Biomass exposure and COPD

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	Deaths in 2010 (95% CI)
Household air pollution*	3·55 million (2·68 million to 3·62 million)
Ambient pollution	3·22 million (2·82 million to 3·62 million)
Occupational risk factors†	0·85 million (0·66 million to 1·06 million)
Lead exposure	0·67 million (0·58 million to 0·78 million)
Second-hand smoke	0·60 million (0·45 million to 0·52 million)
Unimproved sanitation	0·24 million (0·01 million to 0·48 million)
Unimproved water source	0·12 million (0·01 million to 0·23 million)
Residential radon	0·10 million (0·01 million to 0·22 million)

*Household air pollution contributes about 16% to the worldwide disease burden of ambient air pollution.[3] †Occupational risks include carcinogens, asthmagens, air pollutants, etc. Adapted from Lim and colleagues.[3]

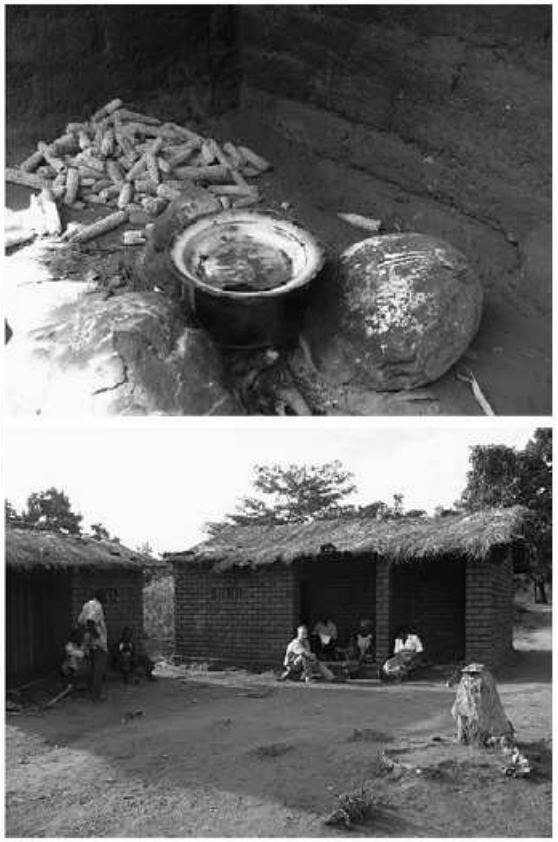
Table 1: **Deaths attributable to environmental risks worldwide**

Gordon, ***Lancet Respir Med*** **2014; 2: 823–60**

Chest Research Foundation, Pune, India

Figure 3: Use of biomass fuel for cooking in an Indian village

Health impact. Malawi



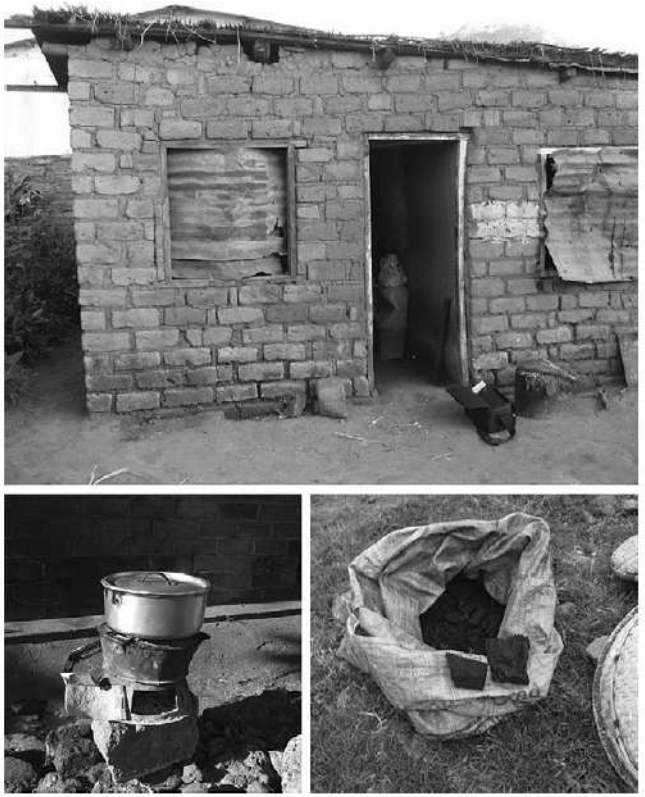


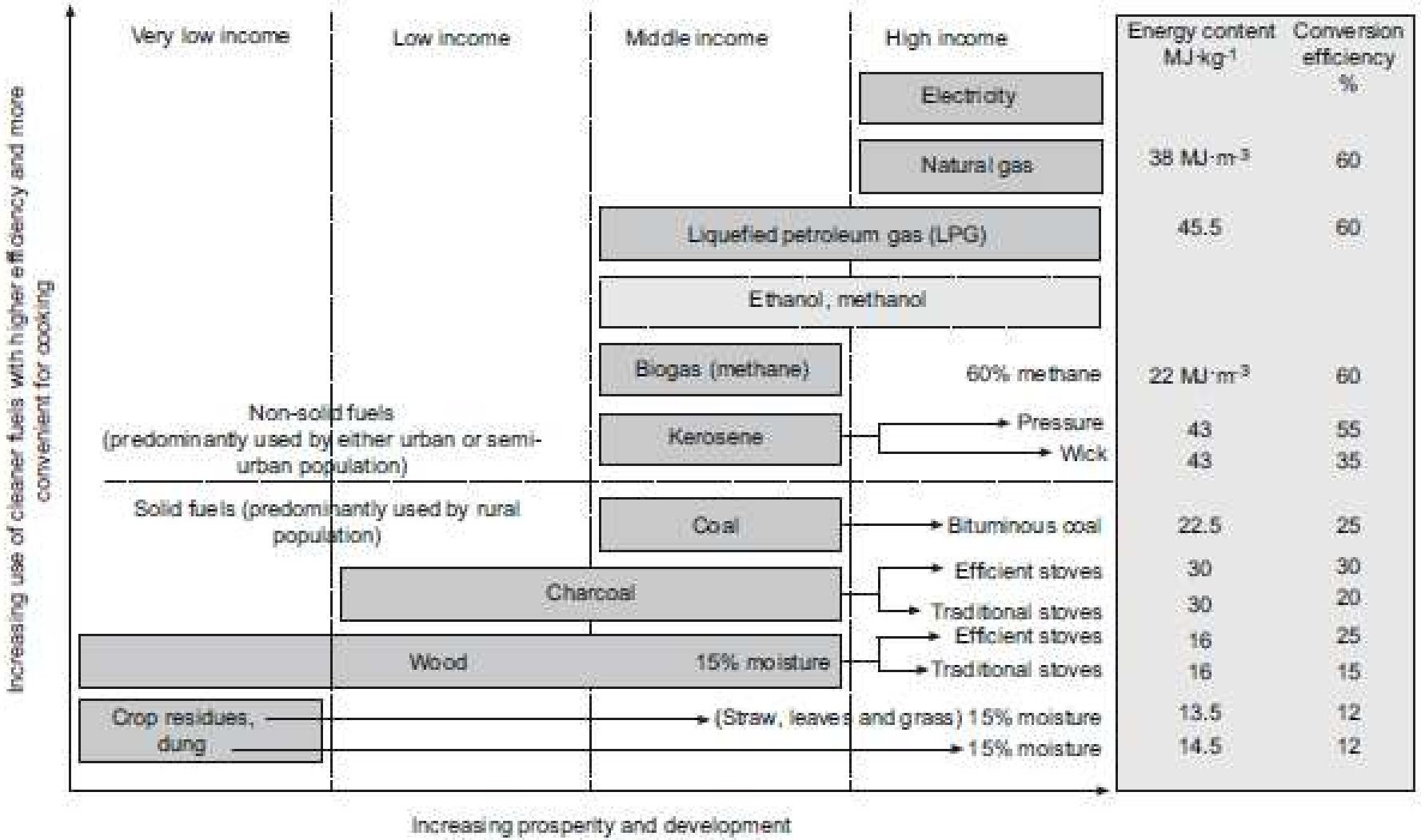
Figure 1 Charcoal stove in urban Blantyre.

igure 2 Three-stone wood burning fireplaces in rural Chikwawa.

