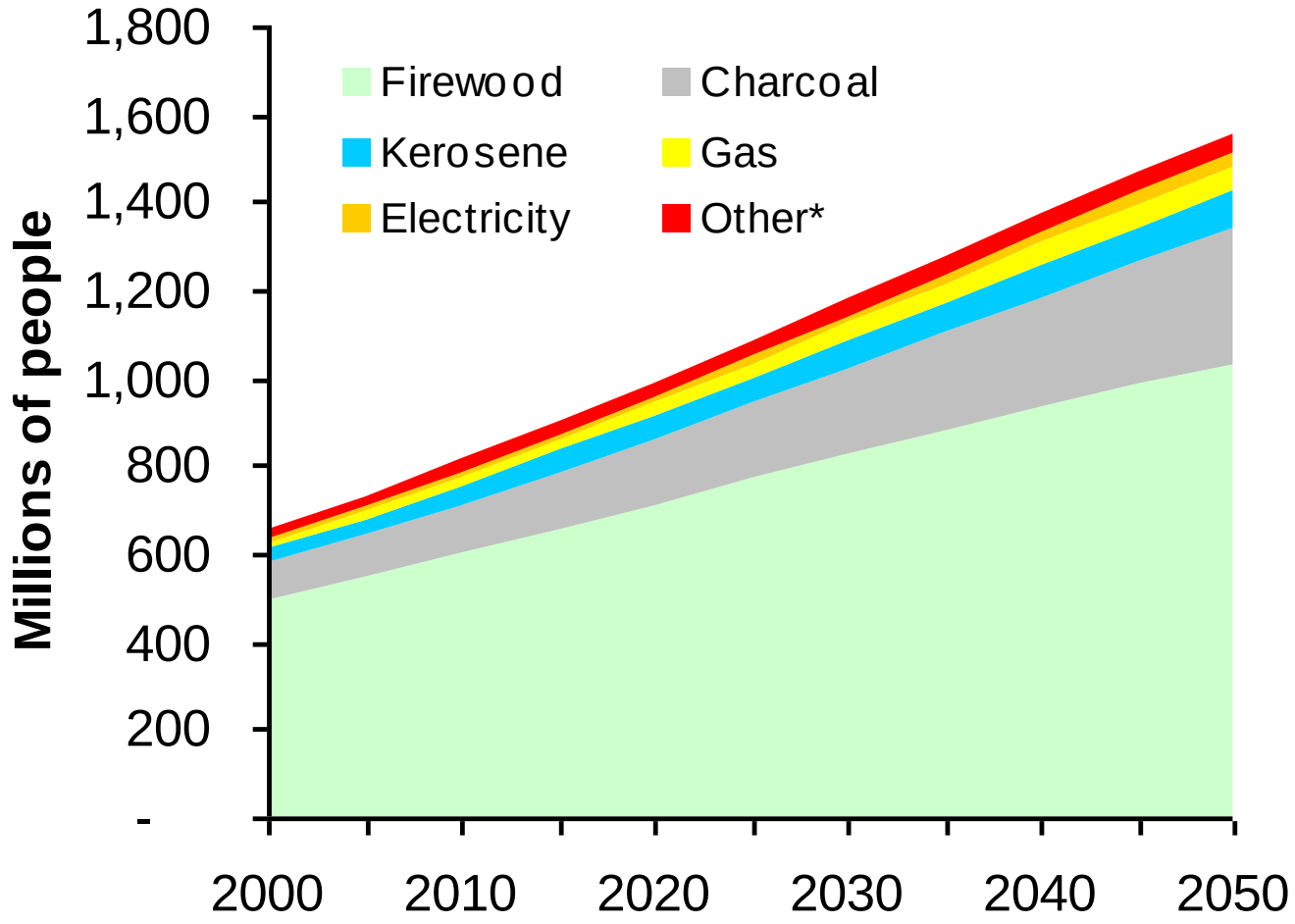




RSV: respiratory syncytial virus

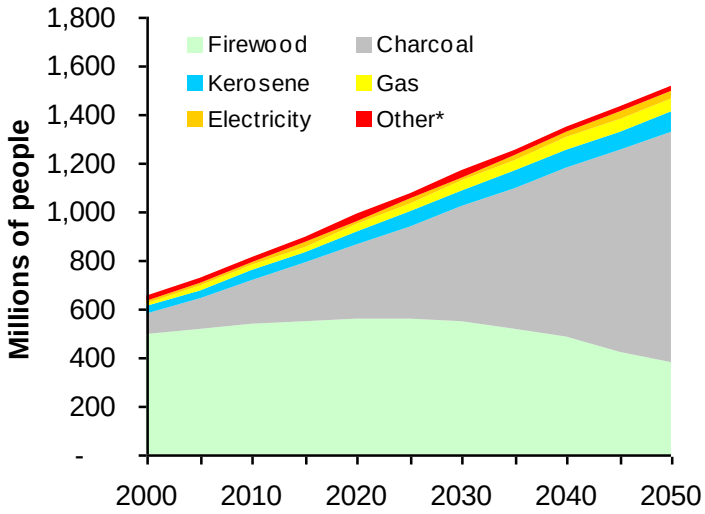
Smith et al *Lancet* 2011; Smith et al *JESEE* 2009

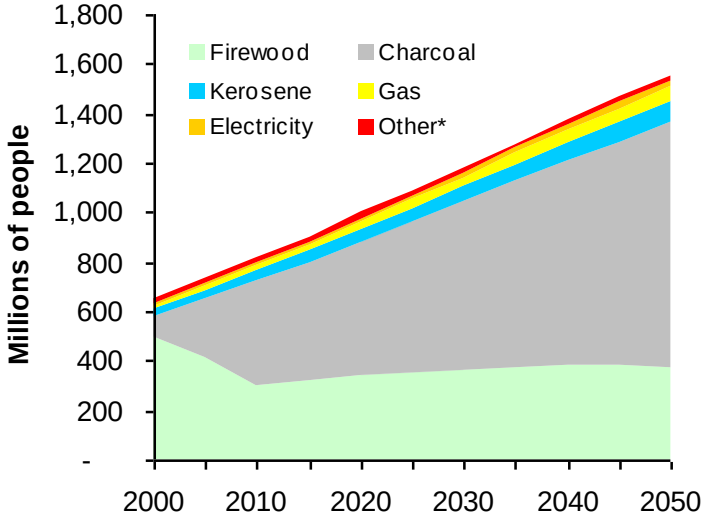
Future fuel use in Africa (business-as-usual)



Bailis et al *Science* 2005

Future fuel use in Africa (fuel transitions)

