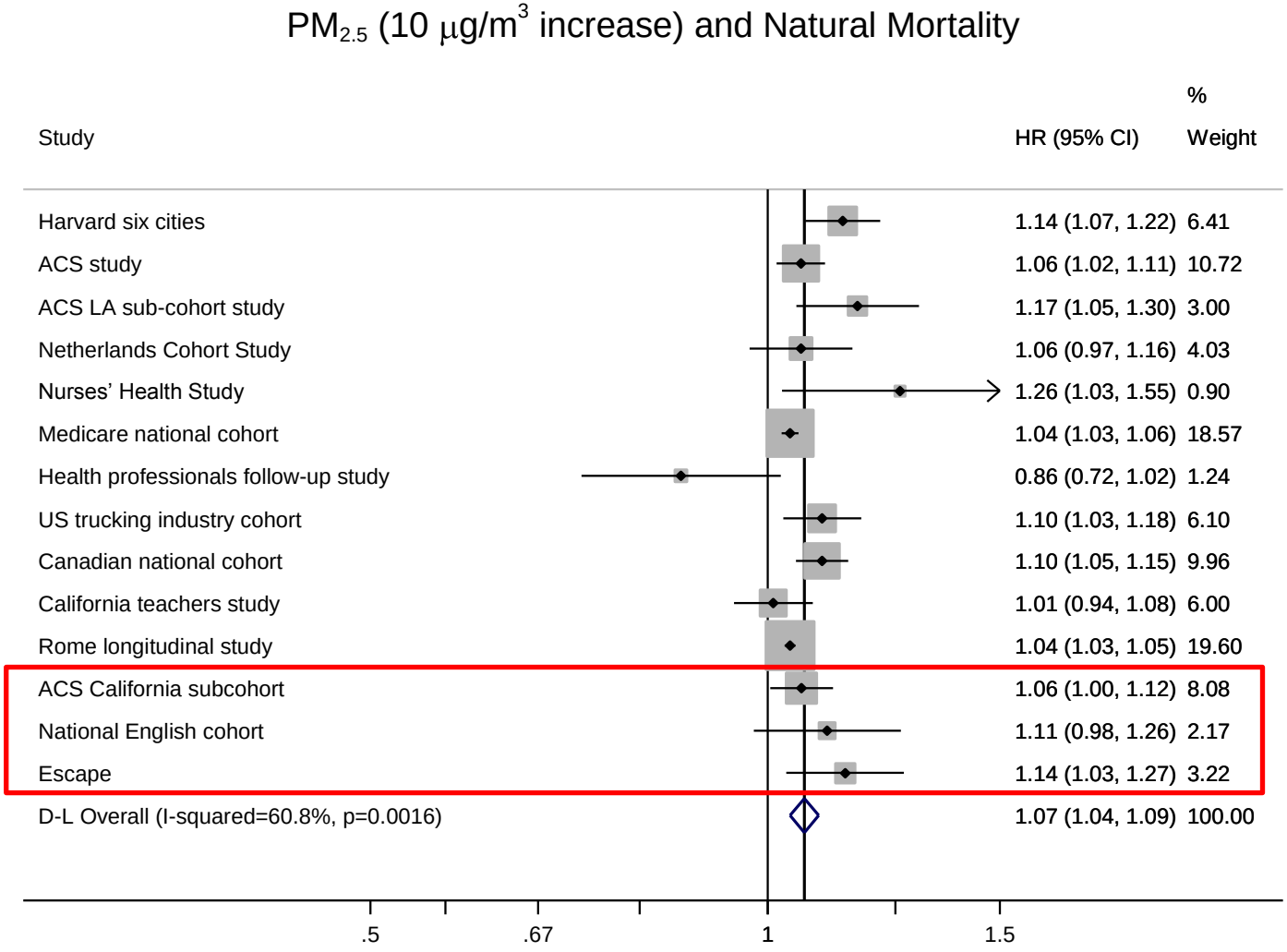
World Health Organization

WHO Expert Meeting: Methods and tools for assessing the health risks of air pollution at local, national and international level