Fullerton, Int J Tuberc Lung Dis 2011

Mortimer, Chest 2012

Utilization of cleaner fuels is related to development



Total population using solid fuels

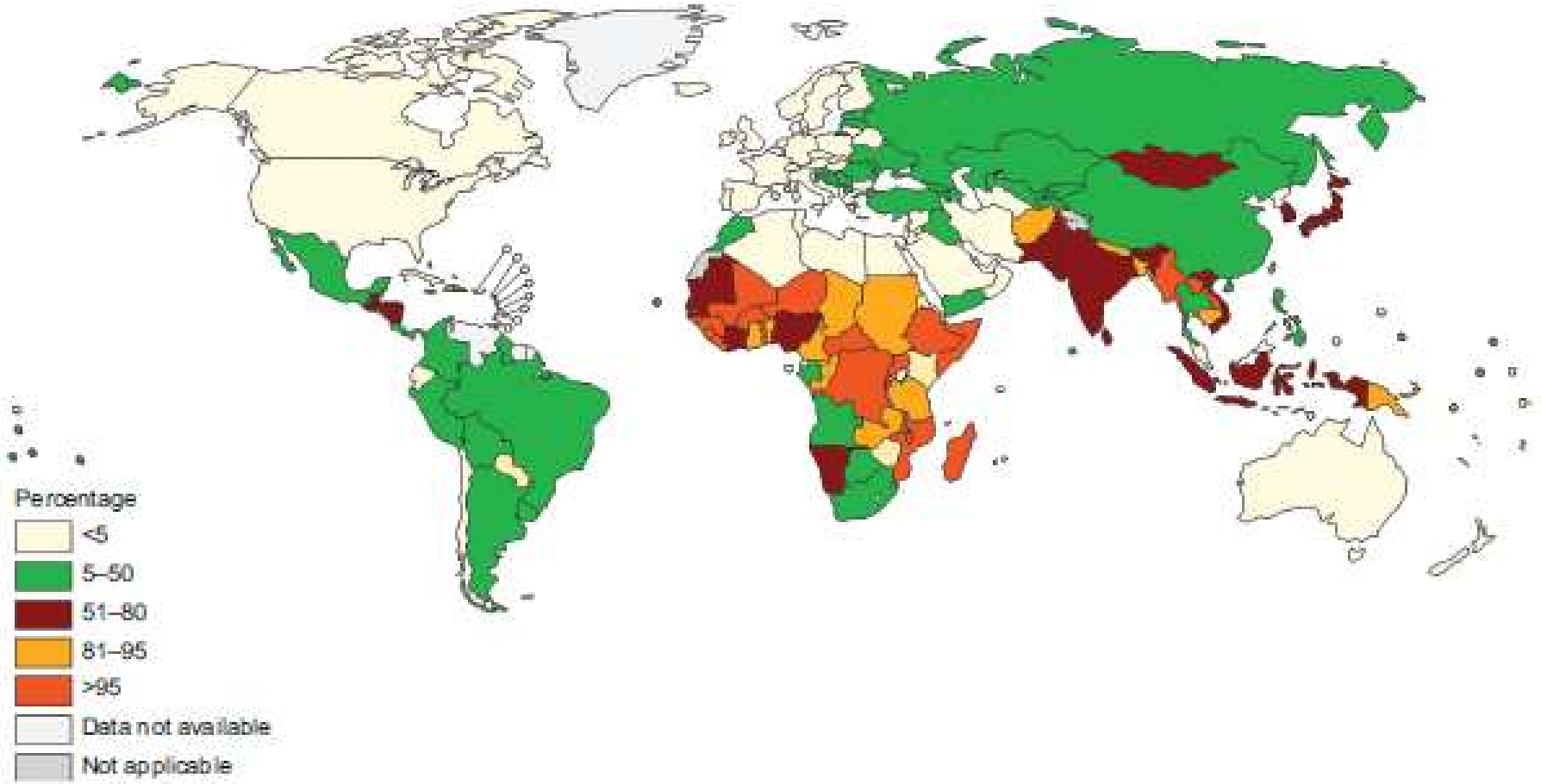


FIGURE 1. Total population using solid fuels in percentage. Modified from [8] with permission from the World Health Organization (WHO). The boundaries used on this map do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country or territory, or concerning the delimitation of its frontiers or boundaries.

Kurmi, Eur Resp J 2012

Household air pollution and mortality

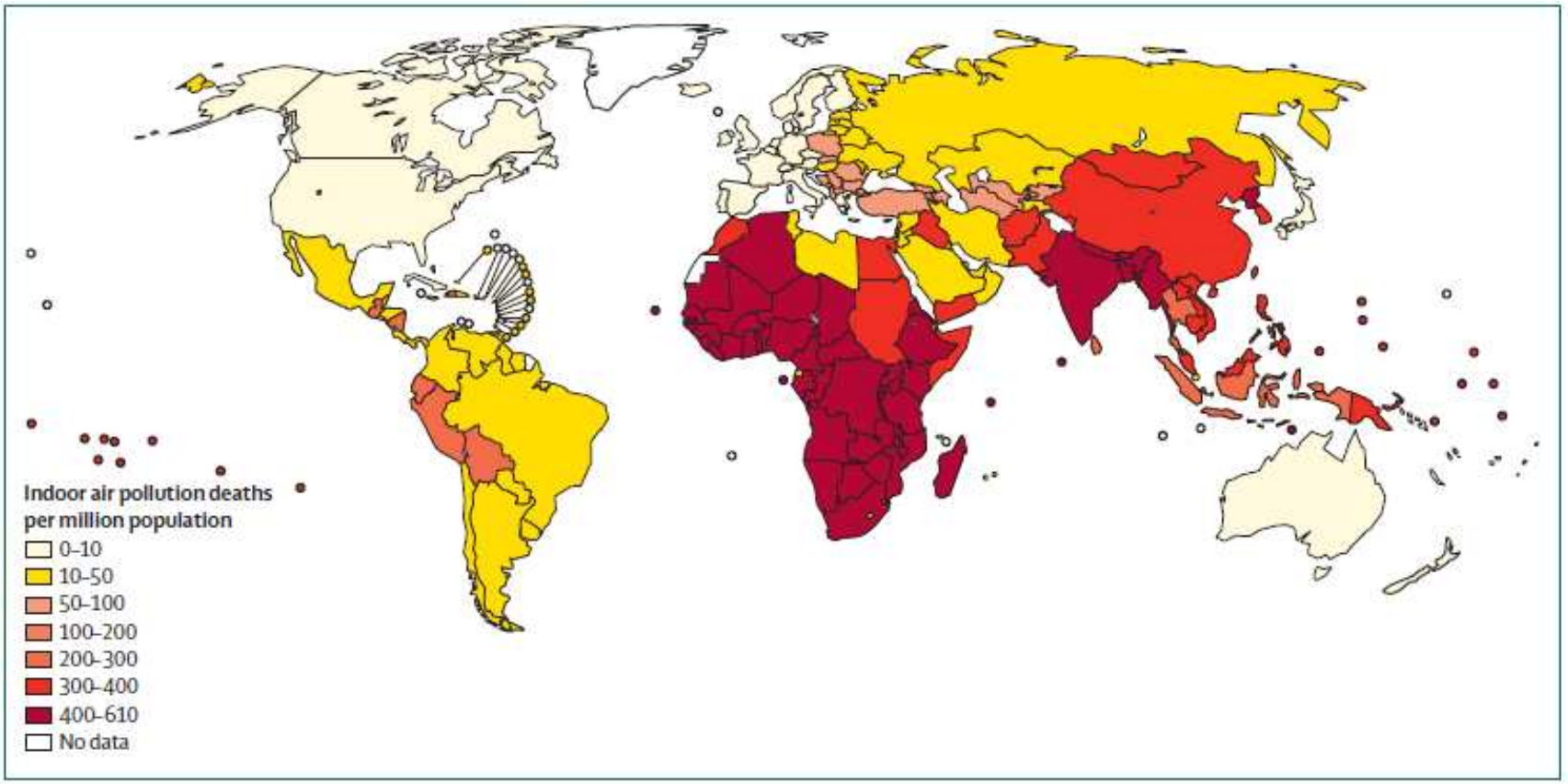
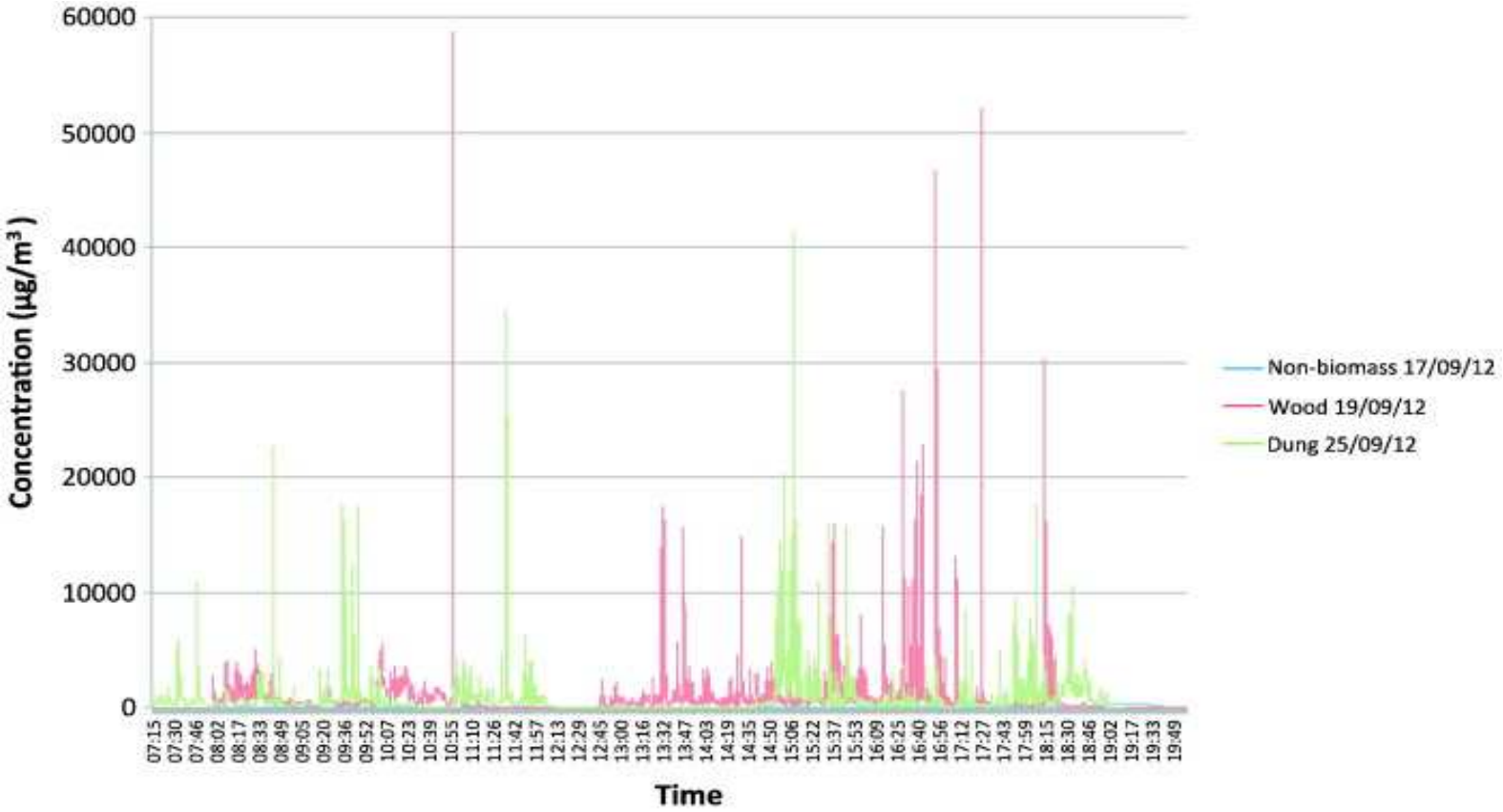