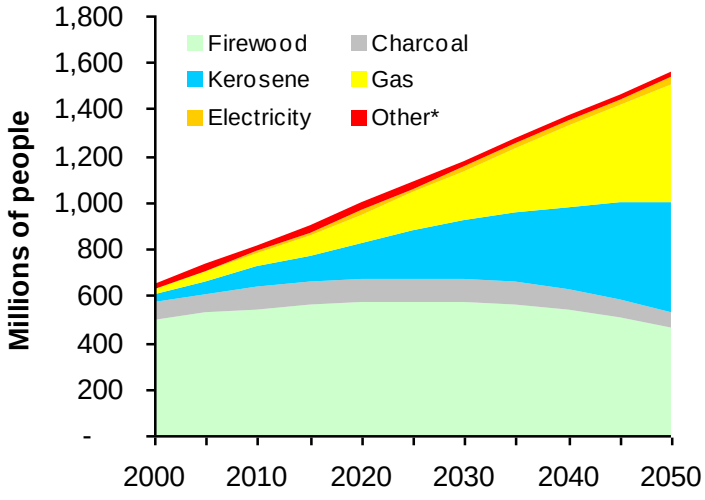


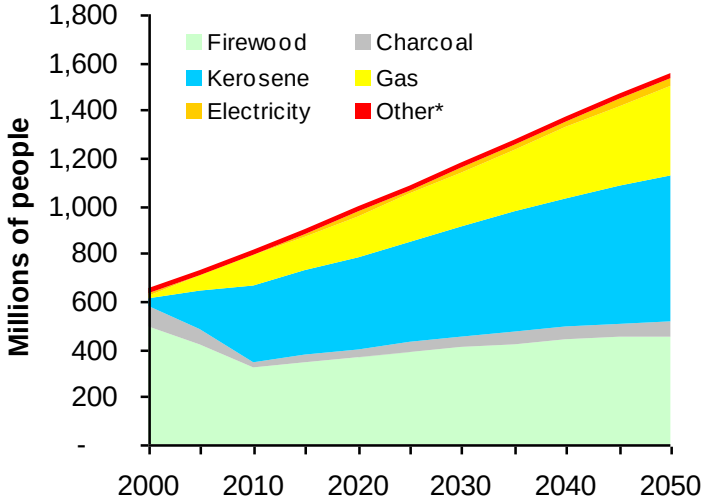


Charcoal scenarios

Gradual

More rapid

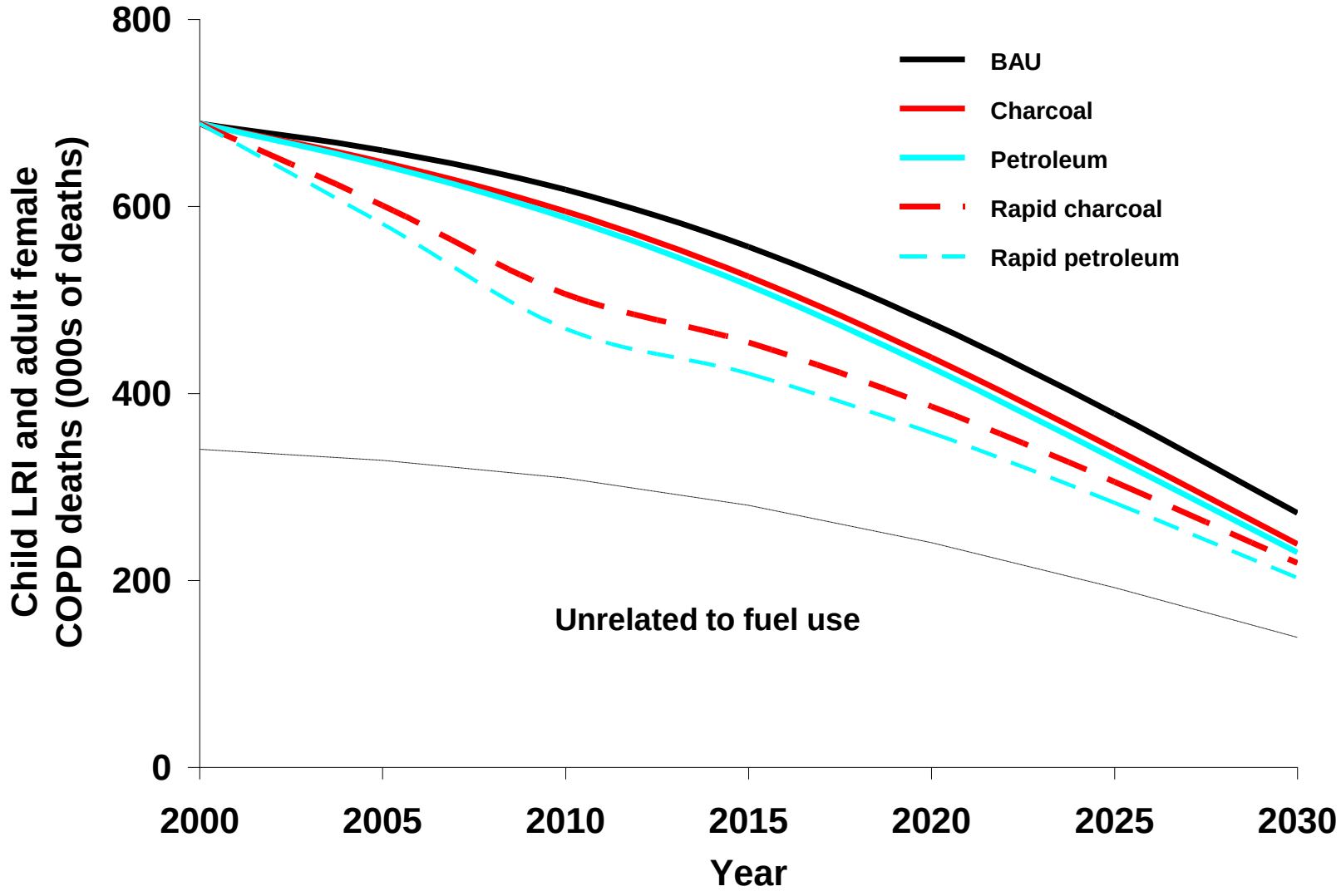




Petroleum scenarios

Bailis et al *Science* 2005

Mortality impacts of fuel use scenarios



Bailis et al *Science* 2005

Can charcoal production be sustainable?





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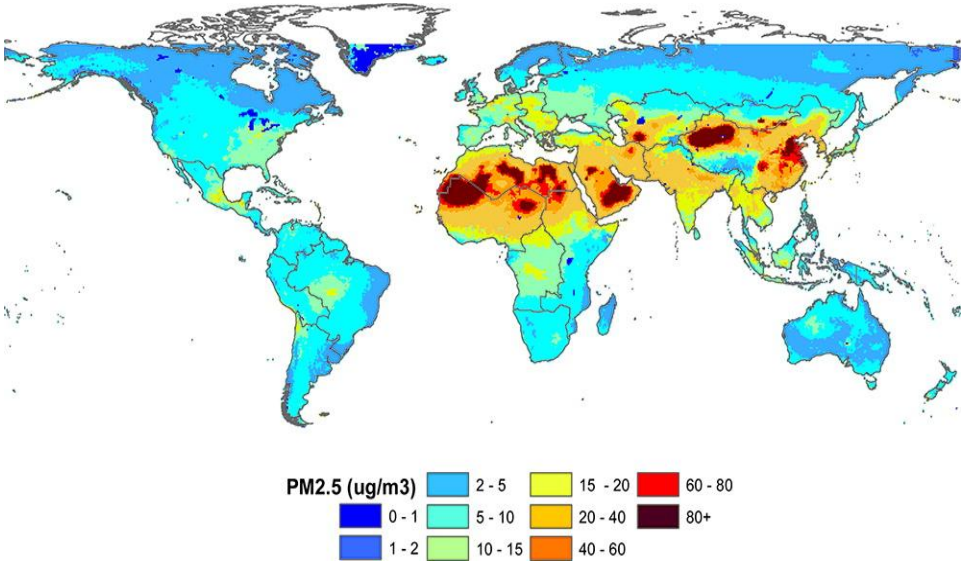
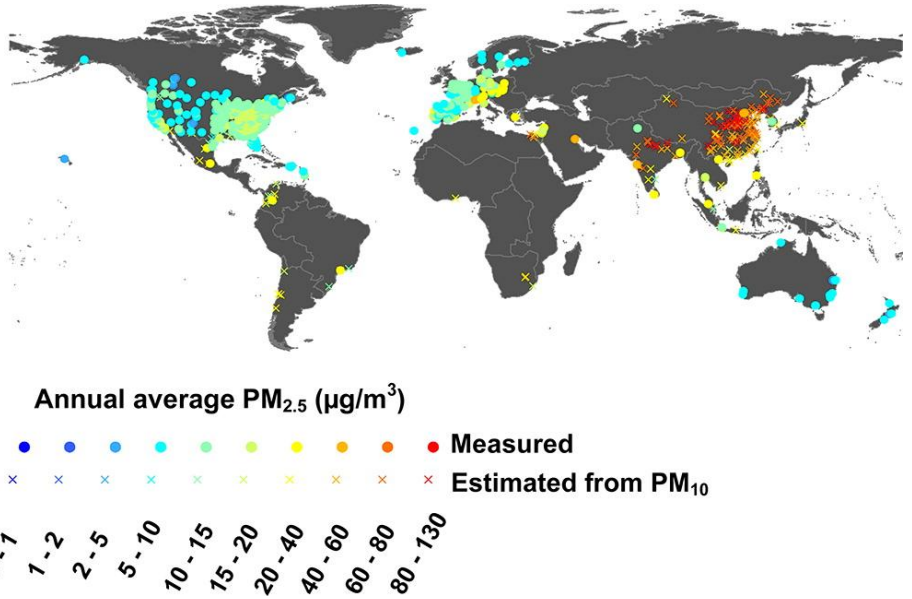
Surface PM level estimates and available PM monitoring data in 2005

