Testimony for the Hearing on Black Carbon and Climate Change

House Committee on Oversight and Government Reform

United States House of Representatives

The Honorable Henry A. Waxman, Chair

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Joel Schwartz

Professor, Departments of Environmental Health and Epidemiology

Harvard University

It is my pleasure to provide this testimony on Black Carbon to the Committee on Oversight and Government Reform. As you have heard from the previous speakers, Black Carbon is modifying our climate. I want to make the related points that Black Carbon is a serious threat to health, that reductions in black carbon will produce immediate health improvements that make such interventions a double win, and that, unlike the case for CO2 emissions, most of those health benefits stay in the country that makes the reductions in emissions. This avoids the blame game, and incentive to get others to shoulder the burden of emissions reductions. Moreover, the estimated health benefits in developing countries are larger than in the developed world, although they too are substantial.

What is the evidence on health effects? I will begin with the developed world, where resources for scientific studies are greater. We have long known that particles in the air were not merely unaesthetic; they were associated with early death. Figure 1 below, taken from the London Smog episode of 1952 illustrates the association, and in this case the particles were almost entirely black smoke, from coal combustion and diesel buses[1]. A similar episode occurred in Donora, PA in 1948[2].

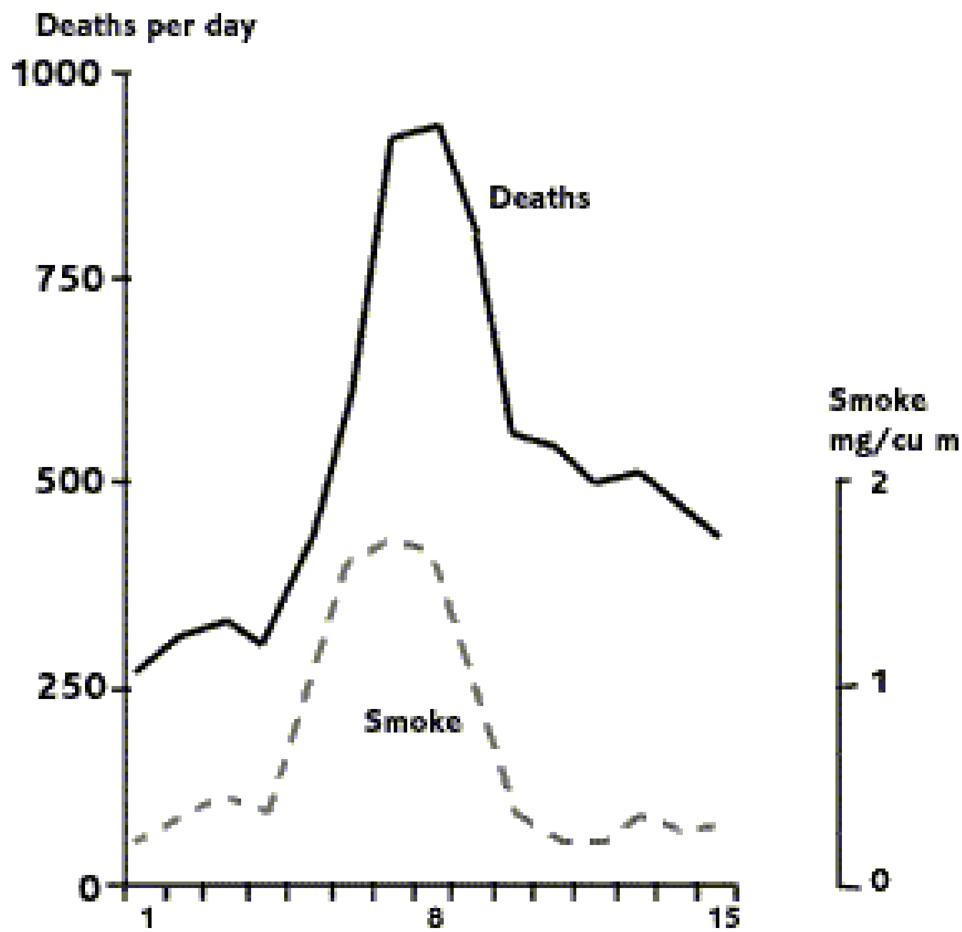


Figure 1. Daily Deaths and Black Smoke in London, Dec 1952.

