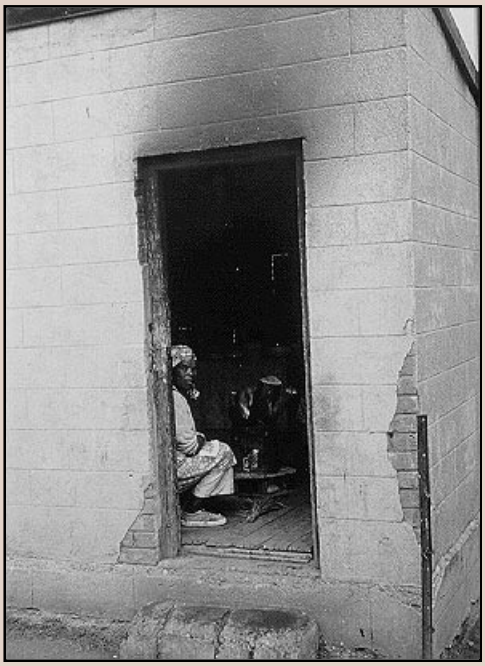


Air pollution caused by burning wood and other unprocessed biofuels has existed for many thousands of years. Economic development has allowed households in the wealthier parts of the world to switch to modern, cleaner fuels, such as gas and electricity. This progress, as well as a focus on the environmental impact of industry, traffic, and the growth of cities, has deflected attention from the fact that by far the largest burden of exposure to airborne pollution falls on poor women and young children in rural areas of developing countries. In many developing countries, biomass fuels remain vital for households in rural and urban areas and will continue to be used in the medium-term at least. The air pollution produced by combustion of these fuels, combined with other sources of air pollution in cities, creates a major public health threat. Although imperfect, scientific evidence strongly suggests that indoor air pollution is a risk factor for acute lower respiratory infections in young children—now the single most important cause of death for children under five years of age.

EHP Capsule Report No. 3 reviews the evidence indicating that indoor air pollution is a substantial health risk for children and considers the most effective approaches to reducing this exposure in the light of experience so far.

Photos courtesy Nigel Bruce.

ENVIRONMENTAL HEALTH PROJECT

Capsule Report

Number 3, January 1999

Lowering Exposure of Children to Indoor Air Pollution to Prevent ARI: The Need for Information *and* Action

Environmental Risk Factors and ALRI

Acute respiratory infection (ARI) is the most important cause of death for children under five years in developing countries. ARI includes chest infections, coughs and colds, and middle-ear infections, but excludes asthma. The most serious type of ARI is *acute lower respiratory infection* (ALRI), most of which (in developing countries) is due to pneumonia. ALRI is believed to account for about 20% of the estimated 12 million deaths each year in children under five and about 10% of perinatal deaths (stillbirths and deaths in the first week of life). ALRI is also the cause of death for many children with measles, pertussis, and human immunodeficiency virus (HIV) (Kirkwood *et al.* 1995).

At present, the main strategy for the control of ALRI is the promotion of community-based early detection and treatment, with follow-up. Increasingly, ALRI control is one component of the integrated management of childhood illness (IMCI). This combines case management (of ALRI, malaria, diarrhea, malnutrition, measles, and other serious infections) with vaccination, interventions to improve care-seeking behavior and compliance with treatment, better nutrition, promotion of breastfeeding, and the use of insecticide-impregnated bednets.

Recently, more attention has been paid to the potential for prevention of ALRI through interventions that address environmental risk factors such as air pollution, housing conditions, and overcrowding (Kirkwood *et al.* 1995). One of these risk factors is indoor air pollution (IAP). The importance of IAP as an environmental threat to health in developing countries, especially among the rural poor, has until recently been poorly recognized.

In developing countries, IAP arises mainly from the domestic use of biomass fuels (wood, dung, and crop residues), coal, and to some extent, charcoal and kerosene. Smoking, already common in some poor rural areas, is set to increase markedly, and environmental tobacco smoke (ETS) will become an increasingly important source of IAP. Globally, the health

Eighteenth Century Conditions Still Exist Today: A Description of the Interior of a Dwelling in Ladakh, India

"He was appalled at the acrid smoke from the yak dung fires which filled every Ladakhi living room in winter and he often insisted that the fire be put out, or lay on the floor to clear his streaming eyes, before he could treat some of his sick patients." A graphic description by William Moorcroft of a situation which still exists for many millions of people today from *Beyond Bokhara: The Life of William Moorcroft, Asian Explorer and Pioneer Veterinary Surgeon,* by G. Alder (1985).