Estimated PM pollution

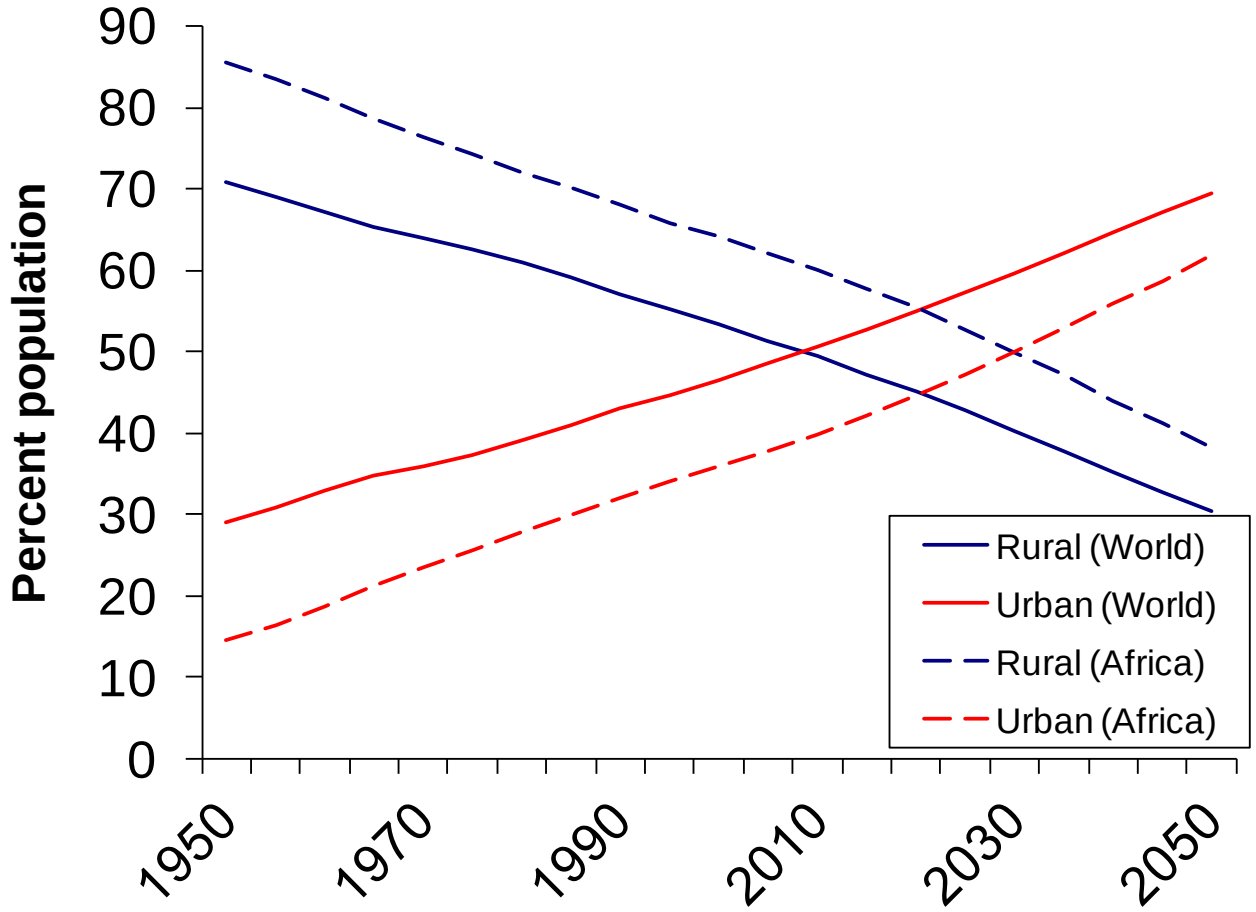


Measured PM data availability



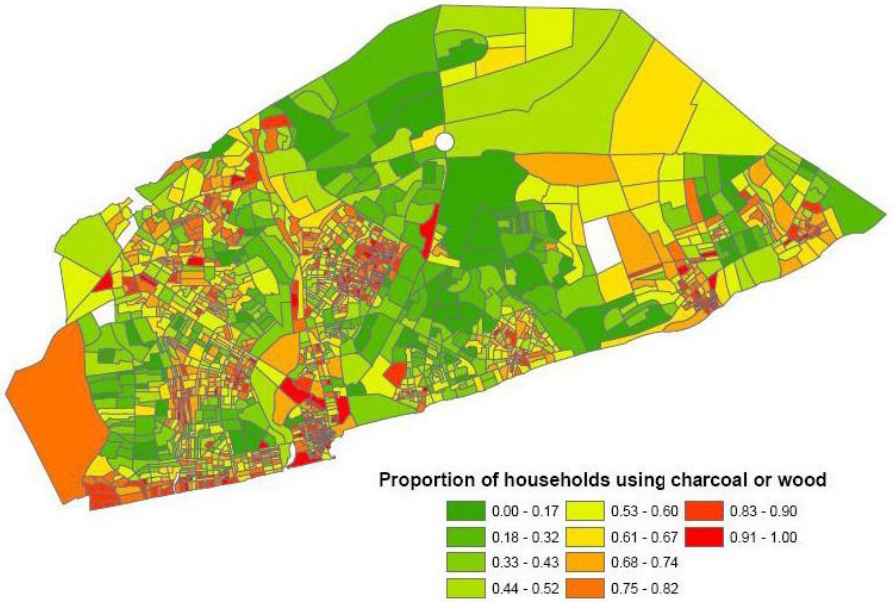
Brauer et al *Environmental Science and Technology* 2012

Urbanization in sub-Saharan Africa



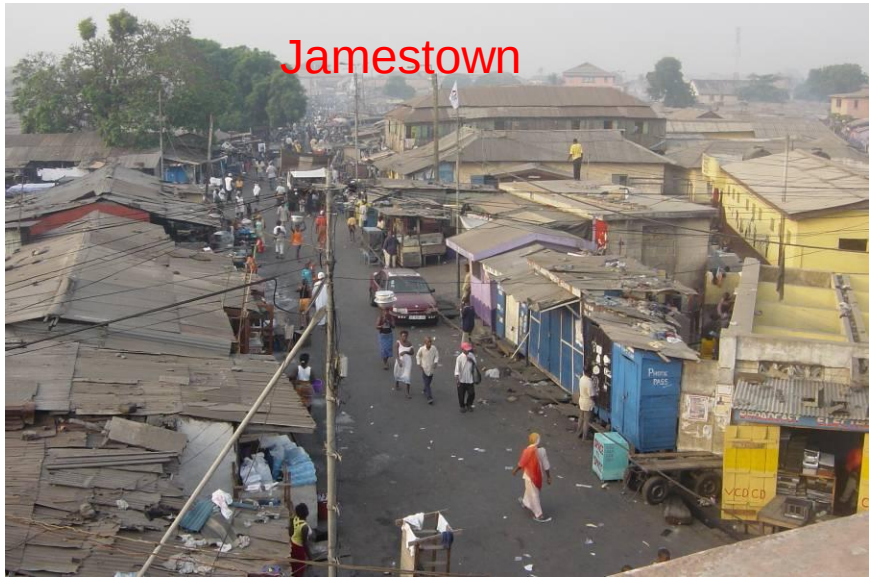
UN Population Division

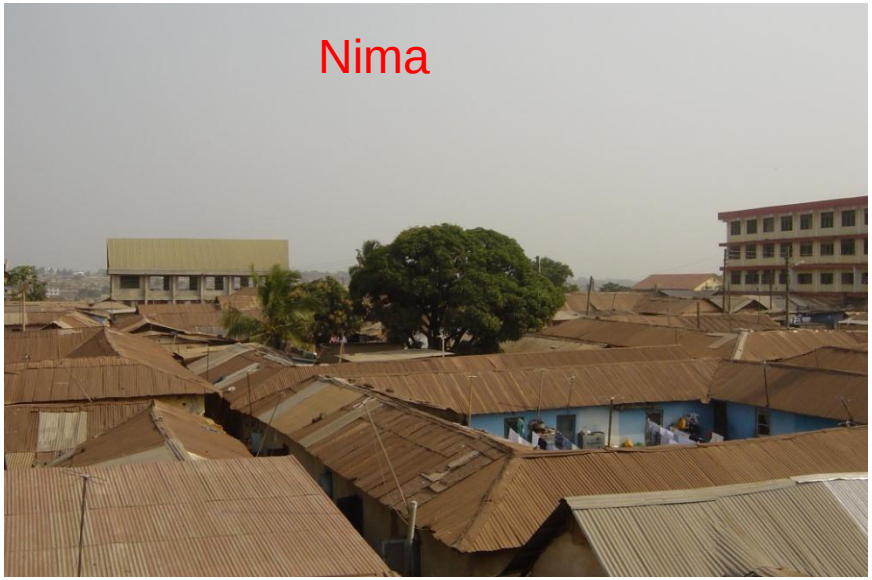
Accra study neighborhoods and biomass fuel use

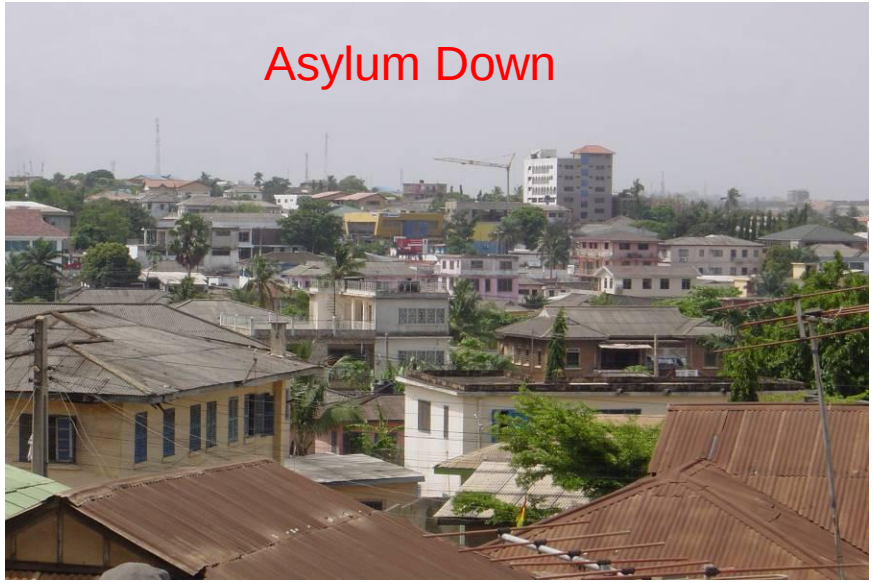


Dionisio et al *Environmental Science and Technology* 2010; Zhou et al *PNAS* 2011