In more recent times we have discovered that it is not just that daily death rates increase on days with high particle concentrations—life expectancy is lower in more polluted areas. Figure 2 shows the life expectancy in six US cities, from the Harvard Six City Study, after controlling for individual risks such as smoking, hypertension, etc, Vs the long-term average level of PM2.5

concentration in the air[3]. PM2.5—particles less than 2.5 micrometers in diameter, encompasses all combustion particles, including black carbon.

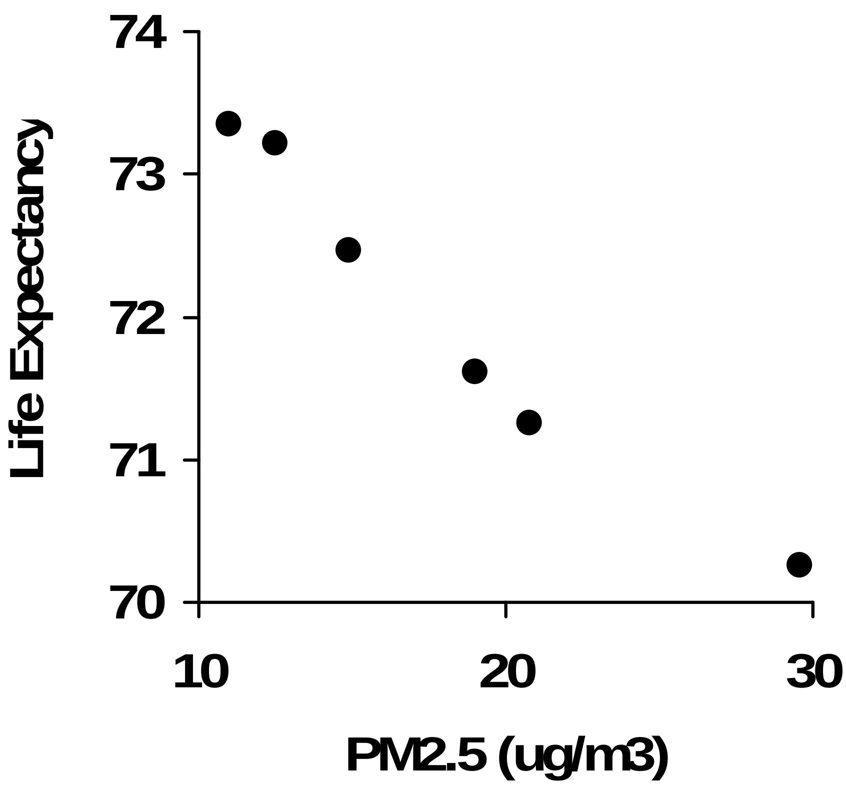


Figure 2. Survival Vs Particle Concentration in the Six City Study.

Since this result was published in 1993, it has been confirmed numerous times. Most recently, we conducted a further ten-year follow-up on the participants, a time after air pollution controls had led to reductions in particle concentrations. Figure 3, shows the results from this most recent analysis[4]. In cities where particle concentrations fell substantially, mortality rates fell substantially, whereas in cities where there was little change in particle concentrations, the mortality rate changed little.