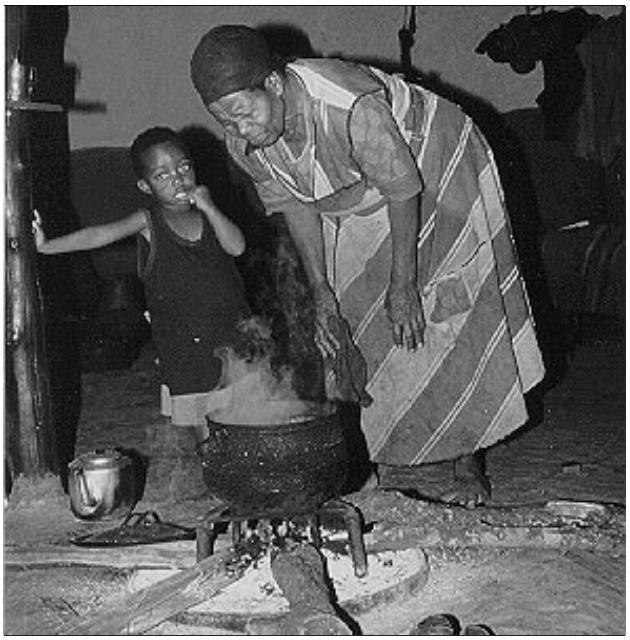
risk resulting from IAP is very substantial for two reasons: first, it affects *large numbers* of young children (and women) living in many of the world's poorest rural and urban communities; and second, these people are exposed to very *high levels* of pollution. It is estimated that about two-thirds of households in developing countries are still dependent on biofuels for cooking and heating, and many of these households use open fires or poor quality stoves.

Health Effects of Indoor Air Pollution Exposure

The Extent of Exposure

Studies in many parts of the world have confirmed that open fires and simple stoves used inside small, often poorly ventilated homes lead to some of the highest levels of air pollution in the world (Smith 1987 and 1993). Smoke from biomass and other domestic fuels contains thousands of chemical substances, and it is not practical to attempt to measure them all. Particulate matter is generally thought to provide a good indication of the health-damaging potential of air pollution, and there are well-established techniques for measuring it, with levels expressed as the weight of particles in micrograms per cubic meter of air sampled (written as $\mu g/m^3$).

Total suspended particulate (TSP) levels during cooking with biomass fuels typically range from several thousand up to 20,000 $\mu g/m^3$ or even higher, while 24-hour average concentrations are typically between 1,000 and 3,000 $\mu g/m^3$. Particulates of less than 10 microns in diameter (expressed as PM_{10}) are able to penetrate into the lungs and are regarded as a more representative measure of health risk. Because these smaller particles constitute the great majority of particulate emissions from biofuels in these settings, PM_{10} concentrations are almost as high as those recorded for TSP. These levels are far in excess of current guidelines and standards. The 1997 U.S. Environmental Protection Agency (EPA) standards recommend that in only 1% of 24-hour periods should ambient levels exceed 150 $\mu g/m^3$ PM_{10}, and that the annual average should not exceed 50 $\mu g/m^3$ PM_{10}. Given that 24-hour average levels in these homes will be representative of those experienced virtually every day of the year, it is reasonable to assume that annual average levels will be around 1,000 $\mu g/m^3$ PM_{10} or higher—some 20 times higher than the EPA standard. The revised air quality guidelines for Europe set by the World Health Organization (WHO) recognize the mounting evidence that relatively small



This rural home in Kwazulu-Natal, South Africa, is typical of many poor rural and urban areas where women and their young children are exposed to high levels of IAP for many hours each day.

increases above the very low level of 20 $\mu g/m^3$ PM_{10} have an impact on health, suggesting that exposure where biomass fuels are used indoors may be as much as 50 times higher than that at which health effects are now being detected.

