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Indoor Air Pollution

at a glance

Why is alleviating Indoor Air Pollution a priority?

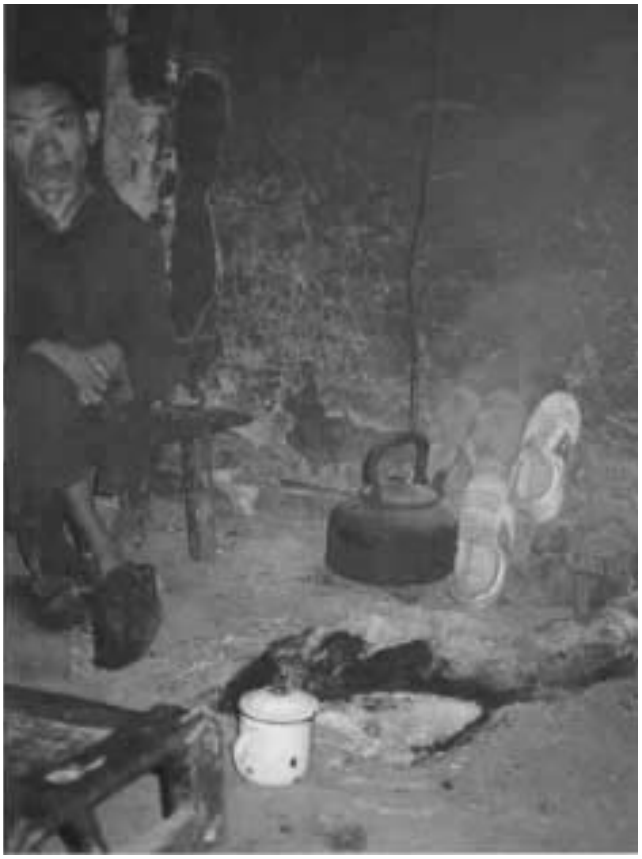
Indoor Air Pollution (IAP) is a major risk factor, **accounting for about 4% of the global burden of disease measured by disability adjusted life years (DALYs) lost**. It is caused by the use of low-cost, widely available traditional energy sources such as coal and bio-mass (wood, dung, crop residues) for cooking and home heating. Bio-mass is still the **main source of energy for 60 to 90% of households in developing countries, about 3.5 billion people.** The health burden from IAP is greater in high-altitude rural areas and amongst poor families who tend to use cheap bio-mass and low quality coal fuels in primitive stoves without proper ventilation. Women and young children are at greatest risk because their gender roles and household responsibilities and behaviors—cooking and spending a lot of time indoors—result in high exposure to IAP (85% of all global particulate exposure occurs indoors).

Bio-mass and coal, while cheap and readily available, are extremely polluting. They pose serious health hazards due to acute and chronic exposure to particulates (PM_{10}), sulfure and nitrous oxides (SO_2, NO_x), carbon monoxide (CO), fluoride (coal), aldehydes and para amino hydrocarbons (PAH). Developing countries account for 77% of all global particulate exposure, where numerous studies have found that IAP levels are typically many times higher than developed world standards for ambient air quality. Concentration levels vary greatly depending on the time of day, season and place of measurement, especially for inhalable particulates (<PM_{10}) and CO levels.

Use of solid fuels, biomass or coal causes respiratory and other illnesses. It also has implications for household safety (burns and disfiguration, fire), allocation and use of the time of household members, especially women, and local ecology (hygiene, fire hazards, ambient air pollution, etc.) Furthermore, IAP is a proxy indicator of inefficient use of scarce sources of energy and household income and assets. For example, up to 85% of the energy generated by a three-stone open fire is wasted, which is a real problem considering that poor families spend up to 20% of their income on solid fuels and/or spend one quarter of their time gathering wood.

How large is the global burden of ill health from IAP?