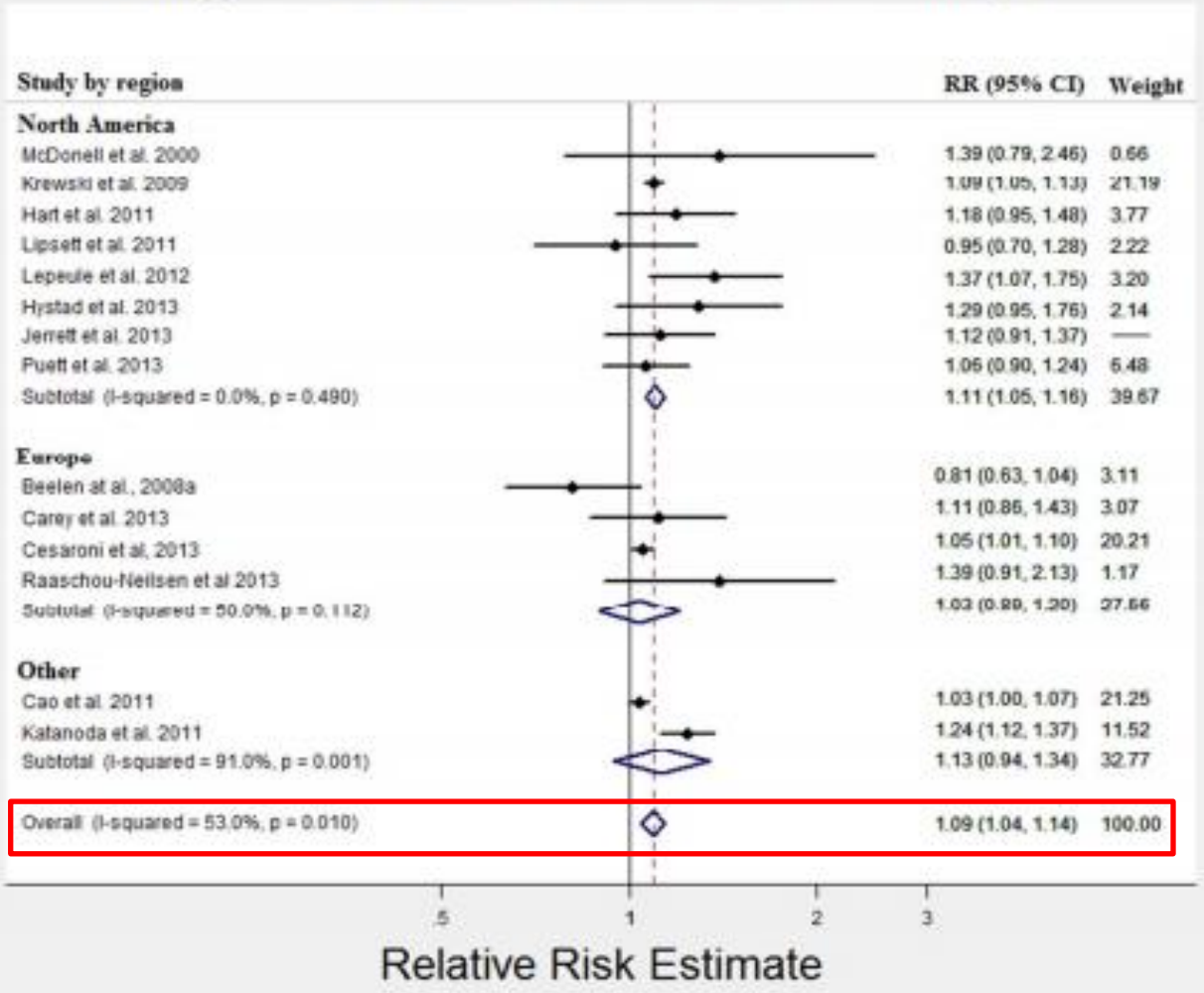
Bonn, Germany, 12-13 May 2014 **EUDCE1408123/8.3/T.4**