Figure 2: **WHO map of household air pollution and mortality**
World map of poverty (not shown) shows nearly identical geographical distribution.

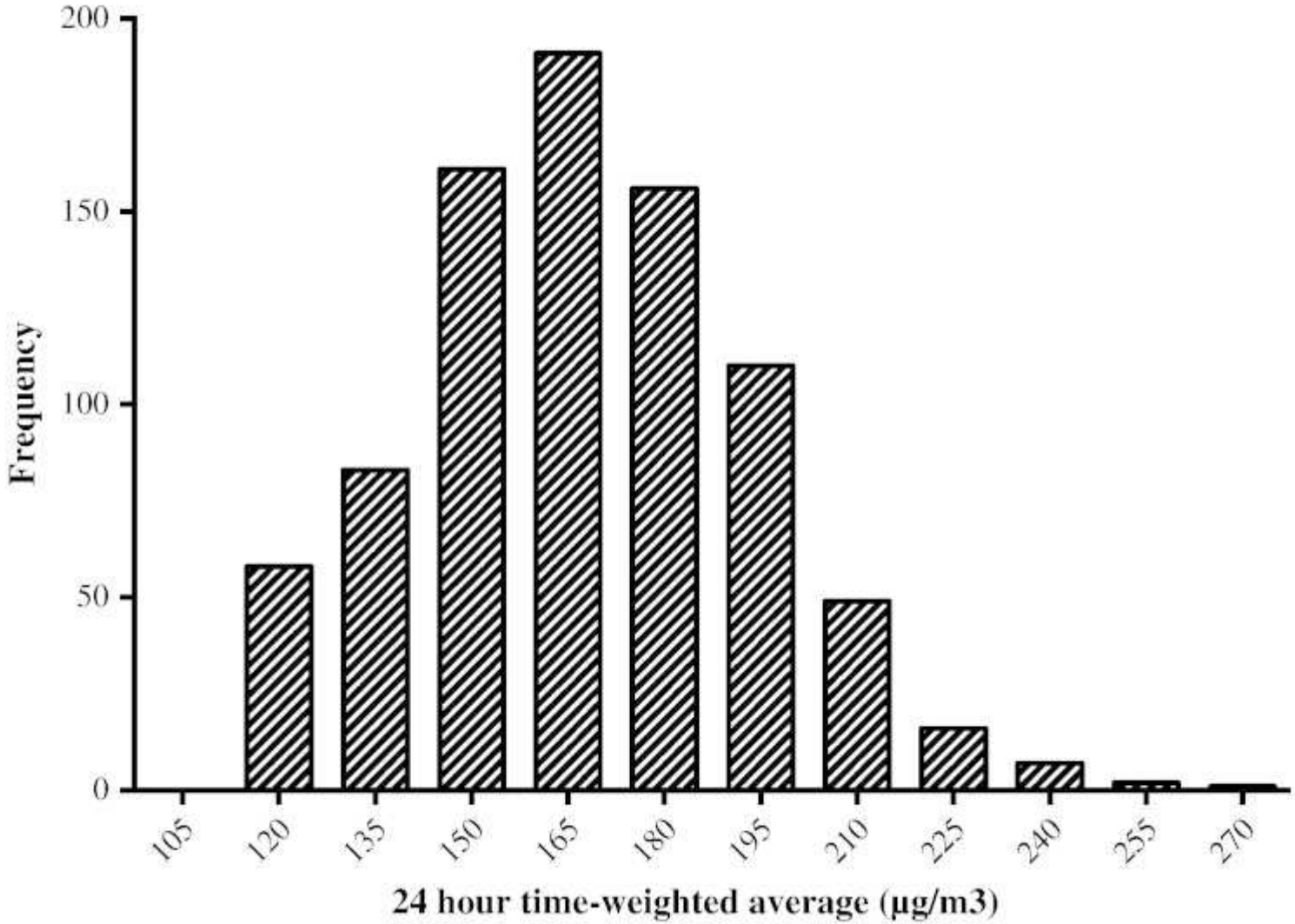
Gordon, ***Lancet Respir Med*** **2014; 2: 823–60**

Higher levels of pollution in kitchen during 12 hours



Devakumar, Environ Int 2014

High Exposure to biomass smoke of children during 24 hours (n=836)



Devakumar, Environ Int 2014

Experimental results in animals : Emphysema and bronchiolitis

- After exposure to wood smoke for 3 hours a day for3 months, guinea-pigs developed mild emphysema
- Rats exposed intermittently to wood smoke for

75 minutes daily for 15 days had

  - mononuclear bronchiolitis
  - and mild emphysema;
  - these conditions became more severe following exposure for 30 and 45 days

- A fibrotic lung reaction simulating silicosis has been produced experimentally in animals exposed to wood smoke
- Exposure to wood smoke may be associated with interstitial lung disease (inflammation of the lung structure leading to fibrosis)

Bruce, WHO 2000

Comparison of lung morphology in COPD secondary to cigarette and biomass smoke (necropsy) in women