Study neighborhoods

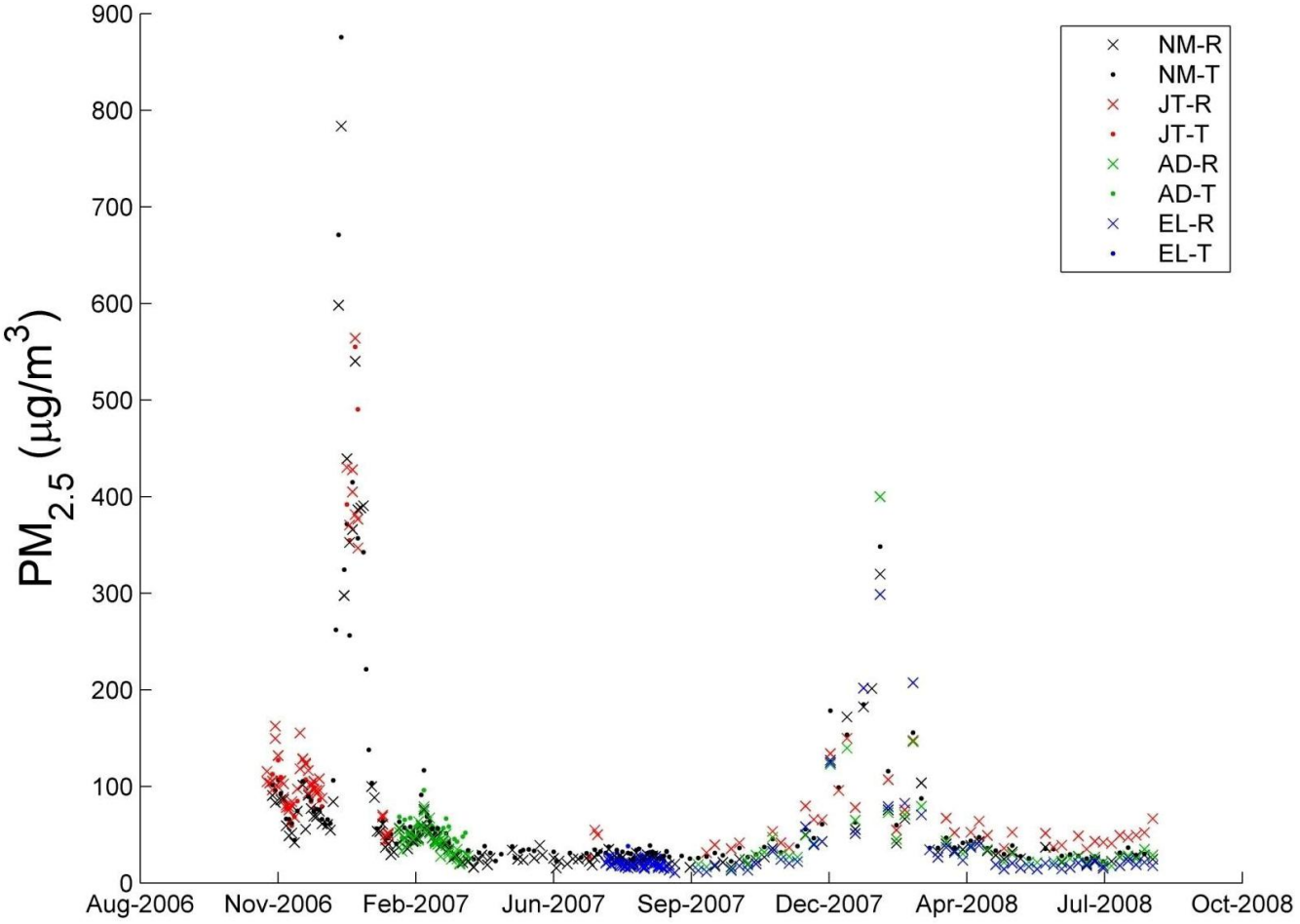






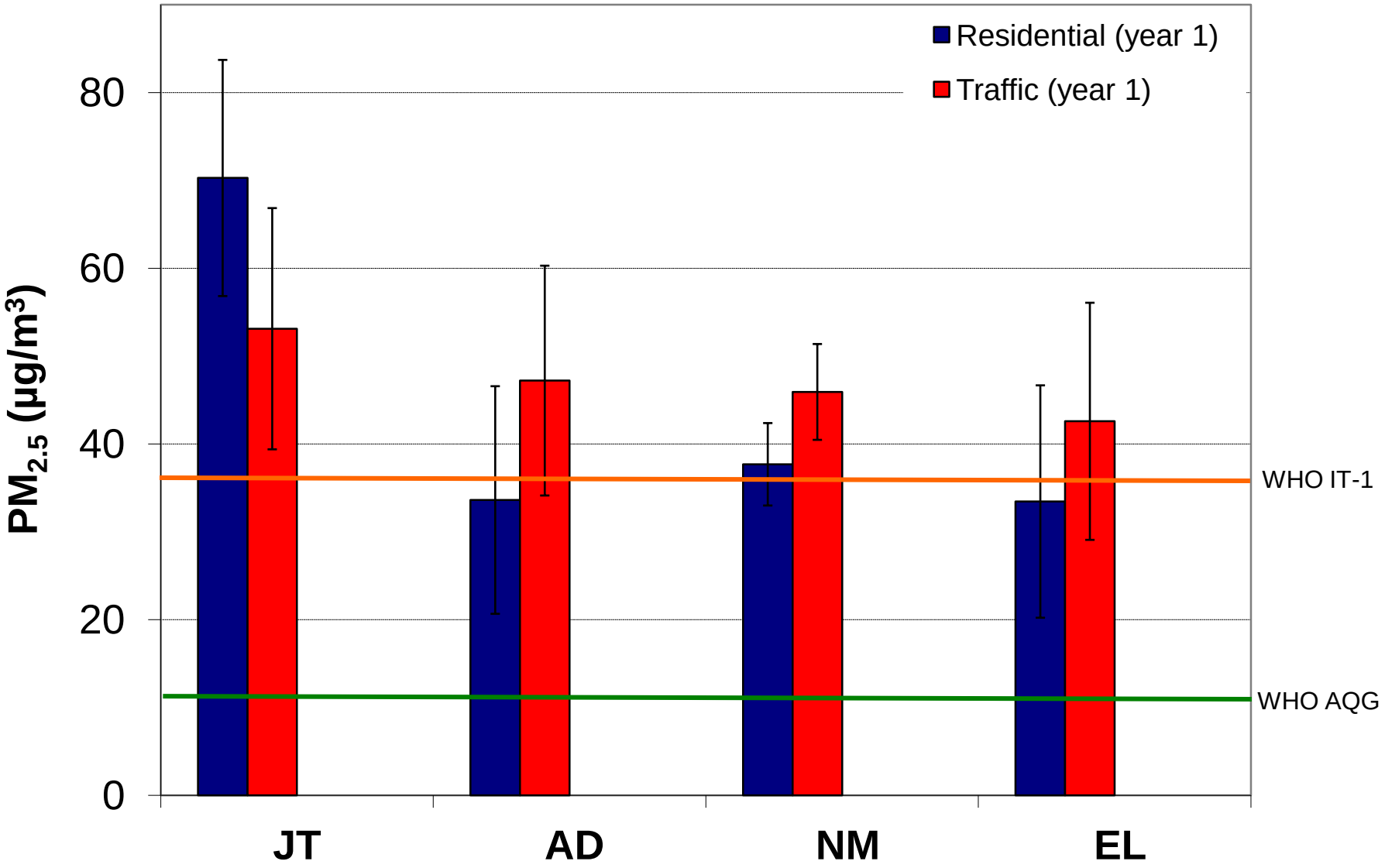
Ambient, household and mobile measurements

48-hour $PM_{2.5}$ measurements 2006-08



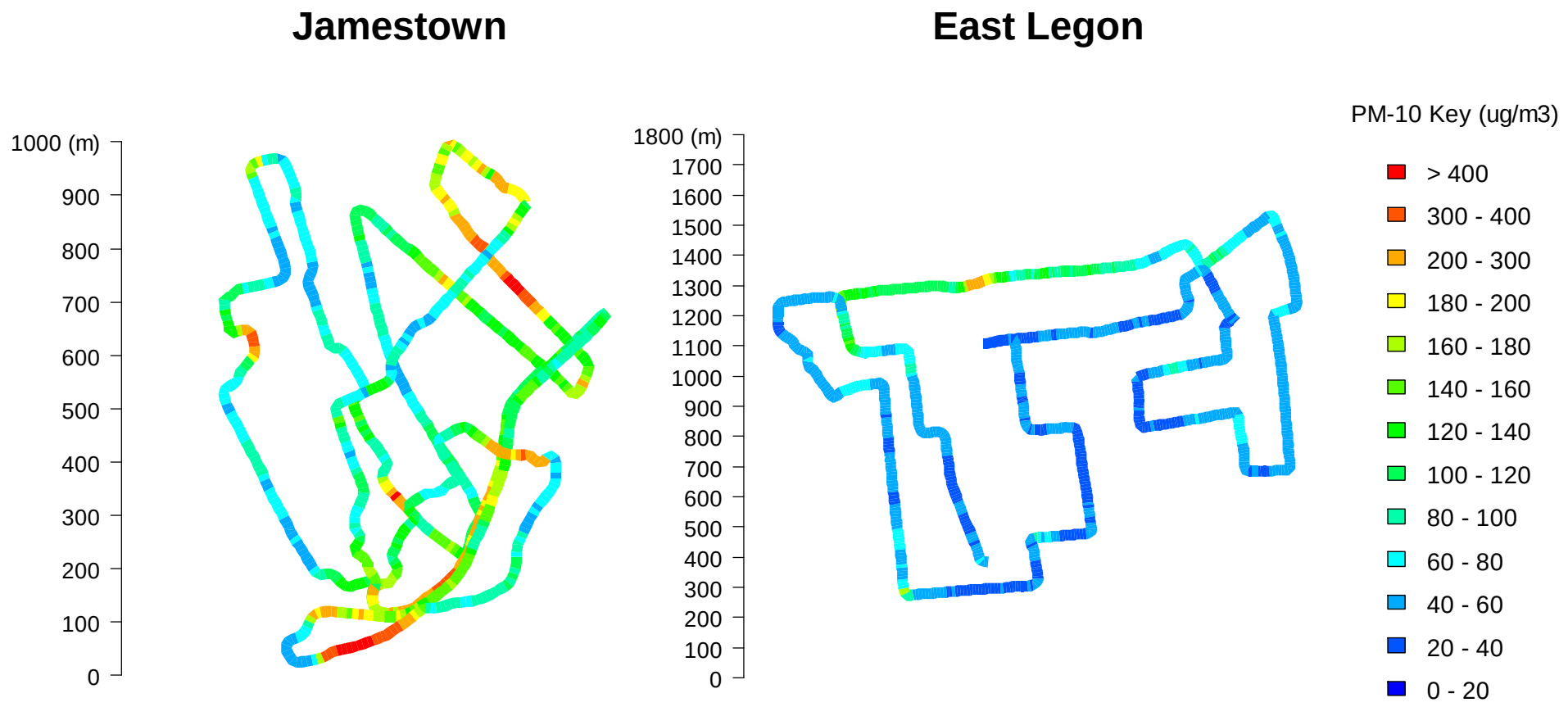
Dionisio et al *Environmental Science and Technology* 2010