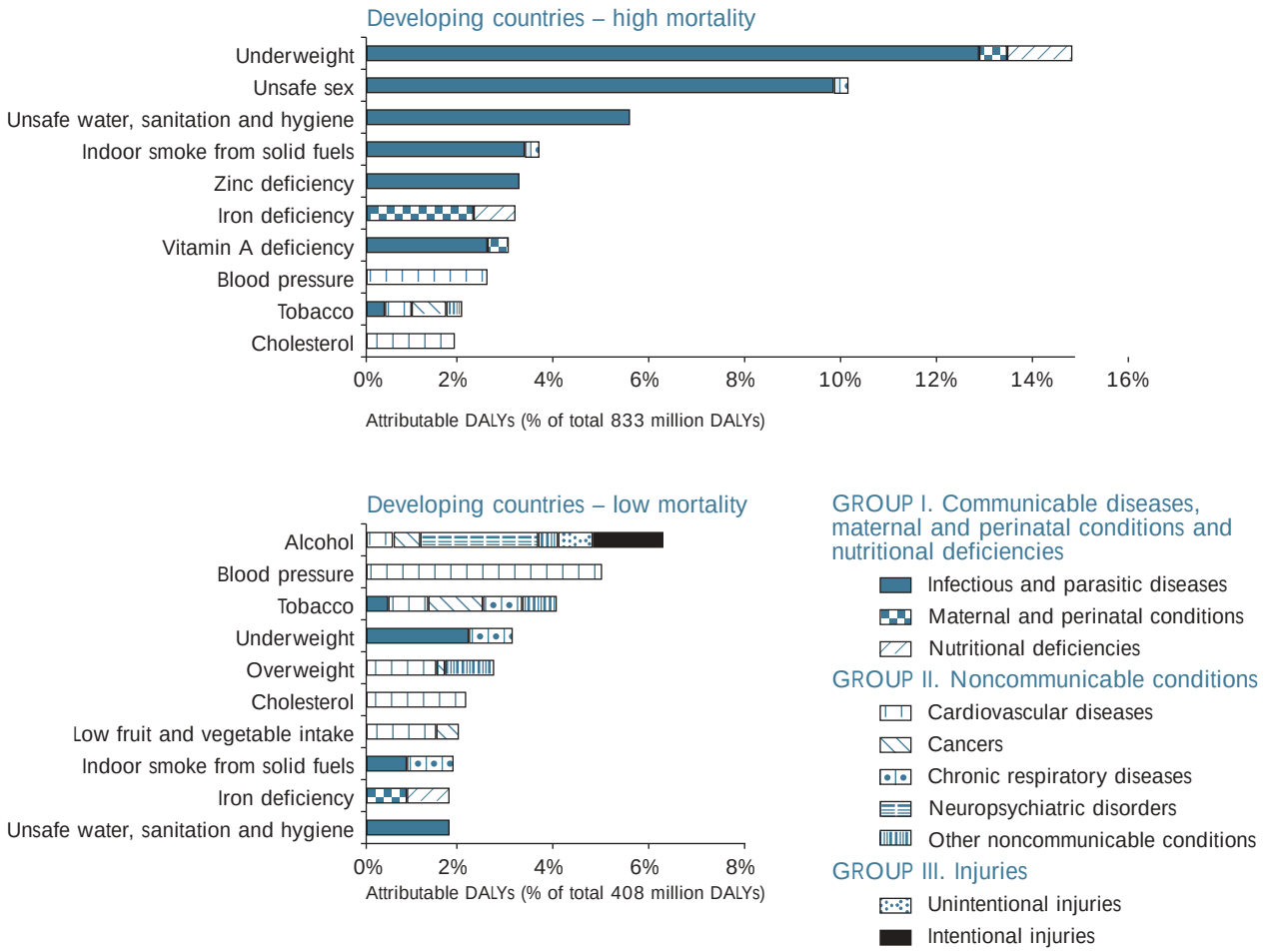
While acute exposure to smoke may result in carbon monoxide poisoning and death, most of the effects occur as a result of long term exposure. There is strong evidence that chronic exposure to indoor air pollutants **increases the risk of a range of respiratory illnesses,** including acute lower respiratory infections (ALRI) in children and chronic obstructive pulmonary disease (COPD) in adults. In addition, chronic exposure to coal smoke results in **increased risk for lung cancer.**



IAP hazards in homes: open fires and cigarette smoke.