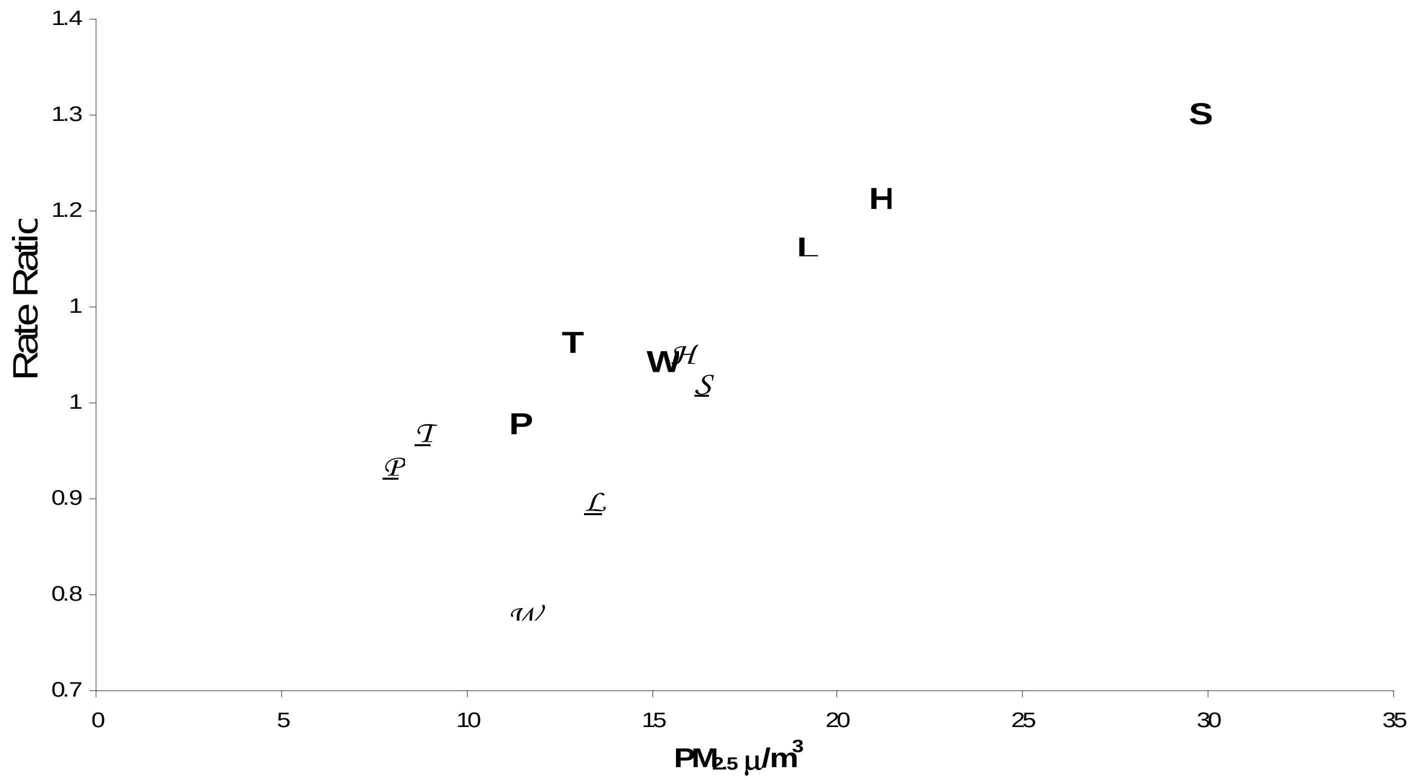


Figure 3. Change in Pollution Correlates with Change in Mortality Rate

Similarly, changes in prevalence of bronchitis, wheezing, etc have been reported following changes in particle concentrations in Germany[5] and Switzerland[6].

But these are studies of all combustion particles. What, specifically, can we say about black carbon? A recent study from the Netherlands estimated exposure to black particles at the home addresses of 5000 participants in a study similar to the Six City Study[7]. The magnitude of the mortality change associated with these traffic particles, or with direct measures of traffic, was considerably larger than seen for PM2.5 in the Six City Study, suggesting that the effect of these diesel particles on health is greater.

We have recently published a similar study looking at the acute effects of black carbon. We used data from 84 black carbon monitors throughout the Boston Metropolitan Area to develop a model predicting concentrations at any address on any day. We geo-coded all of the deaths in Eastern Massachusetts for seven years, and estimated exposure at the home address for each person (who died outside of hospital) on the day before their death, and on a nearby day when they did not die. Thus we had a case-control study where each person stood as his or her own control. This controlled almost perfectly for smoking, hypertension, etc. We found that exposures were higher on the day of death, and that on days at the 75th percentile of BC concentrations, 2.3% more people died than on days at the 25th percentile. This was considerably larger that the acute effect of PM2.5[8].