Table 3 Histological findings

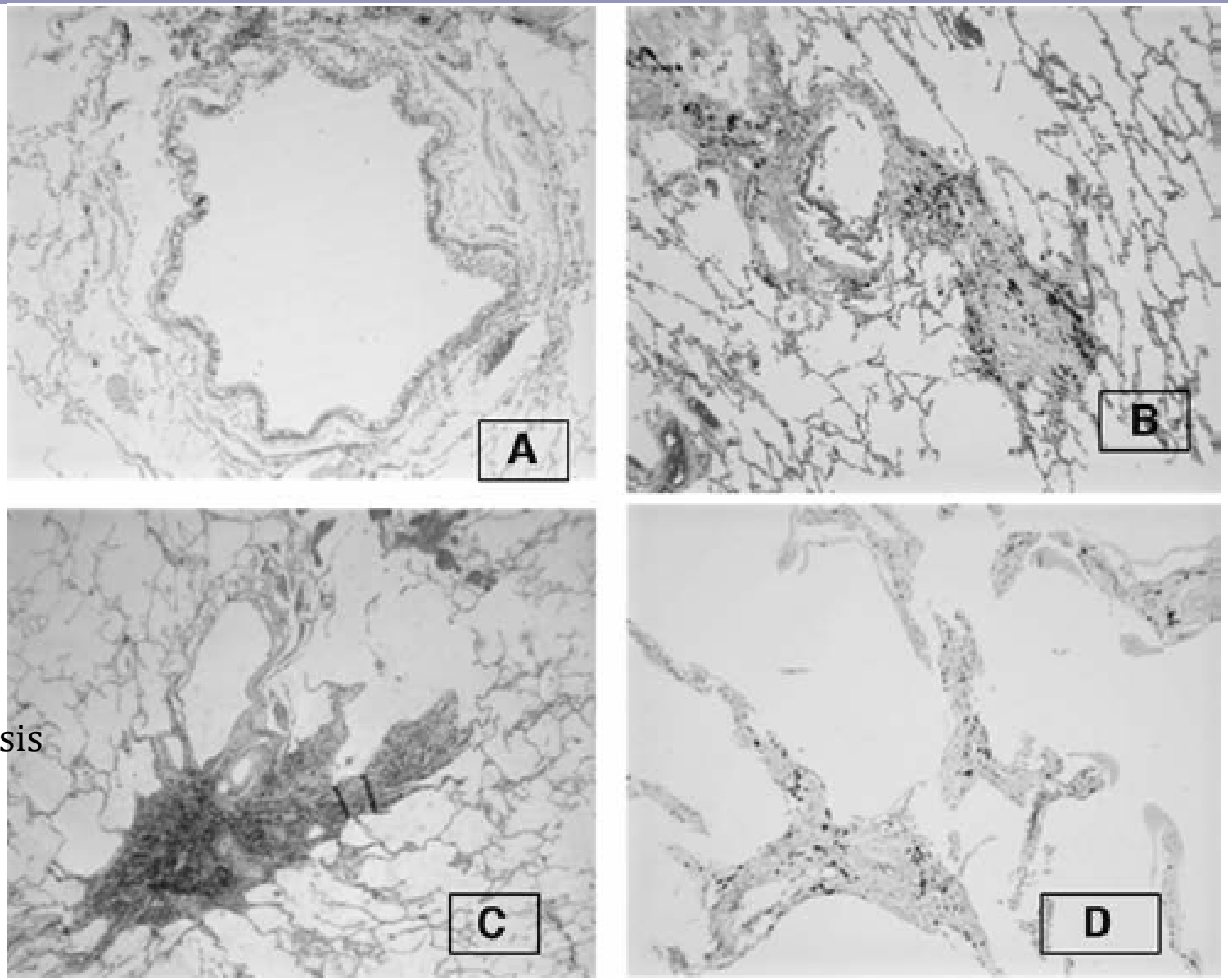
	Cigarette smoke mean ± SD	Biomass smoke mean ± SD	*P* value*
Emphysema grade, *n* (%)			
1	1 (4.76)	2 (7.41)	
2	0	8 (29.63)	0.019†
3	20 (95.24)	17 (62.96)	
Large airways			
The Reid index	862.25 ± 283.03	975.81 ± 280.370	0.10‡
Fibrosis/pigment in bronchial wall	1.66 ± 1.25	2.16 ± 1.65	0.1‡
Small airways			
Inflammation	17.1 ± 18.5	10.7 ± 15.4	0.2‡
Fibrosis	52.7 ± 20.1	76.2 ± 15.5	<0.001‡
Pigment deposition	24.2 ± 21.6	36.5 ± 27.0	0.1‡
Smooth muscle hyperplasia	33.9 ± 25.9	34.7 ± 18.7	0.9‡
Goblet cell metaplasia	22.6 ± 20.8	10.0 ± 14.4	0.02‡
Changes in pulmonary arteries			
External diameter	340.3 ± 60.3	349.0 ± 70.0	0.6‡
Medial thickness	55.2 ± 26.7	49.3 ± 19.2	0.4‡
Intimal thickness	22.3 ± 8.4	31.8 ± 20.4	0.03‡
Fibrosis/pigment on vascular wall	1.7 ± 1.0	2.1 ± 0.9	0.08‡

* Statistical significance was accepted at the $P < 0.05$ level of confidence.

R. M. Rivera et al. INT J TUBERC LUNG DIS 12(8):972–977

Cigarette smoke Small airways Biomass smoke

Métaplasia
FA>B

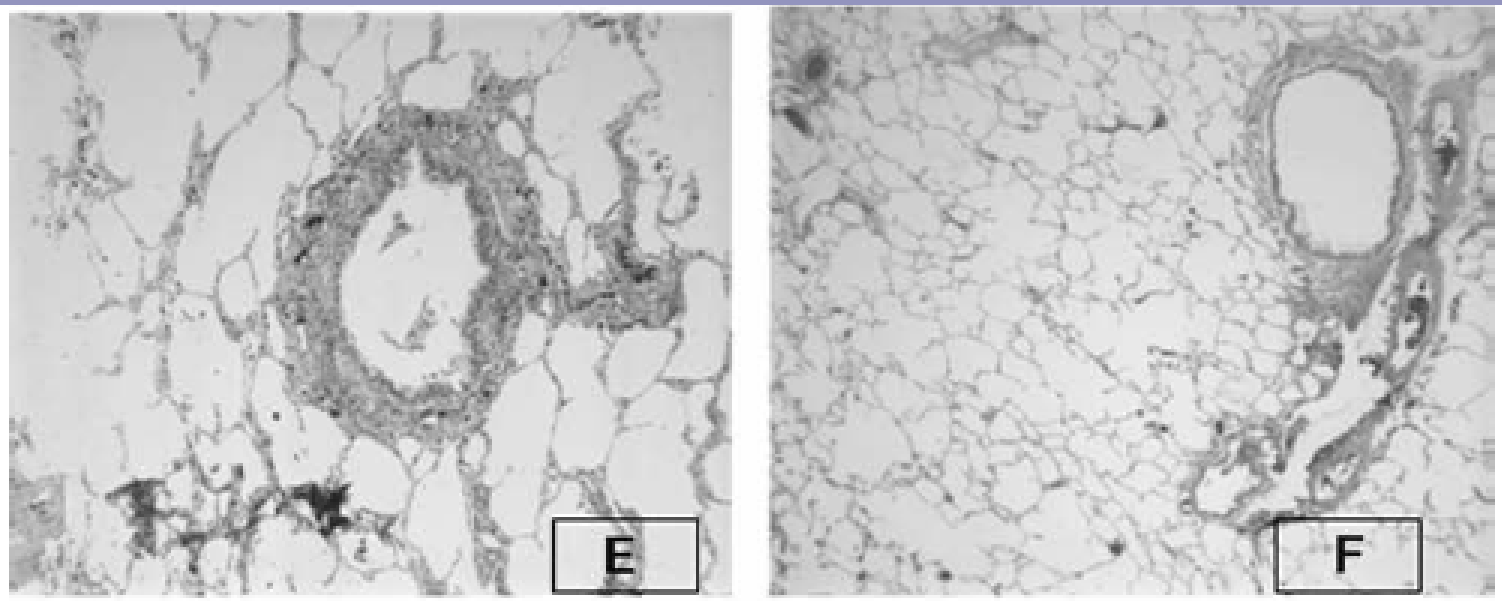


More fibrosis
B>FA

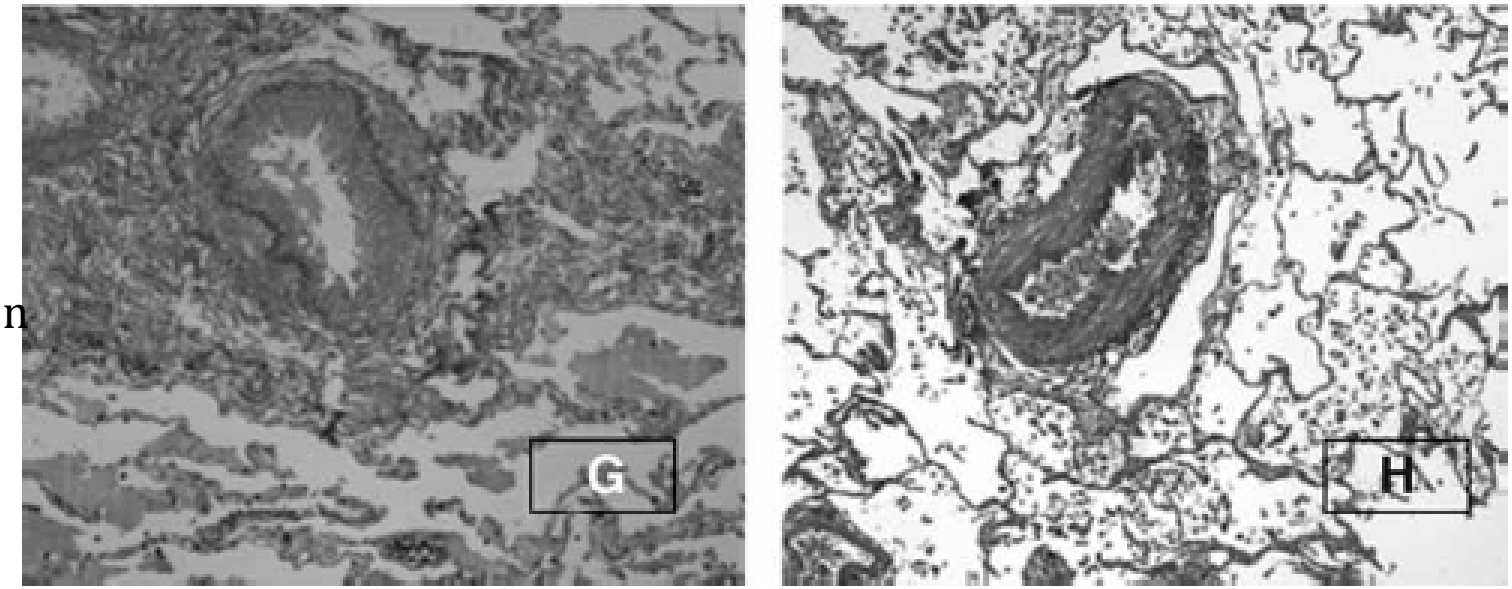
Rivera, INT J TUBERC LUNG DIS 12(8):972–977