Risk of ALRI in Children

Growing evidence strongly suggests that IAP at these high levels of exposure is an important risk factor for ALRI in developing countries. Studies from developing countries and among Navajo Indians examining the association between childhood ALRI and a measure of exposure to indoor air pollution were reviewed by a Technical Advisory Group convened by EHP in 1996 (see box below). The key studies summarized here are those which have focused on ALRI defined in a standard way and which have been carried out in environments where exposure is known, or can be assumed, to be at the typically high levels seen in developing countries. There is reasonable consistency among studies, although some have not found an association. Most of the positive studies report that children exposed to a higher level of IAP were between two and five times more likely to develop ALRI than those unexposed (or exposed less).

A number of methodological weaknesses must be taken into account when assessing the findings. Few studies have directly measured exposure, using instead proxies such as type of fire (traditional or improved), reported hours spent near the fire, or whether a child was carried on the mother's back during cooking. Also a number of the studies drew their samples from among children who had been hospitalized. These are unlikely to be representative. Others did not deal adequately with such confounding factors as socioeconomic conditions, which might be the real explanation for the link.

On the positive side, these selected studies focused on ALRI (rather than using broad definitions of children's respiratory illnesses) and generally used well-defined criteria for cases. In addition, the positive study results are consistent with effects of environmental tobacco smoke (ETS) and outdoor (urban) air pollution.

ETS is air pollution arising from a form of biomass combustion, and although the products are not identical to biofuel pollution, it can be argued that risks associated with ETS may be indicative of those associated with biofuel IAP. The evidence that ETS causes lower respiratory illness in children aged less than three years old has recently been systematically reviewed (Strachan and Cook 1997). Although the great majority of studies were carried out in developed countries where pneumonia makes up a smaller proportion of lower respiratory illnesses in children, it was

Selected Studies of the Association of ALRI and IAP in Developing Countries and among American Indians

Indoor air pollution exposure and lower respiratory infection in young Gambian children by JRM Armstrong and H Campbell (*Int J Epid* 20(2)(1991):424-428).

Ambient air pollution and respiratory symptom complex in pre-school children by S Aswathi, H Glick, R Fletcher, and N Ahmed (*Indian J Med Res* 104(1996):257-262).

Indoor woodsmoke pollution causing lower respiratory disease in children by DA Collings, SD Sithole, and KS Martin (*Tropical Doctor* (1990):151-155).

Smoke-filled rooms and lower respiratory disease in infants by D Kossove (*S African Med J* 63(1982):622-624).

Wood-burning stoves and lower respiratory tract infection in American Indian children by K Morris, M Morganlander, J Coulehan, S Gahagen, and V Arena (*Amer J Dis Children* 144(1990):105-108).

A study of risk factors for pneumococcal disease among children in a rural area of West Africa by T O'Dempsey, T McArdle, J Morris, N Lloyd Evans, I Baldeh, B Lawrence, O Secka, and BM Greenwood (*Int J Epid* 25(1996):885-893).

Domestic smoke pollution and acute respiratory infections in a rural community in the hill region of Nepal by MR Pandey, RP Neupane, A Gautam, and IB Shrestha (*Env Int* 15(1989):337-340).

Risk factors for severe pneumonia in children in South Kerala: a hospital based case-control study by N Shah, V Ramankutty, P Premila, and N Sathy (*J Trop Ped* 40(1994):201-206).

Risk factors for pneumonia among children in Brazilian Metropolitan area by C Victora, S Fuchs, J Flores, W Fonseca, and B Kirkwood (*Ped* 43(1994):977-985).

Other studies are listed in EHP's 1997 and 1998 Annotated Bibliographies on ARI and IAP, available on EHP's website: http://www.access.digest.net/~ehp.

found that smoking by either parent increased risk to the child by between 40% and 90%. Studies of ETS and ALRI in developing countries are not consistent, perhaps a reflection of less intense exposure and the competing effects of more powerful risk factors.

Evidence from studies of ambient urban air pollution, principally in developed countries, has demonstrated that quite small increases (e.g., 10 $\mu g/m^3$ PM_{10}) at relatively low levels (20-50 $\mu g/m^3$ PM_{10}) can have measurable effects on mortality and admission rates for respiratory illness in children (Dockery and Pope 1994). However, these studies are not specific for ALRI, nor for the very youngest children.