In Worcester MA, we obtained addresses on all persons with validated heart attacks over a five year period, and on age and sex matched controls. We found that the risk of having a heart attach increased by 5% as traffic density within 100 meters of the home went from the 25th percentile to the 75th

percentile, and simultaneously increased by 5% for each kilometer closer to a major highway[9]. Traffic is the source of black particles in these urban areas. Others have reported similar results. For example, Peters and coworkers interviewed heart attack victims in the Intensive Care Unit to discover what they were doing immediately preceding the onset of symptoms, and what they were doing at the same time of day on the previous few days. They found that subjects were 2.9 times more likely to be in traffic the hour preceding their heart attack than the same hour of the day before[10]. This held true for people in public transportation, so it is not likely explained by the stress of driving.

Progress has also been made recently on understanding how these particles affect heart disease. For example, we have reported that a measure of arterial stiffness is increased following BC exposure[11], that inflammatory proteins in the blood, which are risk factors for heart attacks, are increased following BC exposure[12], and that depression of the ST segment of the electrocardiogram, and indicator of either inflammation in the heart, or its failure to obtain enough oxygen, was increased following BC exposure[13].

All of this makes it clear that decreasing black carbon concentrations in the developed world will save lives, as well as providing climate impacts. And while the US EPA's recent standards for new diesel engines, as well as the EU upcoming standards, require over 90% reductions in emissions, there is no requirement for retrofit, despite diesel engine lifetimes that are typically 30 years. Hence there is scope for interventions. Retrofit kits are on the commercial market today. Indeed, London required all 6000 existing buses to be retrofit with particle filters in a two-year period, and their entire fleet is now low emitting vehicles.

The situation in the developing world involves even greater health risks, and hence larger potential for interventions that are too good for each country to pass up. Levels of particles in Chinese and Indian cities are much larger than in the US or Europe, as can be seen in Figure 4, and much of this is black carbon from coal or biomass burning.