Updated exposure-response functions available for estimating mortality impacts

Updated long-term effects of $PM_{2.5}$ on natural mortality. 14 studies



Lung Cancer and PM2.5 Meta-Analysis



Hamra G et al. EHP 2014 (under revision)

Comparison of the $PM_{2.5}$ and NO_2 effects in the same studies (per 10 ug/m³ and IQR)

Table 2. Pooled* effects of NO2 and PM (10 µg/m^3 and IQR µg/m^3) on natural and specific-cause mortality

	total or natural mortality					cardio-vascular mortality					respiratory mortality				
	N studies	RR	95% CIs		I^2		N studies	RR	95% CIs		I^2		N studies	RR	95% CIs		I^2
NO_2 (10µg/m3)	10**	1.040	1.015	1.065	91%	NO_2 (10µg/m3)	15^§°	1.152	1.094	1.213	98%	NO_2 (10µg/m3)	7#++	1.024	1.010	1.038	0%
NO_2 (14.6 µg/m3)		1.059	1.022	1.096		NO_2 (17.9 µg/m3)		1.288	1.174	1.413		NO_2 (15.0 µg/m3)		1.036	1.015	1.058	
$PM_{2.5}$ (10 µg/m3)	9**+	1.050	1.024	1.078	78%	$PM_{2.5}$ (10 µg/m3)	14^§°+	1.228	1.084	1.39	98%	$PM_{2.5}$ (10 µg/m3)	6#++,+	1.062	1.022	1.104	11%
$PM_{2.5}$ (5.8 µg/m3)		1.029	1.014	1.045		$PM_{2.5}$ (7.0 µg/m3)		1.155	1.058	1.259		$PM_{2.5}$ (7.0 µg/m3)		1.043	1.015	1.072	

Faustini et al, ERJ, 2014

Conclusions

- Larger evidence base strengthens knowledge on $PM_{2.5}$ effects on mortality
- Linear increases in relative risks for mortality from all-natural causes, CVD, respiratory disease and lung cancer over the range of $PM_{2.5}$ in Europe and North America
- Independent effects of NO_2 of similar size to $PM_{2.5}$

