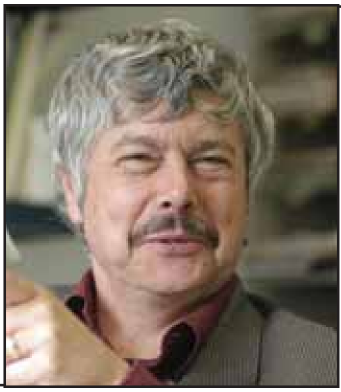
INDOOR AIR POLLUTION



Update on the Impacts of Household Solid Fuels

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The impact of air pollution on health depends on how much pollution people actually experience during their daily lives, which is called their "exposure." Exposures can be great even when emissions do not affect the outdoor environment significantly, if the source of emissions is close to the population.

It has been estimated that nearly half the world's population still uses solid fuels (biomass and coal) for household cooking and spaceheating, mostly in developing countries. In the proper conditions, biomass (wood and agricultural residues) can be burned quite cleanly, producing mostly carbon dioxide and water. Such conditions are difficult to achieve in small-scale inexpensive stoves, however, and the actual emissions of health-damaging pollutants are quite large per unit fuel, although the total emissions are not large in the context of overall fuel use.

Studies in India and China, for example, show that the percentage of fuel carbon fully burned to carbon dioxide is typically only 90 percent, with some fuel/stove combinations doing as poorly as 80 percent. This means that 10 to 20 percent of the fuel carbon is diverted into products of incomplete combustion—primarily carbon monoxide, but including benzene, butadiene, formaldehyde, polyaromatic hydrocarbons, and many other compounds posing health hazards. The best single indicator of the health hazard of combustion smoke is thought to be small particles, which contain many chemicals. Household coal use, largely found in China today, can present additional hazards because of the intrinsic toxic contaminants in some coals, including sulfur, arsenic, fluorine, mercury, and selenium.

This combination of being used in an activity in close daily proximity to a large population with significant emissions of health-damaging pollutants per unit activity means that household solid fuel use produces substantial total population exposures to important pollutants. The exposures are highest in poor women and young children of developing countries, both rural and urban, who are the groups most often present during cooking with solid fuels.

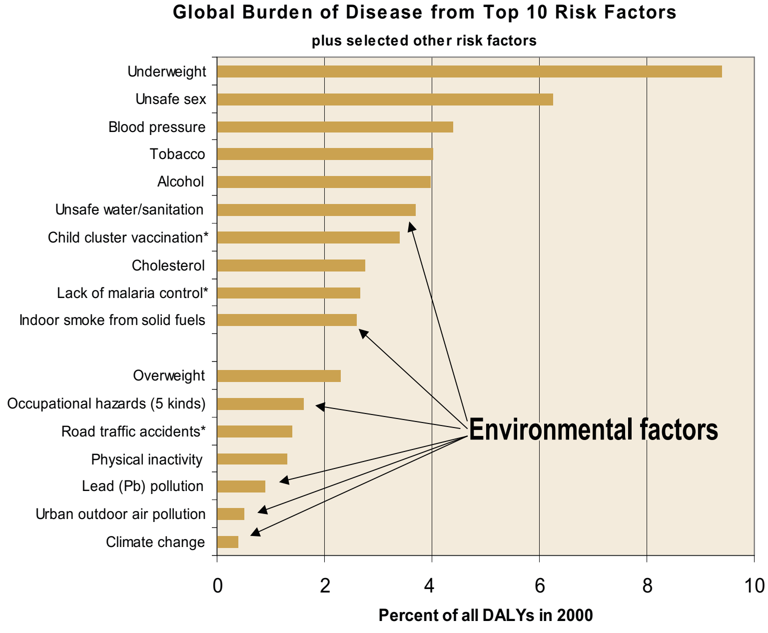
Since the mid-1980s and more frequently since the mid-1990s, there have been many dozens of published epidemiological studies examining a range of health effects from indoor air pollution due to solid fuel use. Because of the difficulty and expense of exposure assessment in households, however, most have used a surrogate for true exposure, often simply whether the households are using solid fuels or not. Even with such an imprecise measure, however, health effects of several sorts have repeatedly been found. The best evidence is for (a) acute lower respiratory infections (pneumonia) in young children, the chief killer of children worldwide and the disease responsible for the most lost life years in the world; (b) chronic obstructive pulmonary disease, such as chronic bronchitis and emphysema, in adult women who have cooked over unvented solid fuel stoves for many years; and (c) lung cancer, though the best evidence is only for coal smoke.