Taken together, the available evidence suggests strongly that IAP should be considered a major risk to the respiratory health of young children. This was recognized in the World Bank's 1993 World Development Report, *Investing in Health*, which stated that a substantial percentage of the burden of acute and chronic respiratory disease could be averted by reducing IAP and improving housing to lessen crowding. Global estimates of excess deaths due to air pollution in the 1997 WHO report, *Health and Environment in Sustainable Development*, showed that far more occur as a result of IAP in rural areas than arise from outdoor pollution in urban areas. Current air quality standards, if applied to the indoor environment, clearly indicate that action is urgently required in settings where recommended levels are so grossly exceeded on a daily basis.

Interventions to Achieve Reductions in Exposure

Although the goal of reducing exposure to IAP may appear straightforward, the central role that the fire or stove has in the activities of the household, providing for cooking, warmth, light, and social functions, makes this a challenging objective. In addition, important practical, financial, and environmental issues are associated with the production and supply of fuel and must be considered when designing interventions to reduce exposure. Such interventions should be:

- able to meet the range of needs of the households in the community for which they are designed;
- able to reduce exposure to harmful emissions while not impairing fuel efficiency;
- affordable; and
- sustainable.

China's Rural Stove Program

In 1980, the Chinese government launched a national rural improved stove program throughout the country, with the aims of improving energy efficiency, protecting the environment, increasing the well-being of women, and improving living conditions in rural households. The targets are to achieve high coverage, using stoves with flues and a heat efficiency of at least 25%. By the end of 1995, over 172 million rural homes had replaced traditional stoves with improved ones (Lin 1998).

Four Basic Approaches

Exposure can be reduced in four ways: by modifying the stove, improving ventilation, using cleaner fuels, or protecting the child from smoke.

Changes to fire or stove and ventilation. The most obvious approach is to introduce a stove with a flue (a pipe connected to the stove) or fitted with a hood or chimney to vent smoke outside. Other design changes seek to achieve more satisfactory combustion, which can result in less hazardous emissions and/or greater fuel efficiency, which in turn can shorten cooking time and thereby reduce exposure. Ventilation can be increased by creating larger windows, opening eaves, or raising the height of the roof.

Although an improved stove may reduce emissions, this is not always the case. Some chimney stoves, while they may reduce IAP, can also impair (or at least not improve) efficiency and reduce space heating and available light in the process. Recognition of the health risk associated with IAP means that much more attention must now be paid to achieving lower exposures, in addition to improving other aspects of stove performance. These considerations make stove development technically complex. Sharing and developing expertise where it is most needed is highly desirable (UNDP 1997, see pages 107–108).

Many improved stove programs have proven to be too costly, inefficient in reducing emissions, or impractical. But there are also successful programs, such as in Kenya, where local people (especially women) and local producers have been involved in design and implementation, or in China (see box on page 4). Until recently the *main* driving force behind many stove programs has been the desire to improve fuel efficiency rather than to reduce human exposures to IAP.

Energy Use in a Rural Electrification Program

Following electrification in a traditionally wood-burning area of rural South Africa, a range of fuels continued to be used. While 100% of the houses studied used electricity for lighting, 84% continued to use wood for cooking and heating water. Of these, 34% used wood exclusively, 31% used wood and kerosene, 10% used wood and electricity, and 9% used all three fuels. Overall, 30% used some electricity for cooking. The main reasons for not using electricity were the costs of fuel and appliances (Luvhimbi and Jawrek 1997).

Substitution of cleaner fuels. Cleaner fuels such as electricity or liquefied petroleum gas (LPG) offer an effective means of reducing exposure, but cost and supply issues will make these fuels largely unavailable to many communities for the foreseeable future. Charcoal yields much lower levels of particulates than wood but can result in hazardous levels of carbon monoxide. Kerosene is often widely available, and while it emits considerably less particulates than unprocessed biofuels, it is not as clean as gas.

In the long term, cleaner fuels represent the best means of achieving low exposures, although it is important to determine whether clean fuels, whatever the source, are an option for a given community. Even where clean fuels are obtainable, cost and other practical considerations may mean that they are not used for all household energy needs, with the result that substantial IAP may persist (see box above).