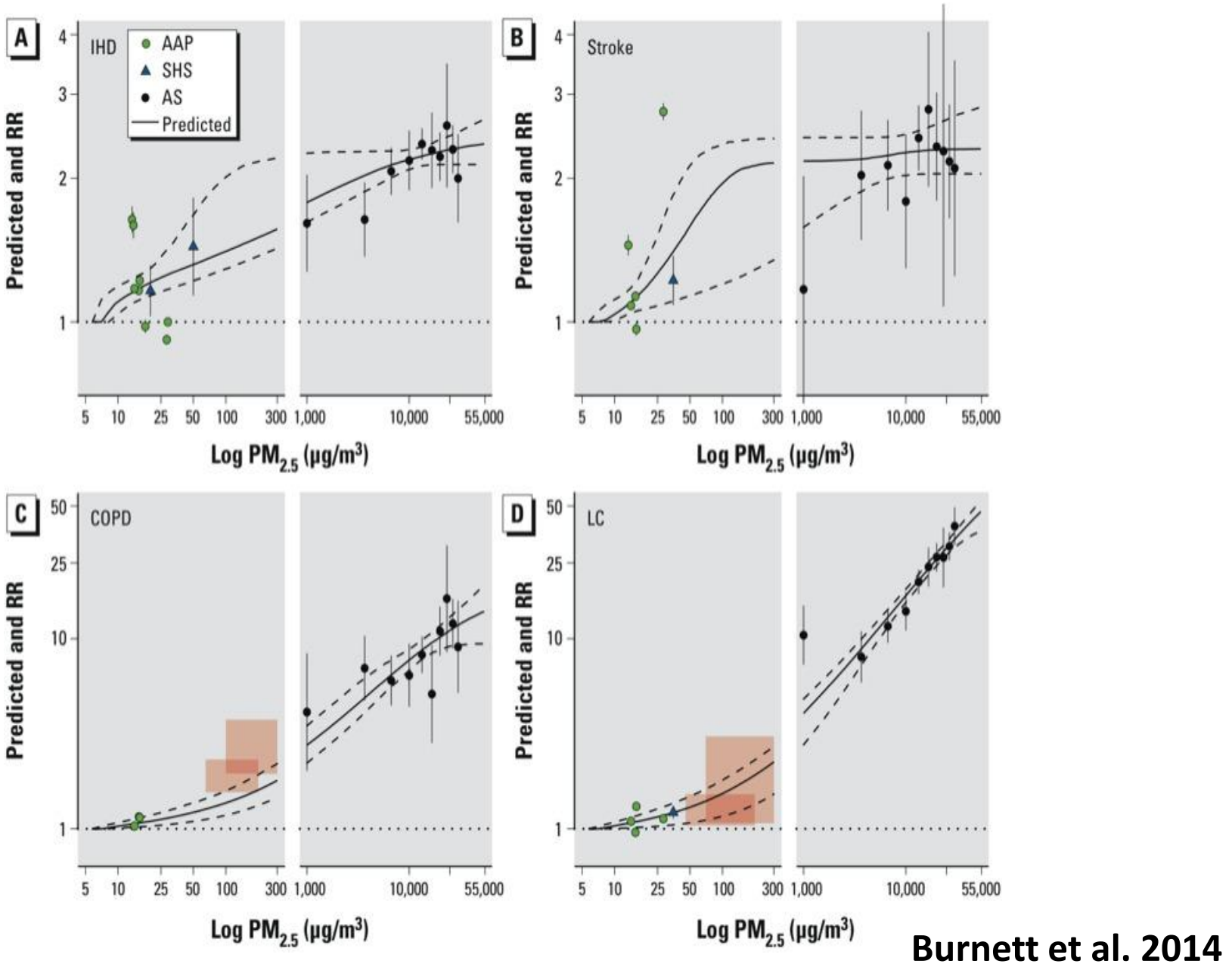
Integrated Exposure-Response (IER) Function for Particulate Matter

- **Rationale:** Most available $PM_{2.5}$ cohort studies are conducted in the US and Europe, but t is questioned whether the cohort findings from low air pollution exposure settings in developed countries are applicable to other, more polluted parts of the world
- **Objective:** to inform the risk estimates across the full range of $PM_{2.5}$ concentrations world wide
- **Method:** integrate evidence on mortality risk due to $PM_{2.5}$ from other combustion sources (second-hand smoke, household burning of solid fuels, active smoking) with risk from ambient $PM_{2.5}$ to estimate risks in highy polluted settings
- **Adopted** in the Global Burden of Disease (GBD) 2010 project
- **Details:** Burnett et al, 2014, EHP

Assumptions and Key Features of IER

- $PM_{2.5}$ exposure from diverse sources is associated with increased death risks from IHD, stroke, COPD, and LC, and with increased incidence of ALRI
- Health effects of $PM_{2.5}$ related with inhaled mass (exposure) only, but not with $PM_{2.5}$ composition and sources
- Relationship between $PM_{2.5}$ exposure and excess mortality not necessarily restricted to be linear
- The RR of mortality from exposure to AAP, SHS, HAP, and AS does not depend on the temporal nature of the $PM_{2.5}$ exposure
- No interaction exists among the various $PM_{2.5}$ exposure types for any cause of mortality
- Curves must fit evidence for ambient air pollution at the low end and evidence for active cigarette smoking at the high end