Annual mean $PM_{2.5}$ (excluding Harmattan)



Dionisio et al *Environmental Science and Technology* 2010

PM10 concentration within neighbourhoods



Dionisio et al *Environmental Health Perspectives* 2010

Adjusted effect of nearby sources on local PM

	Ln($PM_{2.5}$)		Ln(PM_{10})	
	Coefficient	p-value	Coefficient	p-value
Distance to a main road (km)	0.044	0.76	-0.206	0.12
Trash burning	0.465	0.009	0.189	0.25
No traffic	0.0		0.0	
Idling vehicle	-0.214	0.24	-0.126	0.44
Light; < 2 cars per minute	0.097	0.09	0.112	0.03
Medium; < 10 cars per minute	0.174	0.007	0.247	< 0.001
Heavy moving	0.339	< 0.001	0.383	< 0.001
Congested/stopped heavy traffic	0.496	< 0.001	0.528	< 0.001
No stove	0.0		0.0	
Single charcoal stove	0.155	0.01	0.104	0.06
Multiple charcoal stoves	0.313	< 0.001	0.243	0.001
Single wood stove	0.365	0.004	0.287	0.02
Multiple wood stoves	1.089	< 0.001	0.818	< 0.001
Paved	0.0		0.0	
Paved broken	0.161	0.08	0.243	0.005
Packed dirt	0.029	0.60	0.036	0.47
Loose dirt	0.384	< 0.001	0.264	0.001

Dionisio et al *Environmental Health Perspectives* 2010

Sources of local air pollution in Accra

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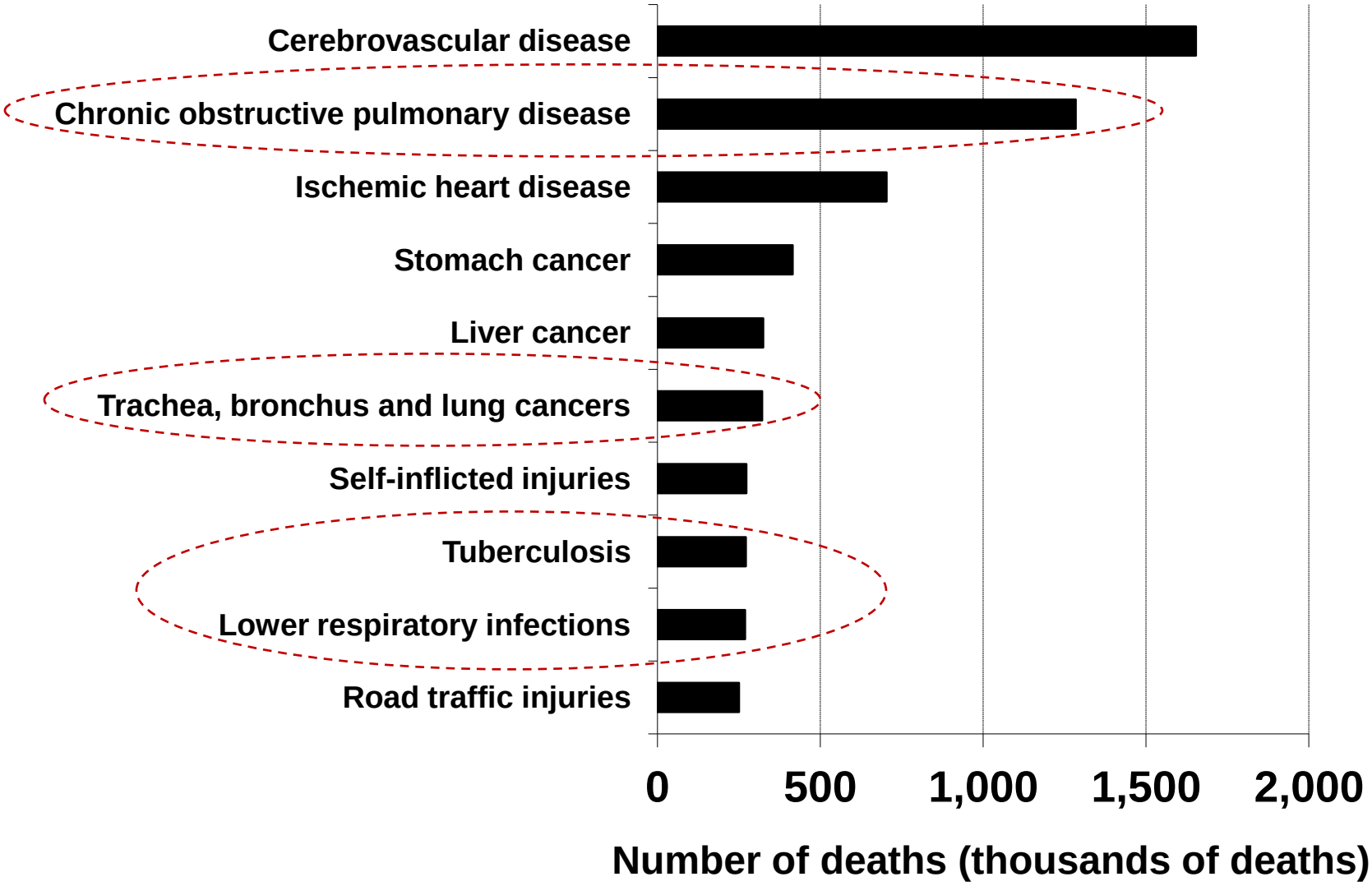
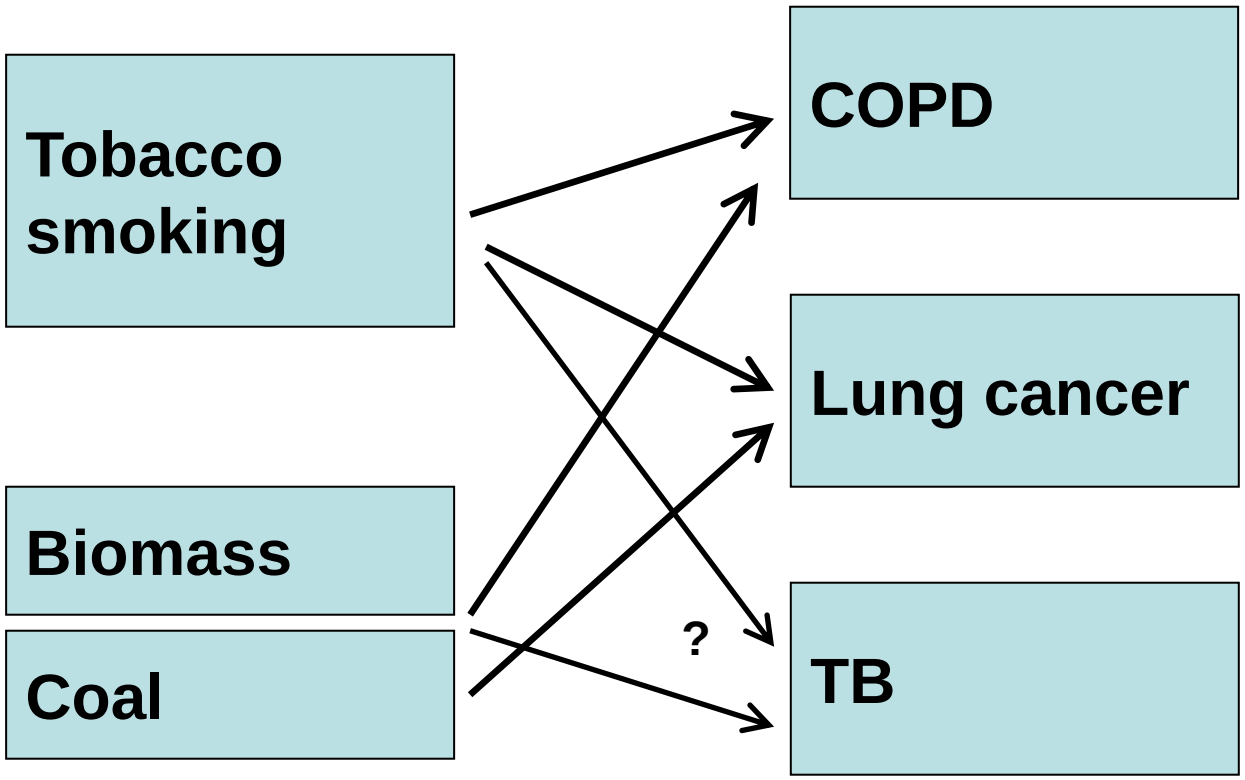
Leading causes of death in China in 2002