Source: Institute of Environmental Health and Engineering, Chinese Academy of Preventive Medicine, 2000.

Burden of disease attributable to 10 selected leading risk factors, by level of development and type of affected outcome



Source: World Health Report, 2002

According to the World Health Report (WHR) 2002 about 36% of ALRI, 22% of COPD and 1.5% of cancers of the trachea, lung and bronchus are caused by exposure to IAP. Other conditions attributed to IAP for which the evidence is emerging but still inconclusive include increased susceptibility to asthma and middle ear infections in children, and tuberculosis, cataracts, and cancers of the nasopharynx and larynx in adults. Two studies have also implicated indoor air pollution in low birth weight and perinatal mortality. Finally, one could include burns (although not directly related to IAP), eye irritation, and fluorosis due to exposure to smoke from coal with high fluoride content through inhalation and ingestion.

Several reviews have tried to estimate the global burden due to use of solid fuels by applying disease specific relative risks or odds ratios to global estimates of the number of households using solid fuels. WHR 2002 finds that **2.7% of the total global burden of ill health measured as DALY's is attributable to IAP,** almost 80% of which occurs in Africa and South and South East Asia. **Indoor Air Pollution ranks eighth globally among risk factors,** and fourth in developing countries with high mortality, which make up 40% of the world population,after underweight, unsafe sex and unsafe water, sanitation and hygiene, but before micronutrient deficiencies and tobacco. COPD and lung cancer are the main causes of death associated with IAP in China whereas ARI account for more than 80% of the deaths and DALYs lost in India.

What can be done to alleviate Indoor Air Pollution?

Eventually, most developing countries will move up the **energy ladder** to liquid or natural gas, or electricity. But this move is inhibited by poor people's **low incomes and limited access to high quality fuel such as liquefied petroleum gas (LPG), natural gas or electricity.** In fact, use of biomass and coal have stagnated at around 25% of all energy sources since 1975, and may even

Many interventions have been shown to be effective in reducing indoor air pollution. These can be grouped into three categories:

Intervention type	Intervention examples	Key monitoring indicators
technologies which aim at **improved cooking/heating devices,** improved fuels, or reduced need for heating	■ better stove design ■ better ventilation to reduce IAP particulate levels in houses ■ switch to cleaner (but typically more costly) fuels ■ chemical treatment of some fuels, eg coal ■ reduce size of fuel pieces, eg briquettes and pellets instead of large coal lumps ■ better insulation ■ solar energy for boiling water	✓ Particulates (PM_{10}) in the air in homes ✓ Carbon monoxide (CO in parts per million or ppm) ✓ Fluoride levels in food (for households that use coal which contains fluoride) ✓ Ideally, have beneficiaries wear a device that measures direct exposure to PM_{10} over a specified time period (eg 24 hours) before and after the intervention
technologies aimed at improving the **living environment**	■ partitions, walls or screens in homes to separate cooking and sleeping/living areas ■ better ventilation or ducts, hoods to carry smoke and particulates outside the house	
behavioral change to reduce exposure and/or reduce smoke generation	■ reduce time spent in kitchen/cooking area ■ keep lids on pots while cooking ■ proper stove maintenance and cleaning ■ push fuel (esp plant stalks) deeper into stove so that less smoke "escapes" into the room ■ keep children away from the smoke	

be increasing with growing poverty and income disparities. According to the World Energy Council, biomass energy use is likely to reach the equivalent of 1.1–1.3 gigatones of oil by 2020. Even when energy transition starts, most households continue to use a mix of modern and traditional fuels and energy sources to meet various household needs.