IERs for Adult Mortality



Burnett et al. 2014

Strengths and Limitations

- **Strength: enables estimation of continuous $PM_{2.5}$ risk functions across the full range of levels all over the world**

- **Limitation: requires assumptions with which expert opinion is not in complete agreement**

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The Global Burden of Disease Study 2010

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A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010

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Lancet 2012; 380: 2224–60

See Comment pages 2053, 2054, 2055, 2058, 2060, 2062, and 2063

See Special Report page 2067

See Articles pages 2071, 2095, 2129, 2144, 2163, and 2197

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See Online for appendix

For **interactive versions of figures 3, 4, and 6** see http://healthmetricsandevaluation.org/gbd/visualizations/regional

Institute for Health Metrics and Evaluation (S S Lim PhD, A D Flaxman PhD, K G Andrews MPH, C Atkinson BS, E Carnahan BA, K E Colson BA, R E Engell BA, G Freedman BA, M K Freeman BA, E Gakidou PhD, R Jasrasaria BA,

Summary

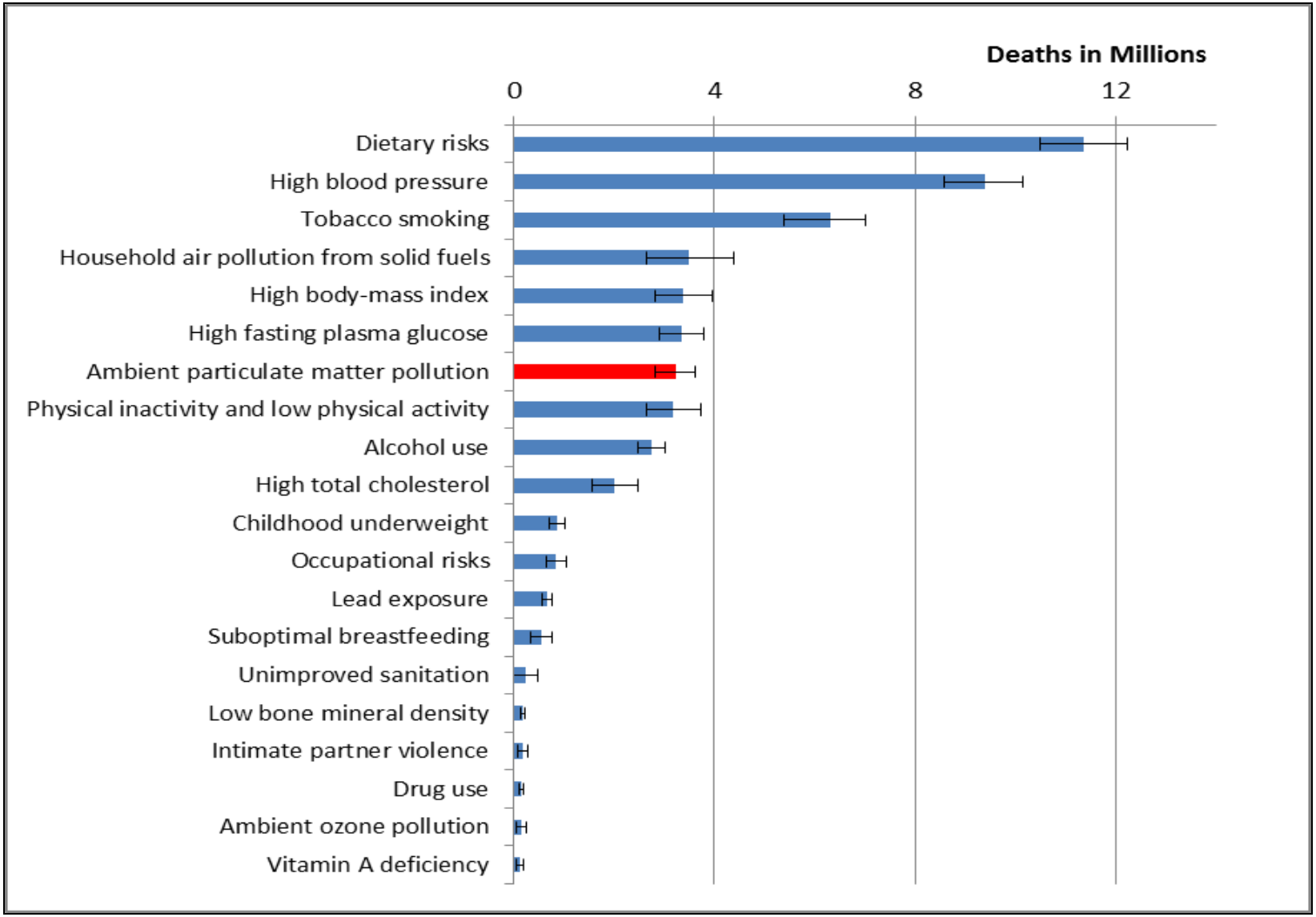
Background Quantification of the disease burden caused by different risks informs prevention by providing an account of health loss different to that provided by a disease-by-disease analysis. No complete revision of global disease burden caused by risk factors has been done since a comparative risk assessment in 2000, and no previous analysis has assessed changes in burden attributable to risk factors over time.