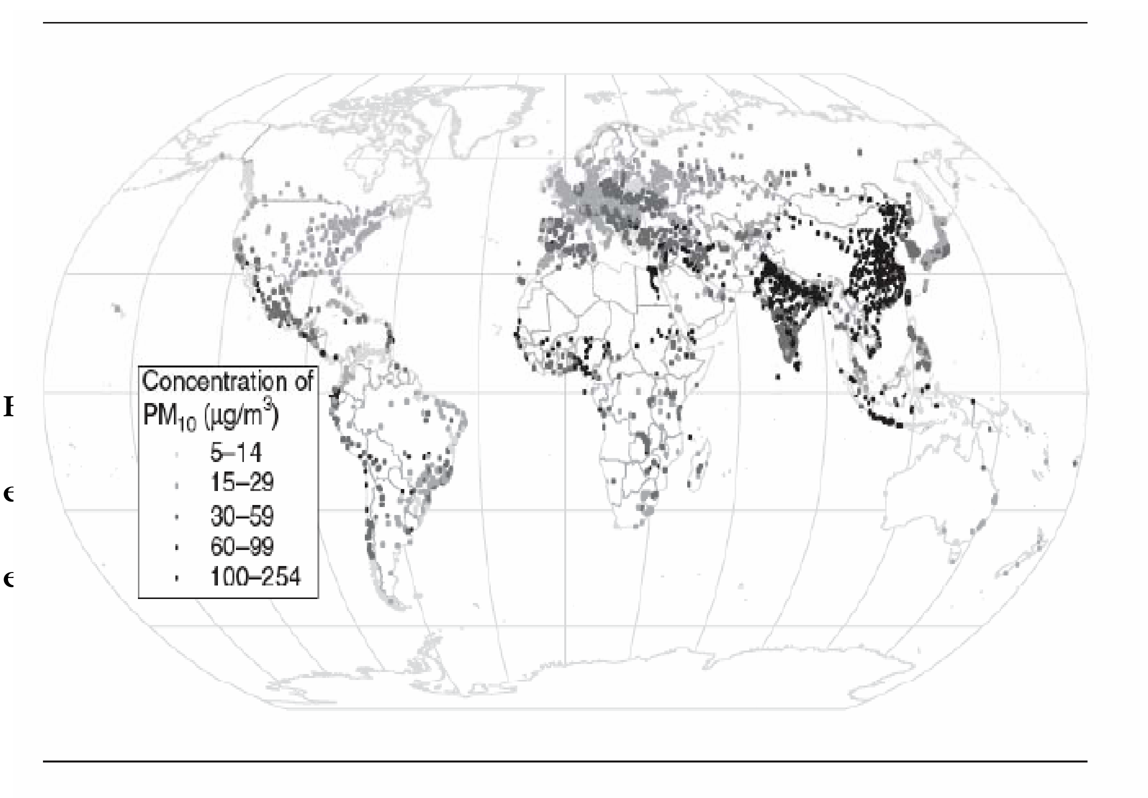
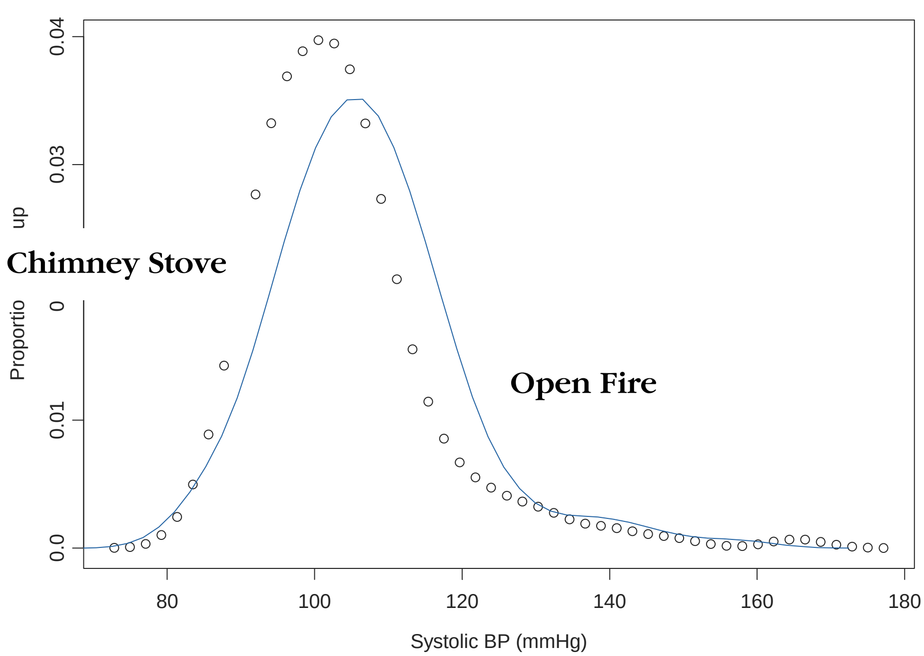


Figure 1. Estimated annual average concentrations of PM_{10} in cities with populations over 100,000 and in national capital cities. Source: (Cohen et al. 2005)

One key difference in developing countries is the level of exposure that occurs at home, due to the use of coal or biomass for cooking, often over open fires. Studies have shown that such exposure is associated with pneumonia in young children, which is the leading cause of infant mortality in most of these countries, and with chronic bronchitis in women who do the cooking. To date, little work has been done looking at the effect of this indoor exposure on heart disease. We recently collaborated with investigators at UC Berkeley on a randomized trial of an intervention giving people in the Guatemalan highlands an enclosed stove with a chimney. This significantly reduced indoor exposure, and resulted in more efficient combustion, and hence lower emissions. Figure 5, below, shows the distribution of blood pressure in the women randomized to get the stove, versus in the women who continued cooking on open fires.