Cigarette smoke Pulmonary arteries Biomass smoke

More de fibrosis B>FA



Vascular lesions : intima inflammation B>FA

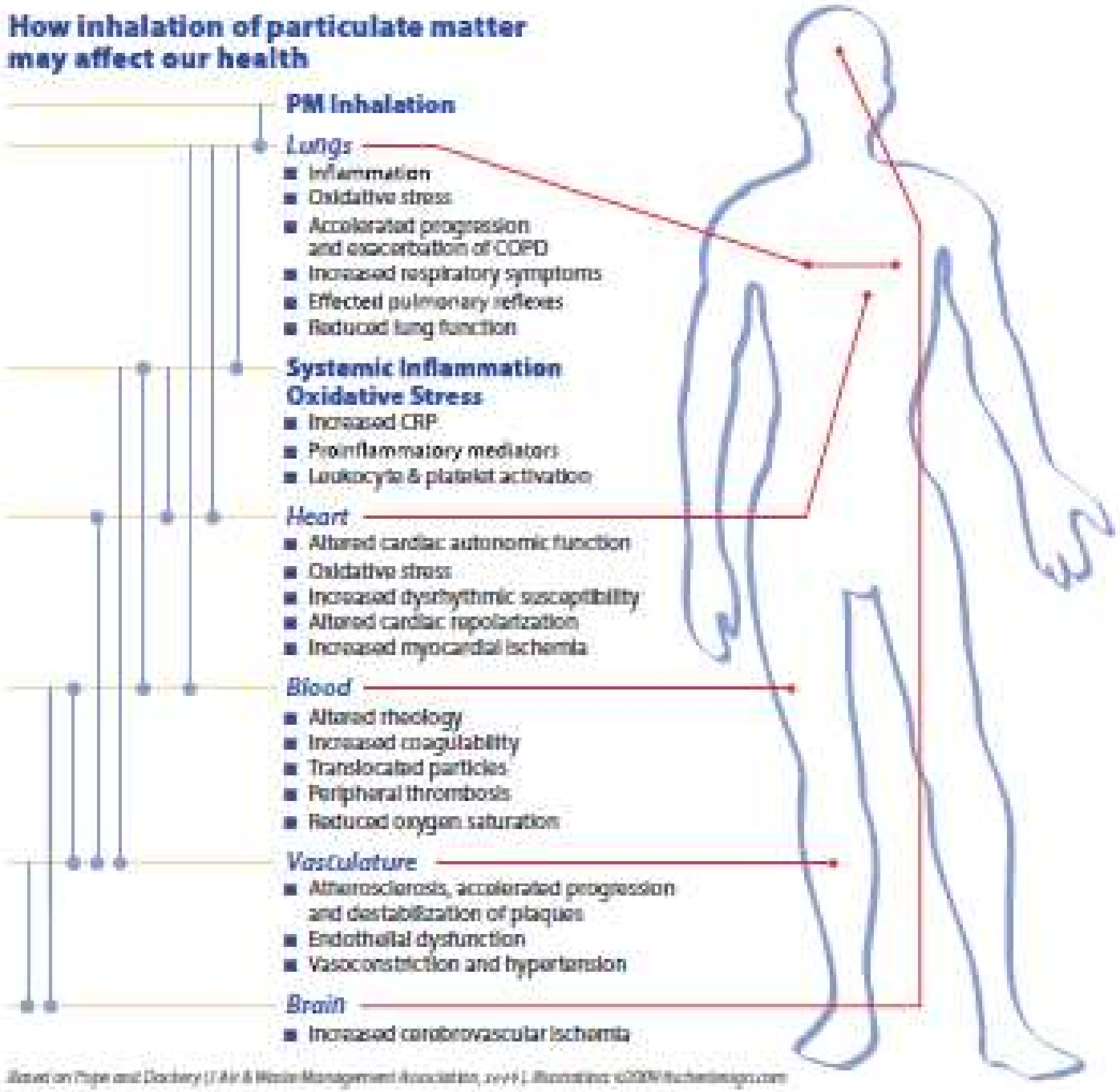


Rivera, INT J TUBERC LUNG DIS 12(8):972–977

Table 1 Lung morphology described after exposure to biomass smoke

Author and reference	Year	Exposure	Specimens	Histological findings
Padmavati[15]	1959	BS	Necropsies	Emphysema, interstitial fibrosis. Blood vessels show subintimal thickening
Padmavati[16]	1964	BS	Necropsies	Emphysema, interstitial fibrosis, pleural thickening, CB
Woolcock[13]	1970		Necropsies	Large amount of fibrosis, emphysema
Master[12]	1974	Air pollution	Lung biopsy	Emphysema, mucus gland hyperplasia, increased anthracotic pigmentation, irregular areas of pulmonary fibrosis
Anderson[11]	1978	Wood smoke		Intrapulmonary fibrosis
Anderson[17]	1979	Wood smoke	Necropsies	Emphysema extensive fibrosis
Ramage[14]	1988	CS + wood smoke	Lung biopsy	Fibrosis and carbon pigment deposit around bronchioles, thickened septae
Grobbelaar[18]	1991	BS + quartz	Lung biopsy	1) Simple anthracosis, 2) anthracosis with macula formation, 3) mixed dust fibrosis
Dhar[19]	1991	BS	Lung biopsy	Mild to moderate fibrogenic reaction, carbon nodules resembling the anthracotic nodules of coal miners
Sandoval[10]	1993	Wood smoke	Lung biopsy	Deposition of anthracotic material, focal emphysema, vascular lesion

How inhalation of particulate matter may affect our health



Based on Pope and Dockery (*J Air & Waste Management Association*, xxvi).

Respiratory tracts infections : cause of mortality in children <5 yrs old

Fig. 1. **A rural home in the highlands of Bolivia with walls blackened by smoke from an open wood fire**

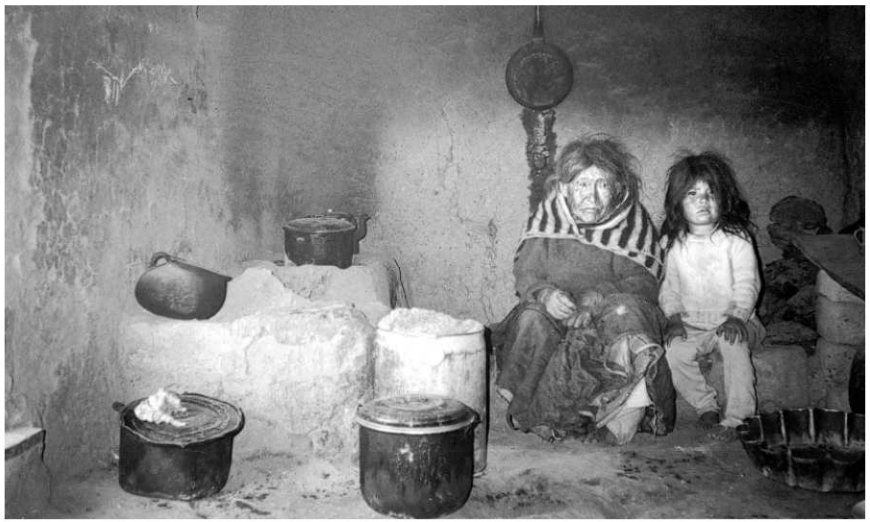
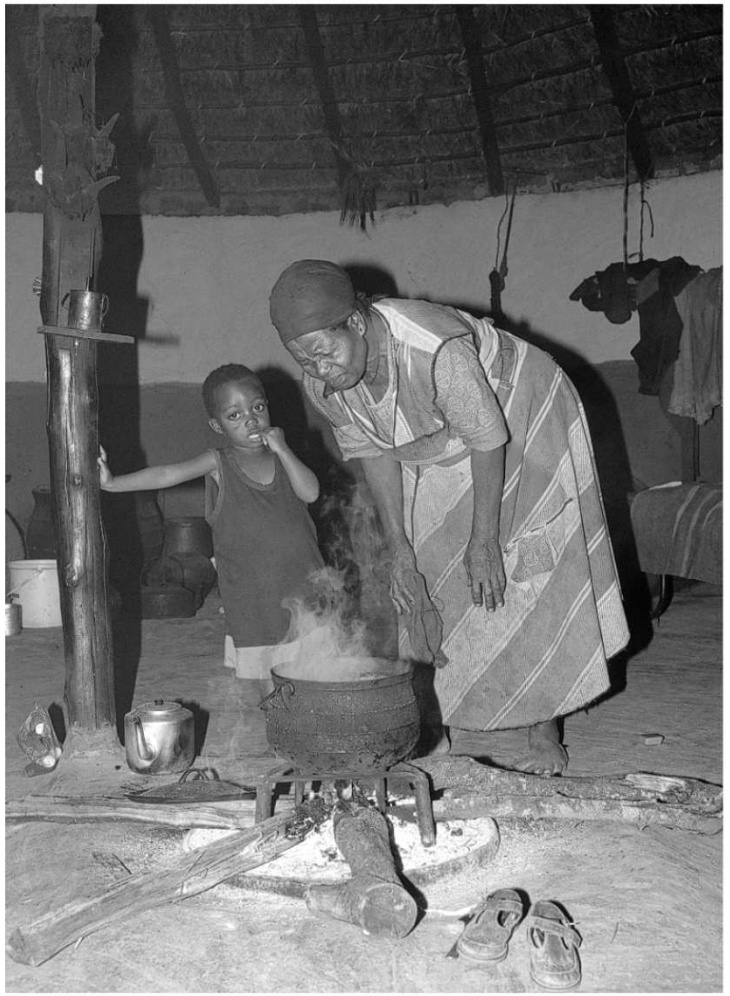