Several intervention studies have shown that simply switching from wood to charcoal, or installing better stoves can reduce exposure to PM_{10} substantially and reduce ALRI incidence. These interventions appear to be highly cost-effective. For example, in India one **improved biomass stove program cost only $50–100 per DALY saved,** slightly higher than the provision of water in rural areas ($35 per DALY saved), but still well within the cost-effective range (< $150–200 per DALY saved). However, before recommending changes in fuel source, technology and behavior, the implications for affordability, commercial viability, socio-cultural acceptability, environmental impact and long term sustainability need to be considered. **Large-scale community-based intervention trials** are needed to document cost-effectiveness, feasibility and long-term sustainability of multi-sectoral interventions.

The World Bank's role

The World Bank is strategically well positioned for **advocacy, and inter-sectoral research and interventions** to alleviate indoor air pollution in poor rural settings. The Bank has already spearheaded numerous initiatives to improve household energy use through energy and rural development operations. An important lesson of experience is that interventions must be evaluated from several perspectives: health, energy, environment, and cultural/social practices, such as the ways in which homes are used. Recent **multi-sectoral intervention** initiatives and advocacy efforts are underway in India, China, Guatemala and other high-burden countries to improve access to efficient and affordable energy through local design, manufacturing and dissemination of **low-cost stove technologies, modern fuel alternatives and renewable energy solutions.**

Best Practices and Implementation Lessons Learned:

- Effectiveness will depend on three key considerations: (i) **the policy and regulatory context;** (ii) **making sure that all relevant sectors/perspectives** are considered in interventions that aim to increase fuel efficiency, reduce health risks and improve local ecology; and (iii) l**ocal community involvement** in technology design and application, especially with regard to stoves and ventilation.
- Improved stove design should be needs-based and tailored to the local ecology and socio-economic conditions of the community.
- All interventions (or combinations of interventions) need to be customized to local circumstances.
- Stove building and maintenance can create income-generating opportunities for the local economy, and enable women especially to make more productive use of their time, earn higher incomes and gain financial independence.
- Subsidies can be offered as an incentive to adopt improved stoves as long as they are managed effectively and phased out gradually to limit continuous reliance on public funding.
- Rural credit schemes can be an effective way to promote demand and finance community-based stove improvement schemes.
- Stove improvement programs need to include a component to inform, educate and communicate the health, environmental, energy and financial consequences of indoor air pollution and how improved stoves together with behavioral change can lead to better health and household finances.
- Long-term sustainable solutions require full participation from local government, NGOs, the commercial sector and local communities.

Selected sources for more information:

People

- World Bank: Enis Baris (health), Kseniya Lvovsky (environment), Todd Johnson (environment/energy)
- WHO: Majid Ezzati, Nigel Bruce, Yasmin von Schirnding
- UC Berkeley, Institute of Global Health: Kirk Smith

Key references

- von Schirnding Y, N Bruce, K Smith, G Ballars-Tremeer, M Ezzati, and K Lvovsky, Addressing the Impact of Household Energy and Indoor Air Pollution on the Health of the Poor—Implications for Policy Action and Intervention Measures, Commission on Macroeconomics and Health Working Paper WG5:12, July 2001
- Bruce N, R Perez-Padilla, and R Albalak, Indoor Air Pollution in developing countries: a major environmental and public health challenge, *Bulletin of the World Health Organization,* 2000, 78(9): 1078-1092

Key websites

- World Health Organization, World Health Report 2002. http://www.who.int/whr/en/
- Indoor Air Pollution: Energy and Health for the Poor. An ESMAP World Bank Initiative (Newsletter). http://wbln1018.worldbank.org/sar/sa.nsf

Recent global event

- Global Health Council Conference, 27–30 May 2003, Washington, D.C. (www.globalhealth.org). The overall theme was "Our Future on Common Ground: Health and the Environment", and IAP was one of the sub-themes.

Expanded versions of the "at a glance" series, with e-linkages to resources and more information, are available on the World Bank Health-Nutrition-Population web site: www.worldbank.org/hnp