WHO 2004

Respirable pollutants from major combustion sources and lung diseases (excluding LRI)



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Tobacco Smoke, Indoor Air Pollution and Tuberculosis: A Systematic Review and Meta-Analysis

Hsien-Ho Lin[1], Majid Ezzati[2], Megan Murray[1,3,4*]

1 Department of Epidemiology, Harvard School of Public Health, Boston, Massachusetts, United States of America, 2 Department of Population and International Health and Department of Environmental Health, Harvard School of Public Health, Boston, Massachusetts, United States of America, 3 Division of Social Medicine and Health Inequalities, Brigham and Women's Hospital, Boston, Massachusetts, United States of America, 4 Infectious Disease Unit, Massachusetts General Hospital, Boston, Massachusetts, United States of America

REVIEW ARTICLE

Risk of Tuberculosis From Exposure to Tobacco Smoke

A Systematic Review and Meta-analysis

Michael N. Bates, PhD; Asheena Khalakdina, PhD; Madhukar Pai, MD, PhD; Lisa Chang, MPH; Fernanda Lessa, MD, MPH; Kirk R. Smith, PhD

INT J TUBERC LUNG DIS 11(10):1049–1061

REVIEW ARTICLE

Tobacco and tuberculosis: a qualitative systematic review and meta-analysis

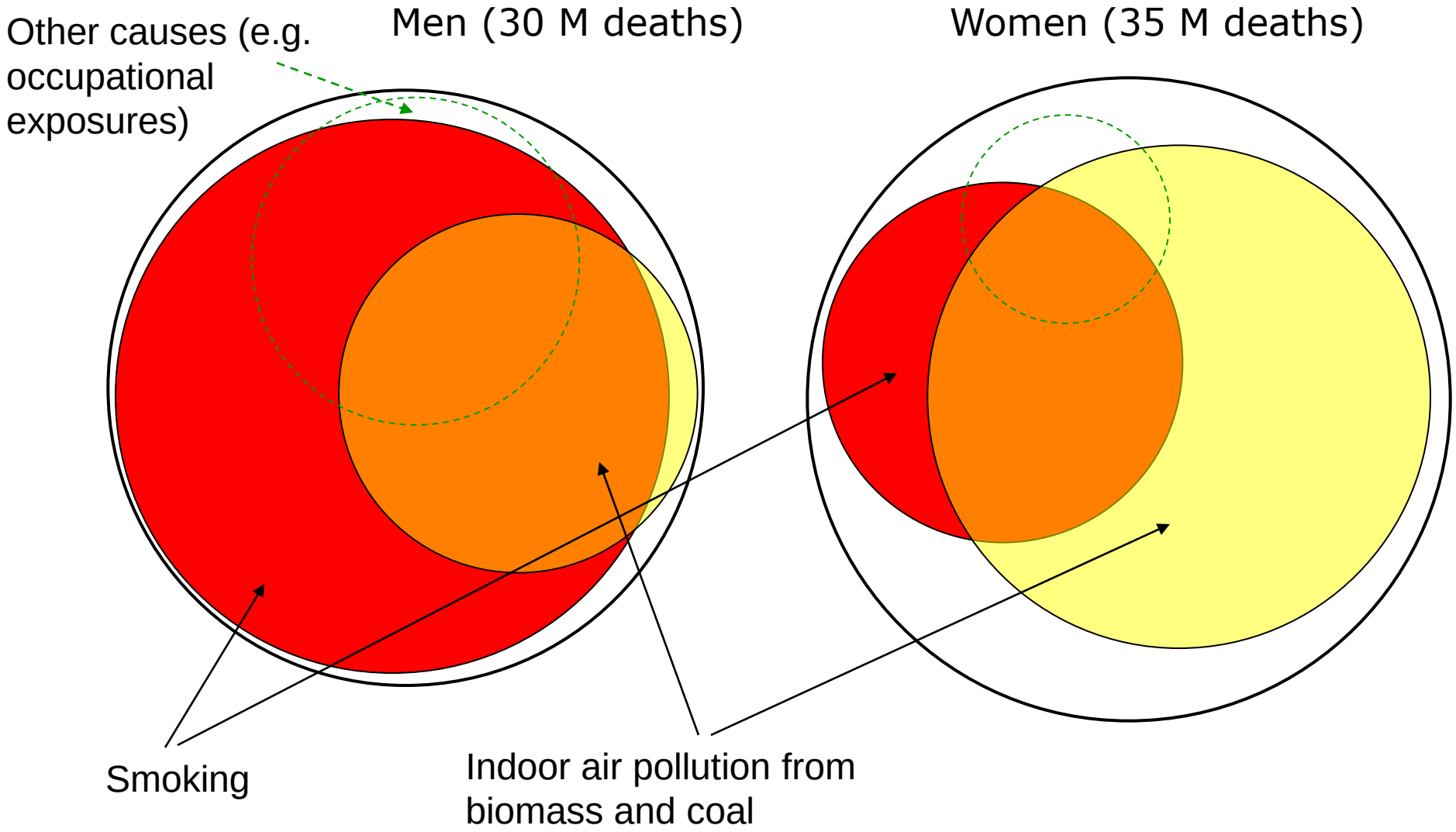
K. Slama,* C-Y. Chiang,* D. A. Enarson,* K. Hassmiller,† A. Fanning,‡ P. Gupta,§ C. Ray§

* The International Union Against Tuberculosis and Lung Disease, Paris, France; † The University of Michigan/ University of North Carolina, Hillsborough, North Carolina, USA; ‡ University of Alberta, Edmonton, Alberta, Canada; § Healis Institute, New Delhi, India

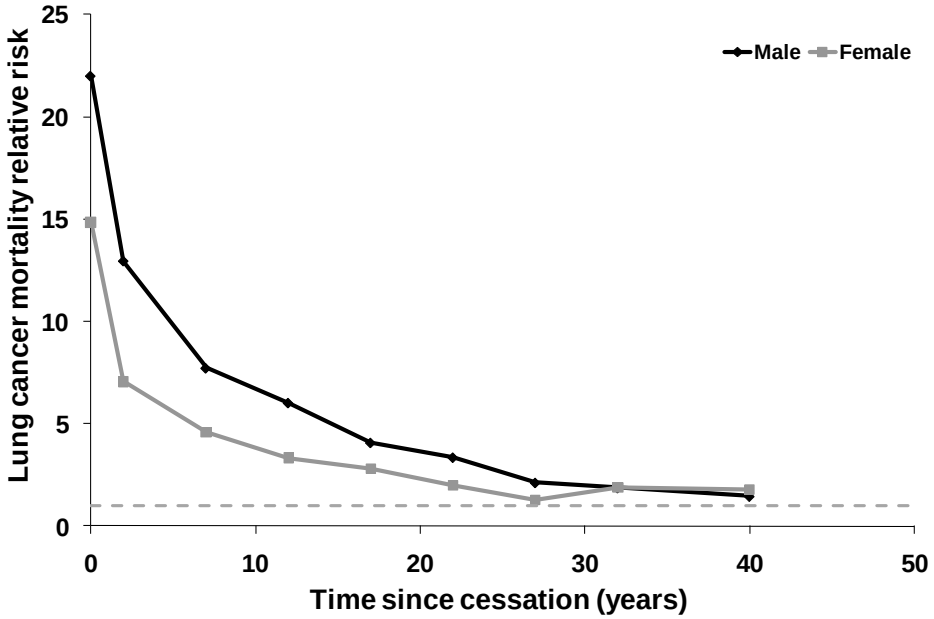
Modeling integrated management of lung disease in China