The reduction in blood pressure is about half of what one obtains from the use of blood pressure medication, and suggests substantial heart disease benefits from cleaning up domestic fuel use[14].

In summary, controlling black carbon exposure, now, has immediate, substantial health benefits that more than justify the program. These benefits accrue to the countries that institute the controls, and simultaneously provide climate-related benefits. Moreover, in both developed and undeveloped countries, the technologies already exist and are available commercially, to accomplish these reductions.

References

1. Office HMsS. Mortality and morbidity during the London Fog of December 1952., London. Report No 95 on Public Health and Medical Subjects, Her Majesty's Public Health Service, London 1954. 1954.
2. Amdur MO. 1974 Cummings Memorial Lecture. The long road from Donora. Am Ind Hyg Assoc J 1974;35(10):589-97.
3. Dockery DW, Pope CA, 3rd, Xu X, Spengler JD, Ware JH, Fay ME, Ferris BG, Jr., Speizer FE. An association between air pollution and mortality in six U.S. cities. N Engl J Med 1993;329(24):1753-9.
4. Laden F, Schwartz J, Speizer FE, Dockery DW. Reduction in fine particulate air pollution and mortality: Extended follow-up of the Harvard Six Cities study. Am J Respir Crit Care Med 2006;173(6):667-72.
5. Heinrich J, Hoelscher B, Frye C, Meyer I, Pitz M, Cyrys J, Wjst M, Neas L, Wichmann HE. Improved air quality in reunified Germany and decreases in respiratory symptoms. Epidemiology 2002;13(4):394-401.
6. Bayer-Oglesby L, Grize L, Gassner M, Takken-Sahli K, Sennhauser FH, Neu U, Schindler C, Braun-Fahrlander C. Decline of ambient air

pollution levels and improved respiratory health in Swiss children. Environ Health Perspect 2005;113(11):1632-7.
7. Hoek G, Brunekreef B, Goldbohm S, Fischer P, van den Brandt PA. Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study. Lancet 2002;360(9341):1203-9.
8. Maynard D, Coull BA, Gryparis A, Schwartz J. Mortality risk associated with short-term exposure to traffic particles and sulfates. Environ Health Perspect 2007;115(5):751-5.
9. Tonne C, Melly S, Mittleman M, Coull B, Goldberg R, Schwartz J. A case-control analysis of exposure to traffic and acute myocardial infarction. Environ Health Perspect 2007;115(1):53-7.
10. Peters A, von Klot S, Heier M, Trentinaglia I, Cyrys J, Hormann A, Hauptmann M, Wichmann HE, Lowel H. Particulate air pollution and nonfatal cardiac events. Part I. Air pollution, personal activities, and onset of myocardial infarction in a case-crossover study. Res Rep Health Eff Inst 2005(124):1-66; discussion 67-82, 141-8.
11. O'Neill MS, Veves A, Zanobetti A, Sarnat JA, Gold DR, Economides PA, Horton ES, Schwartz J. Diabetes enhances vulnerability to particulate air pollution-associated impairment in vascular reactivity and endothelial function. Circulation 2005;111(22):2913-20.
12. O'Neill MS, Veves A, Sarnat JA, Zanobetti A, Gold DR, Economides PA, Horton ES, Schwartz J. Air pollution and inflammation in type 2 diabetes: a mechanism for susceptibility. Occup Environ Med 2007;64(6):373-9.
13. Gold DR, Litonjua AA, Zanobetti A, Coull BA, Schwartz J, MacCallum G, Verrier RL, Nearing BD, Canner MJ, Suh H, Stone PH. Air pollution and ST-segment depression in elderly subjects. Environ Health Perspect 2005;113(7):883-7.
14. McCracken JP, Smith KR, Diaz A, Mittleman MA, Schwartz J. Chimney stove intervention to reduce long-term wood smoke exposure lowers blood pressure among Guatemalan women. Environ Health Perspect 2007;115(7):996-1001.