The World Health Organization, in a risk assessment that combined the results of many studies, compared the burden of illness and premature death from solid fuel use along with other major risk factors, including outdoor air pollution, tobacco smoking, and hypertension among others. The results indicate that solid fuel use may be responsible for 0.8–2.4 million premature deaths each year. As shown in the Figure below, using the central ("best") estimates for the risk factors examined puts solid fuel use approximately tenth among major health risks in the world in terms of potentially preventable lost life-years.

More recent studies indicate that the past studies of solid fuel use and pneumonia in young children probably overestimated the risks due partly to confusion of upper and lower respiratory infections, the former not bringing a death risk but being quite difficult to distinguish in field research from dangerous lower respiratory infections. On the other hand, there is now growing evidence of health effects of other kinds, including tuberculosis, cataracts, several other cancers, low birthweight, and heart disease. Effects in men are also being seen. Thus, while the estimated impact on childhood pneumonia may decrease in future risk assessments, the impact of other diseases will probably be added.

It is one thing to determine that ill health is associated with a particular risk factor, but quite another sometimes to show that reduction in the risk factor will actually produce an improvement in health. This has only been done in two cases to date, one in south China with coal and another in Guatemala with wood. The China study, done in retrospect, showed reduction in lung cancer and chronic obstructive pulmonary disease due to introduction of improved stoves in the late 1970s. The other, a randomized trial of improved stoves in highland Guatemala, is just now being completed. It focused on childhood pneumonia but also examined heart and lung effects in women.

Estimated burden of disease in 2000 measured as lost healthy life years (DALYs) from major preventable risk factors. Those marked with an asterisk are based on outcomes in the Global Burden of Disease database of the World Health Organization (WHO). The remaining estimates are from the Comparative Risk Assessment managed by WHO (Ezzati and others 2004).



Although the risk estimates will continue to be refined and new health effects probably will be added, the challenge in a development context is to find a viable intervention that can be relied on to reduce exposures and improve health cost-effectively. Improved fuels, such as LPG, undoubtedly produce fewer emissions and exposure themselves, but they are expensive and, at least at first, people generally do not completely switch away from solid fuels but continue to use them for some tasks. Well-designed, built, and used improved stoves with chimneys do reduce kitchen pollution substantially, but they produce much lower reductions in human exposures because the smoke is still released in the vicinity of the household. In addition, successful dissemination of well-operating and durable stoves in large populations has not been easy. That such stoves may also have social and economic benefits, however, encourages further work to find ways to disseminate them widely.

It is perhaps surprising that biomass stoves also contribute to global warming even when the fuel is harvested renewably and is thus "carbon neutral," that is, the fuel carbon released into the atmosphere is captured by regrowth of the biomass. This is because the products of incomplete combustion are more powerful greenhouse pollutants than CO_2, the primary greenhouse gas. In addition to methane and other gases, a particularly powerful greenhouse pollutant from small-scale biomass combustion is now thought to be black carbon particles. Thus, the 10–20 percent of carbon diverted to non-CO_2 pollutants means that there is a net contribution to global warming even if the CO_2 is completely recycled in a renewable fuel cycle. To be truly greenhouse-neutral, a biomass fuel cycle must not only be renewable but also combusted efficiently, which is not the case in simple biomass stoves. With the high diversion of carbon to greenhouse pollutants in many household biomass stoves, it is even possible to argue that an efficient clean-burning fossil fuel such as LPG could be introduced as a greenhouse measure. The attractiveness of this approach, however, depends on assumptions related to discount rates and atmospheric warming potentials of the different pollutants involved.

To blunt global warming, it is the world's use of fossil fuels that needs to be addressed.

This is not to say that the growing risk of global climate change is due to the stoves of the poor. Far from it! However, since the high greenhouse emissions from small stoves per unit fuel have the same cause as the health-damaging pollutants (incomplete combustion), it raises intriguing possibilities for introducing improved stoves and fuels that reduce both risks at once, i.e., produce substantial "co-benefits." The costs of reducing carbon emissions from stoves with higher combustion efficiency look to be well within those now being considered in various carbon trading or Clean Development Mechanism schemes. Thus, it may be possible to purchase carbon savings at a reasonable price and achieve substantial health benefits as a side product, or vice versa. What has not been shown, however, is whether it is possible to introduce high-efficiency stoves to large populations such that they are built, operated, and maintained for long-term reliable performance.

The only large-scale successful improved stove effort to date was in China, which facilitated the introduction of perhaps 180 million improved stoves in the 1980s and 1990s without any foreign involvement. It focused on fuel savings but did apparently achieve some reduction in pollution exposures as well by use of chimneys, although little if any improvement in combustion efficiencies. Nepal is currently engaged in a national program, but no air pollution or health assessments of the results have been done to date. Since better standard methods and new equipment for assessing the pollution and health implications of improved stove programs are now being developed and field-tested, however, there should be reliable information soon about the actual changes produced by this and other improved stove and fuel programs around the world.

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