Fig. 2. **A traditional home in KwaZula, Natal, South Africa with an open wood fire**



Bruce, WHO 2000

Mexico : Significant increase of respiratory symptoms

TABLE 2. CRUDE PREVALENCE OF RESPIRATORY SYMPTOMS AND RESPIRATORY DISEASES DIAGNOSED BY PHYSICIANS ACCORDING TO FUEL USED FOR COOKING AT TIME OF SURVEY

	Gas Only ($n = 67$)		Biomass ($n = 778$)		
Variable	No.	Percent	No.	Percent	p Value*
$FEV_1/FVC < 70\%$ (GOLD stage I and above)	6	9.1	105	13.5	0.31
$FEV_1/FVC < 70\%$ and $FEV_1 < 80\%$ predicted (GOLD stage II and above)	0	0	21	2.7	0.17
Obesity (BMI > 30 kg/m^2)	21	31.3	180	23.1	0.13
Peak $PM_{10} > 2.6$ mg/m^3	1	1.6	149	20.7	< 0.001
Passive smoking	19	28.8	211	27.3	0.79
Asthma diagnosed by a physician	3	4.5	38	4.9	0.87
Bringing up phlegm all day	6	8.9	211	27.3	0.001
Phlegm more than 3 mo/yr	4	6.3	127	16.7	0.03
Cough or phlegm all day	14	20.9	286	36.8	0.009
Cough all day lasting more than 3 mo/yr	8	11.9	80	10.3	0.67
Phlegm all day lasting more than 3 mo/yr	2	3.0	99	12.7	0.02
Has wheezed in the past	20	30.3	355	46.1	0.01
Medicine prescribed for wheezing in the past	8	11.9	134	17.2	0.28
Previous attacks of wheezing with dyspnea	9	13.4	167	21.5	0.12

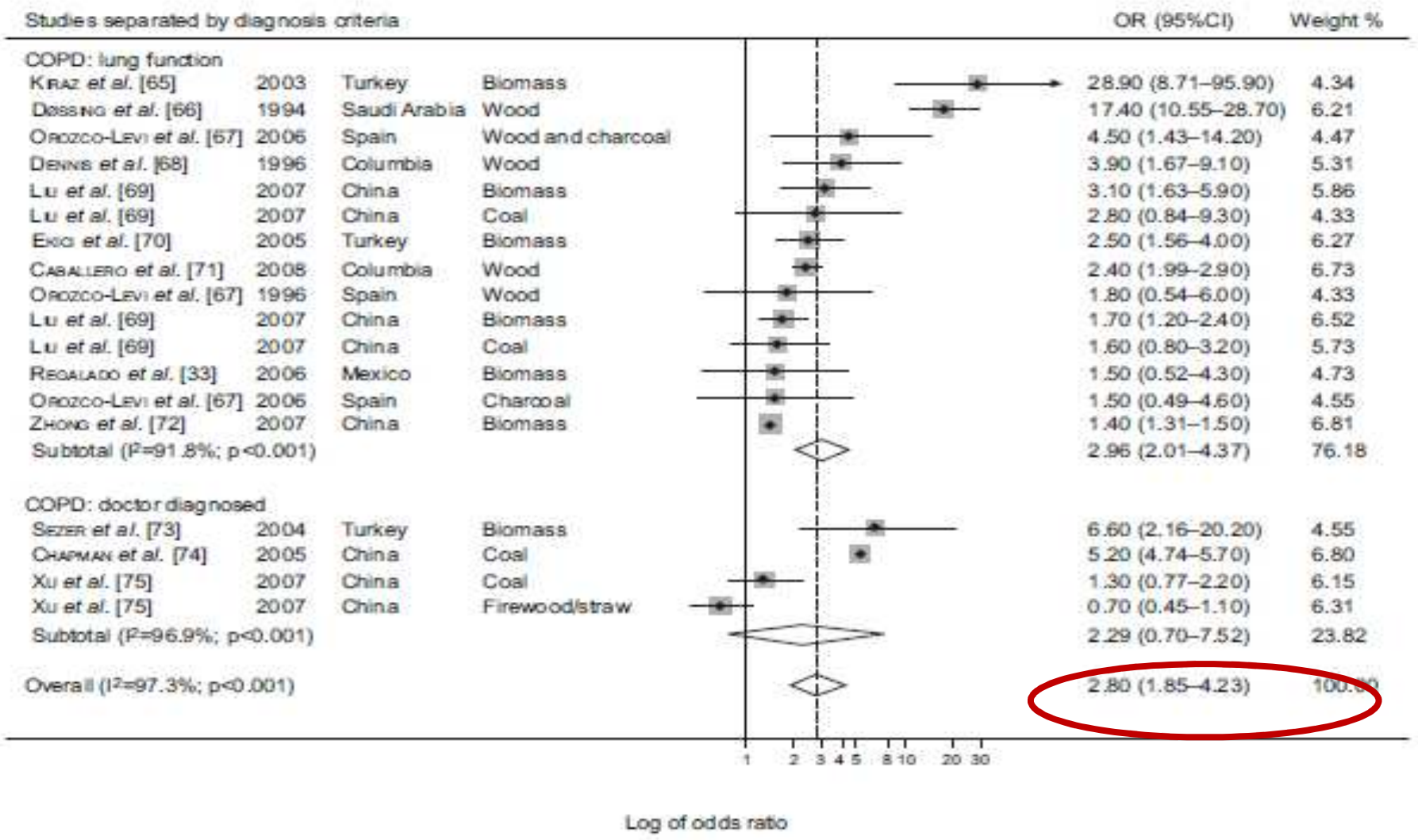
Regalado, Am J Respir Crit Care Med Vol 174. pp 901–905, 2006

Exposure to biomass smoke is associated with deficits in lung function,

- FEV1 and FVC were significantly reduced in the population using biomass compared with non-biomass using population
- Even in the yougest age group (18-25 yrs old) and in women
- Biomass add an additive effect to tobacco exposure

Kurmi Eur Resp J 2013

Exposure to biomass and risk of COPD



Kurmi Thorax 2010

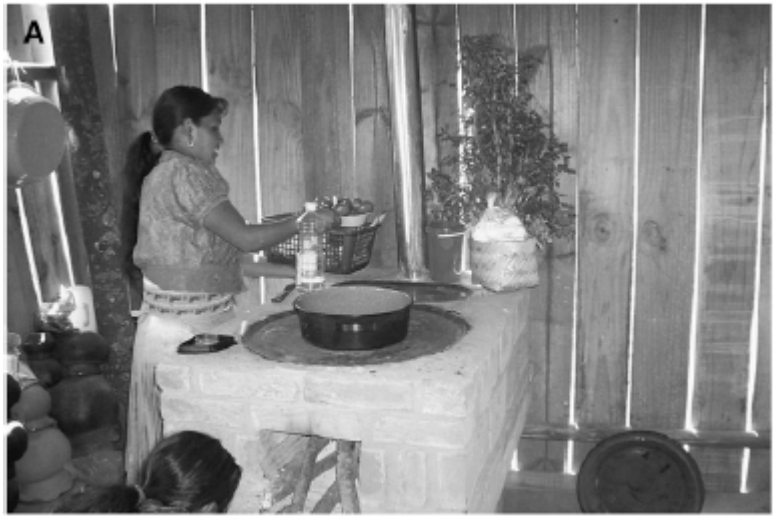
Indoor particulate matter less than 2.5 microns in mean aerodynamic diameter ($PM_{2.5}$) and Carbon Monoxide (CO) levels during the burning of mosquito coils and their association with respiratory health