Methods We estimated deaths and disability-adjusted life years (DALYs; sum of years lived with disability [YLD] and years of life lost [YLL]) attributable to the independent effects of 67 risk factors and clusters of risk factors for 21 regions in 1990 and 2010. We estimated exposure distributions for each year, region, sex, and age group, and relative risks per unit of exposure by systematically reviewing and synthesising published and unpublished data. We used these estimates, together with estimates of cause-specific deaths and DALYs from the Global Burden of Disease Study 2010, to calculate the burden attributable to each risk factor exposure compared with the theoretical-minimum-risk exposure. We incorporated uncertainty in disease burden, relative risks, and exposures into our estimates of attributable burden.

Findings In 2010, the three leading risk factors for global disease burden were high blood pressure (7·0% [95% uncertainty interval 6·2–7·7] of global DALYs), tobacco smoking including second-hand smoke (6·3% [5·5–7·0]), and alcohol use (5·5% [5·0–5·9]). In 1990, the leading risks were childhood underweight (7·9% [6·8–9·4]), household air pollution from solid fuels (HAP; 7·0% [5·6–8·3]), and tobacco smoking including second-hand smoke (6·1% [5·4–6·8]). Dietary risk factors and physical inactivity collectively accounted for 10·0% (95% UI 9·2–10·8) of global DALYs in 2010, with the most prominent dietary risks being diets low in fruits and those high in sodium. Several risks that primarily affect childhood communicable diseases, including unimproved water and sanitation and childhood micronutrient deficiencies, fell in rank between 1990 and 2010, with unimproved water

http://www.thelancet.com/themed/global-burden-of disease

Global deaths in 2010 (95% uncertainty intervals) attributable to the top 20 risk factors



http://ghdx.healthmetricsandevaluation.org/global-burden-disease-study-2010-gbd-2010-data-downloads

Mortality impacts from air pollution in a Comparative Risk Assessment context

- **Many public health and policy decisions require that the mortality attributable to ambient air pollution be considered in the context of mortality due to other major health risk factors**

- **CRA provides a way to provide comparable estimates for the various risk factors, but requires that consistent approaches be used to estimate risks for each**

- **By applying a common $PM_{2.5}$ exposure metric the IER provided internal consistency among estimates for the various combustion-related risk factors, and enabled estimation of the burden of cardiovascular mortality attributable to HAP**

- **Current estimates assume that air pollution-attributable mortality is independent of other risk factors and more research is needed to address this issue**