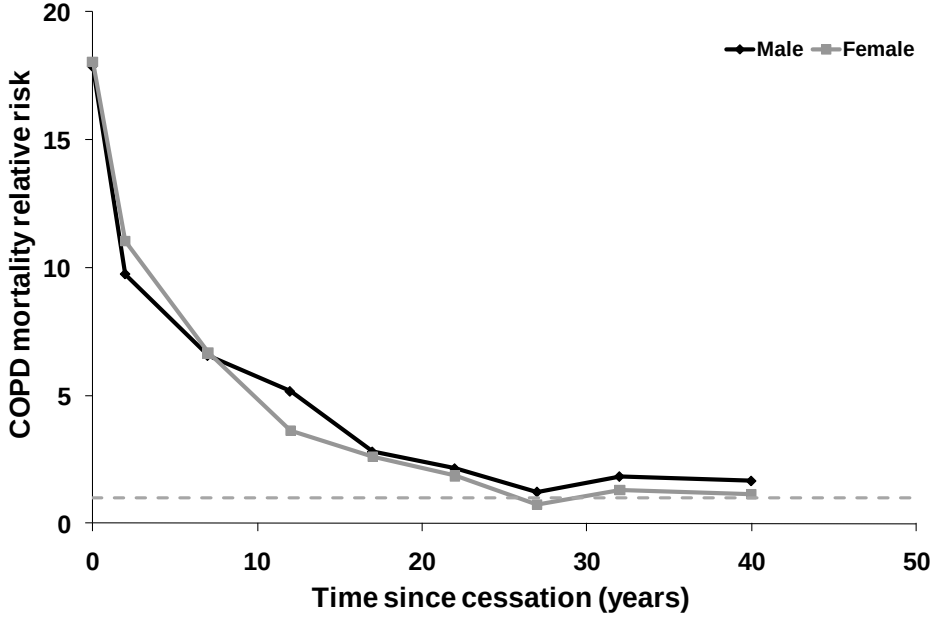
- Objective: To quantify the potential benefits of smoking and biomass/coal use reduction scenarios on chronic and communicable lung diseases in China, over time
  - Chronic disease models to incorporate multi-causality and time-dependent effects (time-dependant proportional multi-risk model)

Multi-causality and multiple risk factors for projected COPD deaths in China, 2003-33



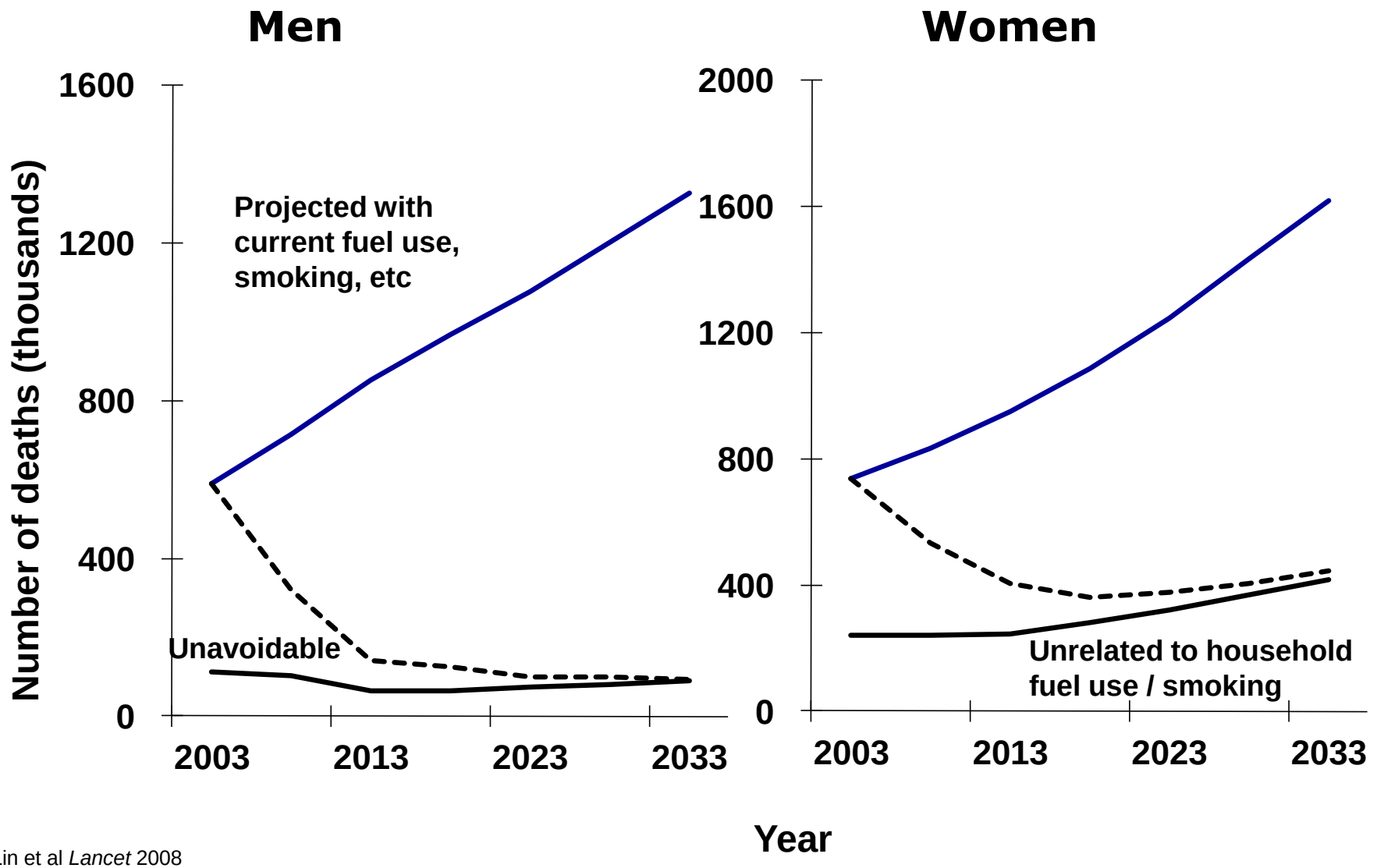
Relative risk of dying from lung cancer and COPD among current and former smokers