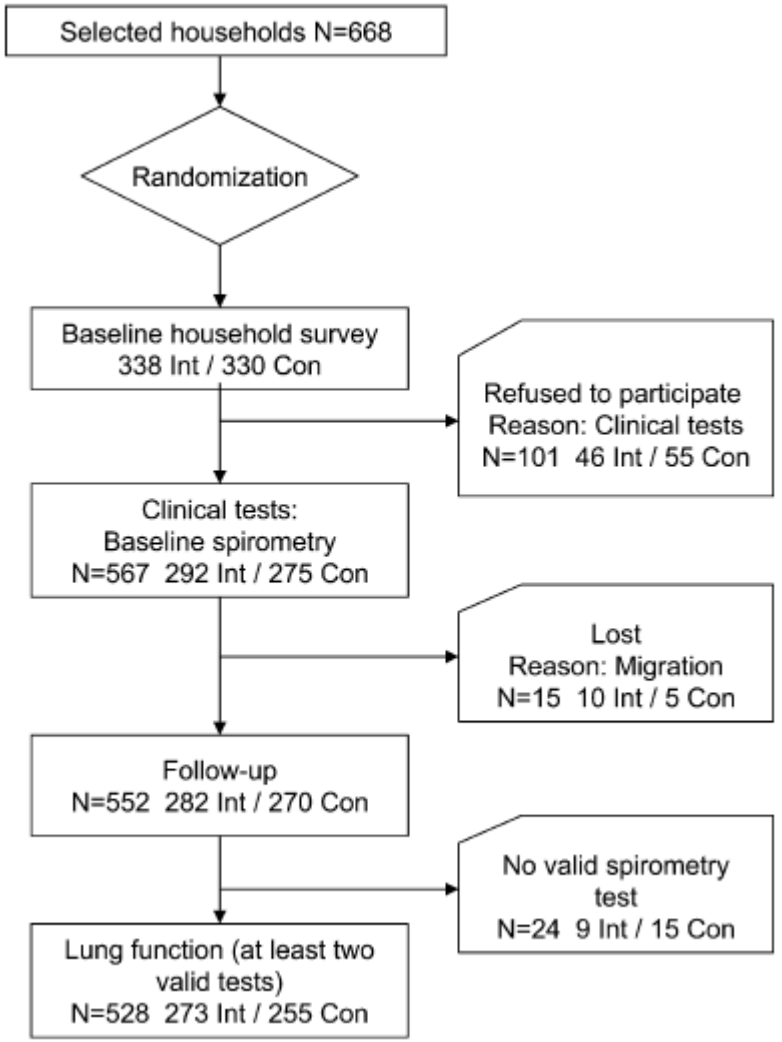
Coil	Background	WCDC	WODC	WODO
$PM_{2.5}$ levels ($\mu g/m^3$)				
Mosquito Coil – A (n=3)	72 ± 10	1031 ± 582	510 ± 511	84 ± 35
Mosquito Coil – B (n=3)	53 ± 10	848 ± 623	467 ± 514	61 ± 31
Mosquito Coil – C (Low Smoke) (n=3)	74 ± 20	355 ± 179	170 ± 142	62 ± 10

(WCDC: Window Closed, Door Closed, WODC: Window Open, Door Closed, WODO: Window Open, Door Open)

Salvi et al. Chest 2015

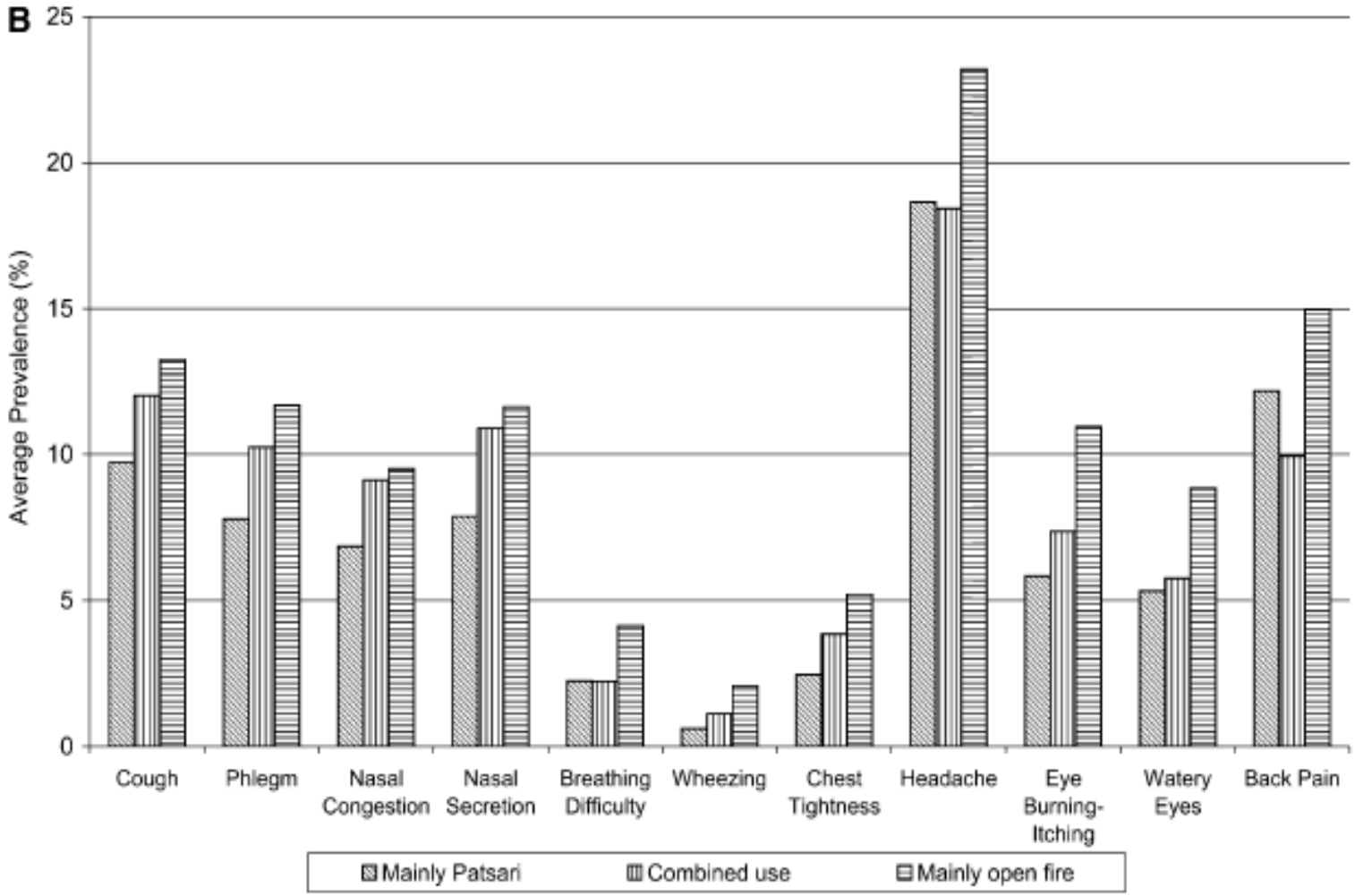
Intervention studies





Romieu, Am J Respir Crit Care Med 2009

Intervention : decrease of respiratory symptoms and in lung function decline after one year of follow-up (31 ml vs 62 ml)



Romieu, Am J Respir Crit Care Med 2009

Evaluation of interventions to reduce air pollution from biomass smoke on mortality in Launceston, Australia: retrospective analysis of daily mortality, 1994-2007

Fig 2 Launceston, Tasmania, showing reduced visibility associated with smoke from domestic wood heaters (left) and same view on clear day (right)

	Deaths per 1000 person years		
	1994-2000	2001-07	Percent decrease (95% CI)
All Tasmania			
All cause mortality:			
All year	8.33	7.12	14.6 (5.2 to 24.0)
Winter	9.32	7.88	15.5 (6.4 to 24.6)
Cardiovascular mortality:			
All year	3.73	2.65	28.9 (5.6 to 42.2)
Winter	4.28	2.96	31.1 (18.6 to 43.7)
Respiratory mortality:			
All year	0.78	0.62	20.5 (8.3 to 32.7)
Winter	1.00	0.76	22.9 (7.6 to 38.3)

Fay H Johnston *research fellow*[1], Ivan C Hanigan *research associate*[2 3], Sarah B Henderson *epidemiologist*[4], Geoffrey G Morgan *associate professor*[5 6]

BMJ 2013;345:e8446


LE CUISEUR SOLAIRE


FOUR SOLAIRE

TABLE 3 Research priorities on health effects of, exposure to and interventions for solid fuel smoke

Research priorities	Types of studies
Health effects	
Basic studies	Genetic susceptibility to various health effects
	Comparative studies on exposure to solid fuel smoke, tobacco smoke, passive smoking and traffic pollutions
	Studies on different types of health outcomes associated with exposure to solid fuel smoke but with little evidence
Epidemiological studies	Relationship between exposure and health outcomes
	Different health outcomes, e.g. cervical cancer, visual impairment, lung growth in children, asthma in children
	Studies on acute health effects of exposure to solid fuel smoke
	Dose–response curve of health effects
	Studies on toxicity of fuel types
	Studies on health effects of other contributors to indoor air pollution (oil mist, deep frying, mosquito coil, etc.)
Clinical	Mechanisms of health outcomes related to solid fuel smoke
	Characterisation and early diagnosis of health outcomes
	Histopathological differences between inhalation of biomass and tobacco smoke
Exposures	
Measurements	Standardisation of cross-sectional and longitudinal monitoring of exposure
	Better data and more focus on personal monitoring of exposure
	Modelling of personal exposure to better estimate the exposure data
	Monitoring of intervention of improved cooking stoves in terms of exposure and their performance in the long term
Equipment	Research and development on types of equipment, such as cost, size, weight, power supply and resistance to extreme conditions for developing countries
Interventions	
Improved cooking stoves	Types of stoves (multiple stoves, multiple fuel scenarios, multiple types of food cooked and different cooking practices)
	New biomass stove technology, better combustion and efficiency, and less pollutants emissions
Social intervention	Impact of massive educational programmes on raising the awareness of health effects of exposure to biomass smoke
	Acceptance of health interventions/health promotions
	Resistance to stove/health intervention programmes
Fuel types	Research on inexpensive but cleaner fuel types or source of heat such as production of briquettes and charcoal from agricultural wastes
Effects	Impact of improved cooking stoves programmes on the health outcomes

Adapted from [20] with permission from the publisher.

Summary

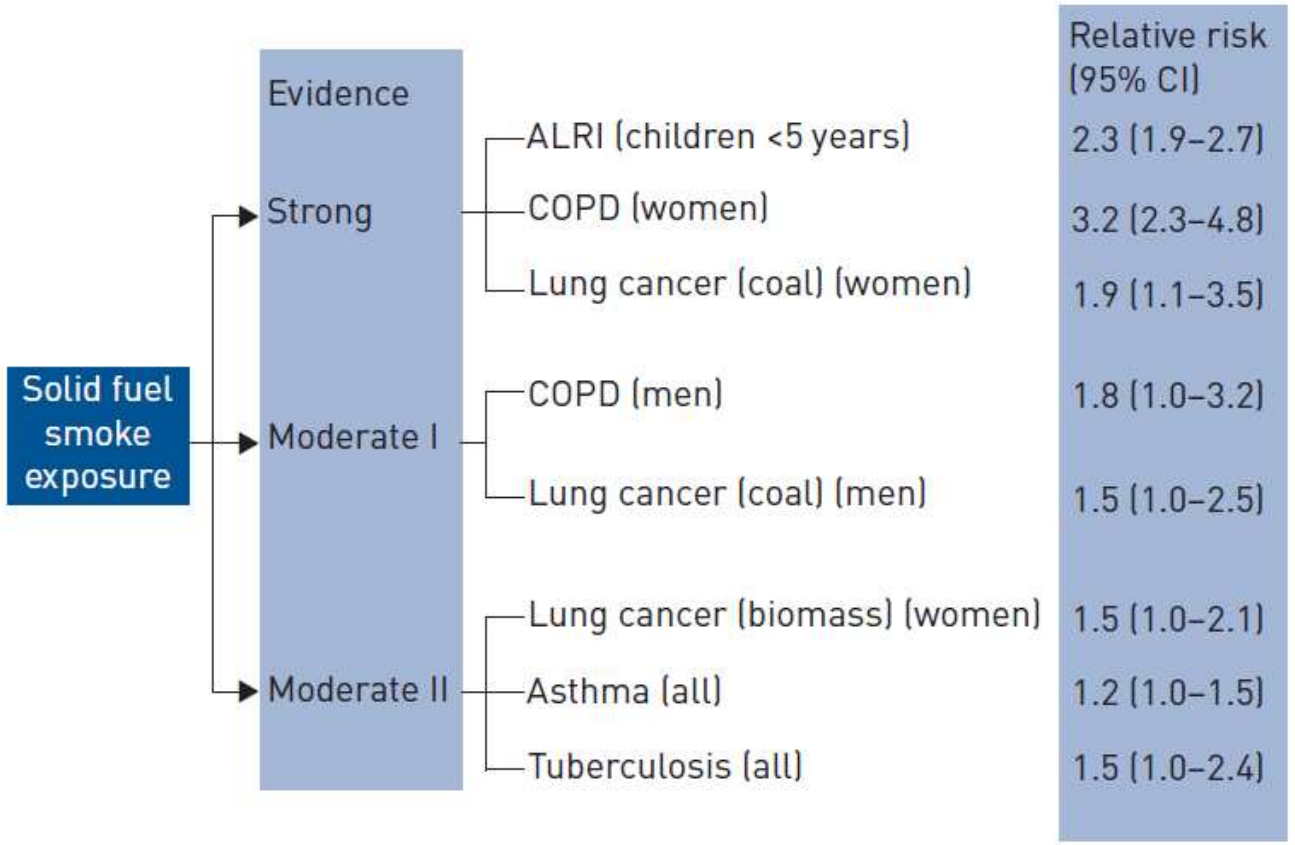


Figure 3 – The major respiratory health effects associated with exposure to biomass and solid fuel smoke. ALRI: acute lower respiratory infection; COPD: chronic obstructive pulmonary disease; CI: confidence interval. Reproduced and modified from TORRES-DUQUE *et al.*, 2008.

Conclusions

- Biomass exposure : priority of public health
- Biomass smoke : heterogeneity in composition particules (coal, particules..)
- Respiratory and cardio-vascular effects
  - New-born babies
  - Young children
  - Women
- Increase of respiratory symptoms
- Lung function decline
- Risk factor of COPD
- Intervention studies are needed

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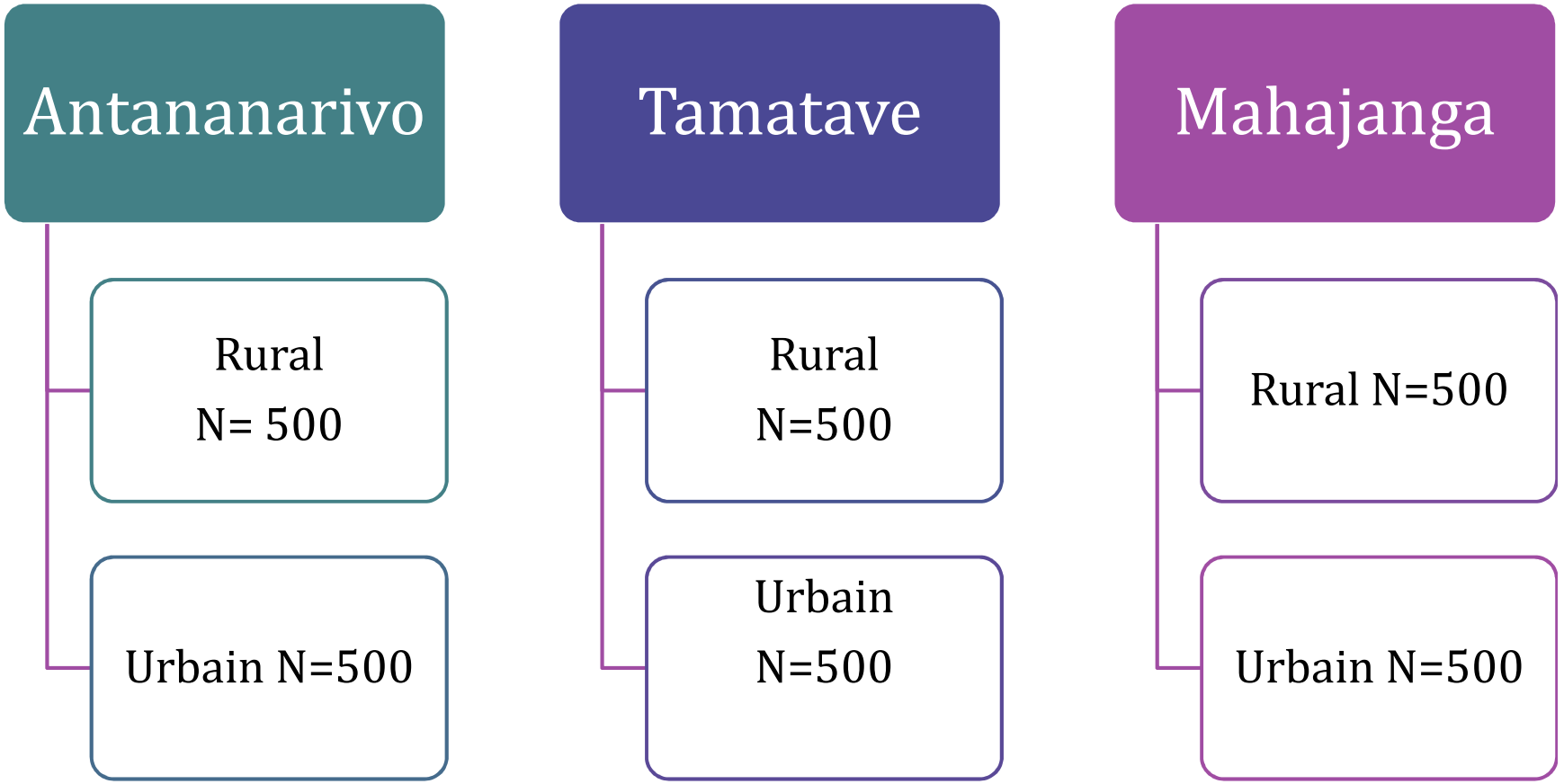
Research project



La population étudiée sera sélectionnée par un sondage en grappe dont l'unité est le foyer, à partir d'un recensement de la population.

Comité scientifique

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Antananarivo :

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Thanks