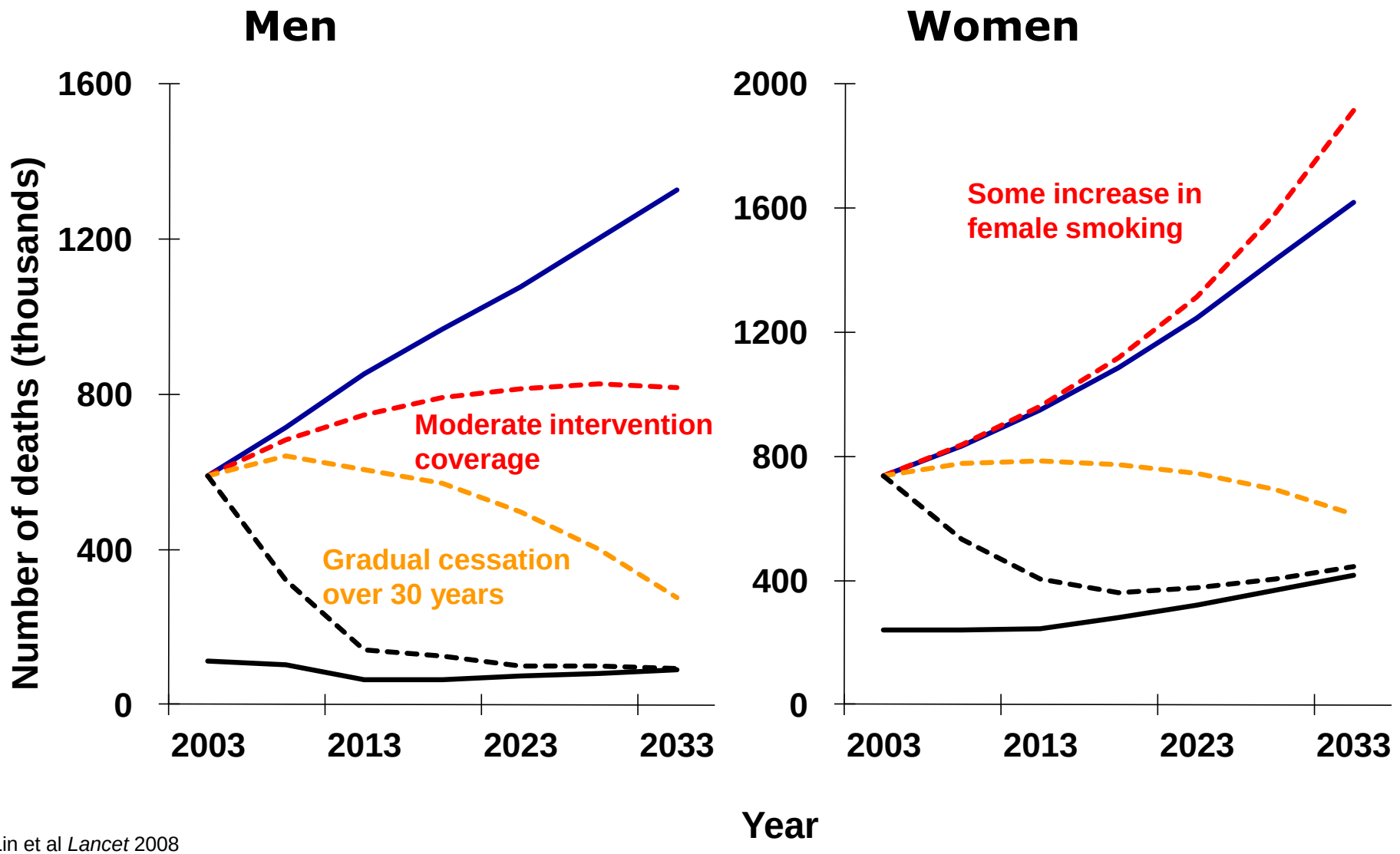
Oza et al *Preventive Medicine* 2011

Annual COPD deaths under scenarios of smoking and solid fuel use



Lin et al *Lancet* 2008

Annual COPD deaths under scenarios of smoking and solid fuel use



Lin et al *Lancet* 2008

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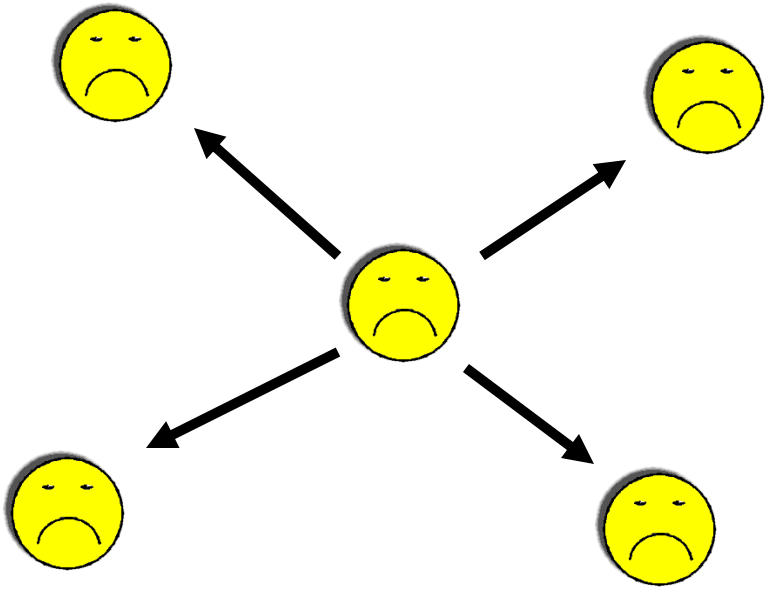
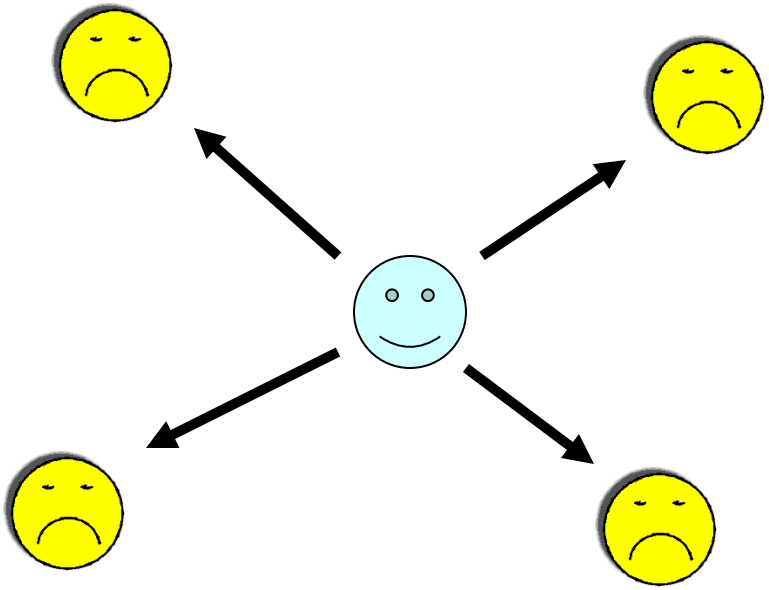
  - TB model to incorporate indirect effect through transmission from source cases

Dependence of TB infection



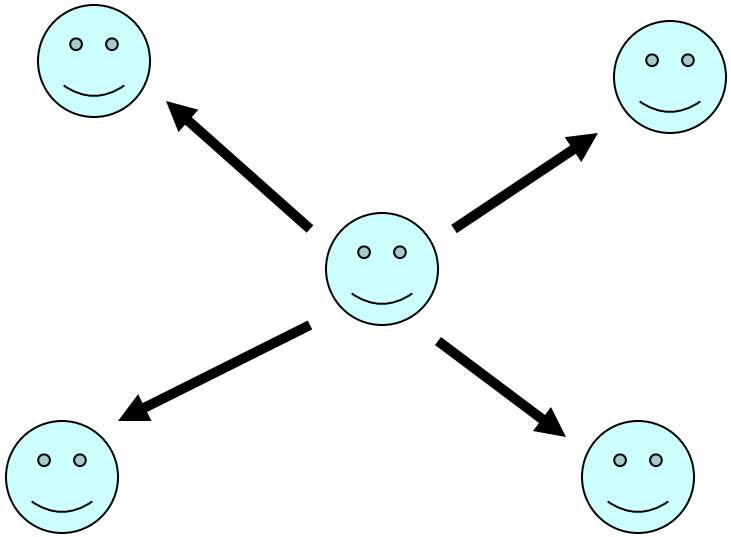
Dependence of TB infection/intervention

Direct effect

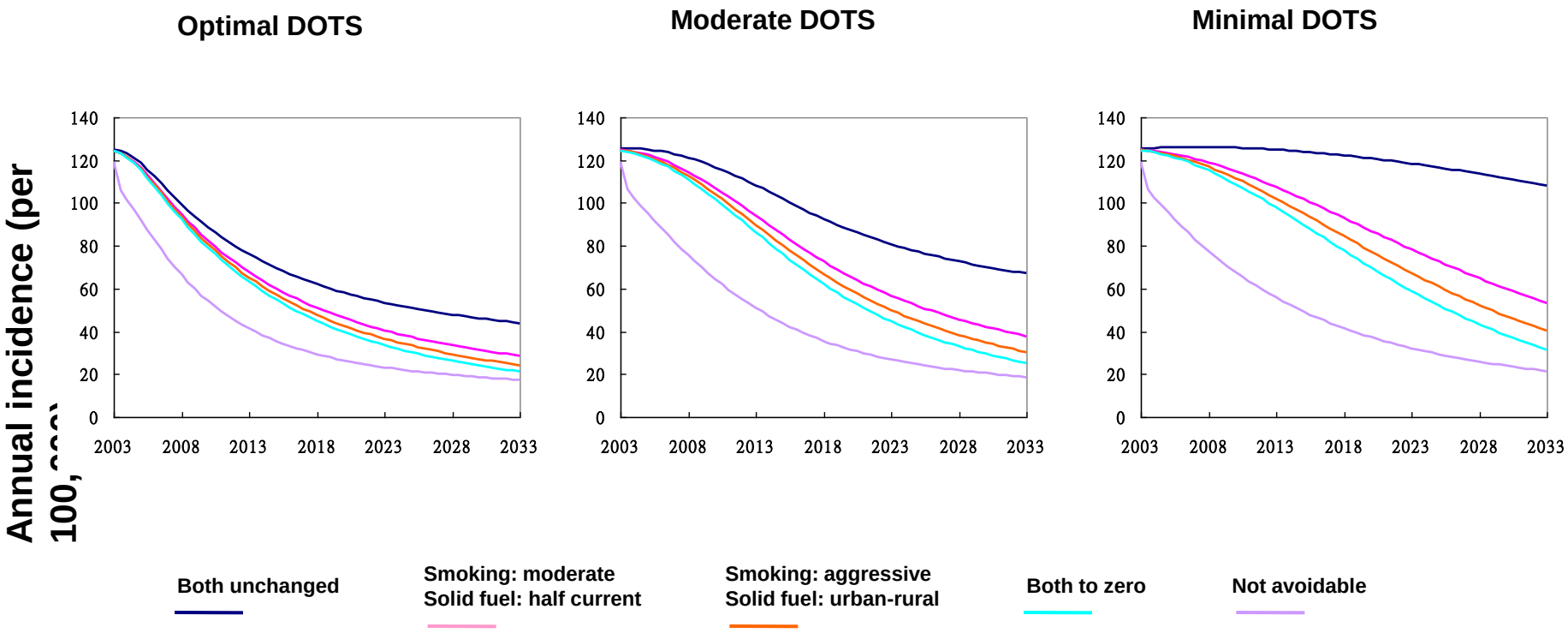


Dependence of TB infection/intervention

Indirect effect



Annual incidence of infectious TB under different scenarios of smoking, solid fuel use, and DOTS (Guizhou province)



Lin et al. *Lancet* 2008

Potential interventions for indoor air pollution

- Cleaner fuels
  - Petroleum and electricity: limited by cost and especially by delivery infrastructure
  - Pre-processed biomass/coal (charcoal, pallets, liquid/gaseous fuels)

- Alternative (ventilated) stoves
  - High-quality stoves are relatively costly
  - Performance of low-cost stoves highly program- and user-dependent
  - Benefits would be substantially less in urban or densely populated areas

Does electrification reduce the use of biomass and coal fuels? (Inner Mongolia)

Does electrification reduce the use of biomass and coal fuels? (Inner Mongolia)

Non-fuel options for reducing household air pollution – do they work?

Traditional stove

Biomass pellet gasifier stove for cooking & heating

Potential interventions for indoor air pollution

- Behavior change
  - Limited options for cooking/heating behaviors
  - Some options for childcare behaviors
  - Can be effective in combination with fuel/stove interventions

- Housing change
  - Benefits will vary based on whether cooking or heating is the main use of fuel; particularly relevant where heating is an important use of energy
  - May be very costly but the benefits can be large and permanent
  - Opportunities where there is large change in housing stock

- Local / regional packages of interventions will be needed