Behavior change to protect the child. Greater knowledge about the health hazards of IAP may motivate mothers to protect their young children from pollution, either by placing the child away from the kitchen, or relocating the cooking tasks away from the main living area. This approach, however, raises issues of supervision and, consequently, safety. As a general principle, sharing knowledge about health risks with a community is one part of a collaborative process of identifying effective solutions.

Implementation and Programming Issues

The need for a household health perspective. The goal of reducing IAP exposure is one important objective within a broader approach aimed at the whole home environment: the goal of achieving a *healthy home* (see box below). An important example of this focus on healthy homes is provided by the work carried out in Vietnam by the Lund Center for Habitat Studies (Lund University 1993). What emerges from experience to date is a need to view IAP as one aspect of the supply and use of household energy. Energy requirements in the home; production, supply, cost, and environmental dimensions of fuel supply; devices to utilize energy; housing conditions; behaviors influencing the health impacts of energy use; and the people involved at all stages (especially women) are all relevant and must be considered when designing interventions to reduce exposure.

Goal: Achieving a Healthy Home

To work with households (and women in particular), local organizations, and producers to reduce exposure to IAP through household interventions that meet the requirements of the family and community, that are fuel-efficient and economically and environmentally sustainable, and that fit in with other initiatives aimed at making the home environment healthier.

Collaboration is essential. Interventions in the field of household energy and the home environment need to draw on the influence and expertise of a wide range of agencies, organizations, and individuals. Collaboration among health, local government, environment, energy, and

development organizations is needed to achieve more appropriate and effective change. However, experience has shown that collaboration is often problematic in practice—especially for organizations that are more familiar with traditional "vertical" programs.

Lack of attention to IAP. It is surprising that the IAP issue has not received more research and policy attention given the extent of exposure of so many of the world's most vulnerable populations. One explanation is that historically and in the media, air pollution is seen as arising from traffic and industry in the cities of the developed world, and more recently in those of developing countries. Another is that the scientific evidence on the health effects of IAP in developing countries has been regarded by many as insufficiently robust. In addition, the poor, mainly rural, communities concerned, and in particular women and children, do not have a strong voice in forums where global environmental policy is determined.

What Is Being Done?

Research groups, energy and development non-governmental organizations (NGOs), and large agencies, among others, have carried out a range of household energy and IAP initiatives over many years, including stove development, improvements to house design, forestry and other aspects of energy supply, such as solar and hydro energy, as well as the health studies already mentioned (and other studies on adult respiratory health).

The following sections review the type of related activities that health, development, and energy organizations and agencies are pursuing. Relatively few programs have combined environment and health perspectives, although this situation is beginning to change.

Health Programs: Prevention and Management of ALRI

As already mentioned, the current state-of-the-art strategy for the control of ALRI is IMCI, an approach supported and promoted by USAID, WHO, and UNICEF. CARE's current Maternal and Child Health program includes activities on ALRI, but the focus is mainly on primary care and education, without specific integration of environment-related initiatives. In terms of approach, however, the involvement of women and building the capacity of communities are promoted. Thus, although these programs do not explicitly implement environmental approaches to the prevention of ALRI, participative community development is recognized to be important.

Household Energy and Development Programs

Stoves, clean renewable fuels, and other household energy initiatives have been developed by many groups, including NGOs, bilateral donors, national governments and ministries, and development organizations, including UNICEF, CARE, and many others, with some involvement in stove programs. As noted, these have mainly focused on energy saving, environmental protection, and fuel supply. Important networks exist also, including the Foundation for Woodstove Dissemination (FWD), the Asian Regional Cookstove Program (ARECOP), the Food and Agriculture Organization (FAO) Regional Wood Energy Development Program in Asia, and the Latin American Dendro-Energy Network. It is also important to recognize the parts played by economic development in general, national energy strategies, and the commercial energy sector in making cleaner fuels more accessible.

Initiatives Combining a Health and Environment Perspective

The growing recognition of the importance of an environment and health perspective is well demonstrated by the recent World Resources Report (1998-99), a joint publication of the World Resources Institute (WRI), the U.N. Development Program (UNDP), the U.N. Environment Program (UNEP), and the World Bank. The role of IAP as a major global public health issue is recognized, especially with respect to ALRI, and approaches to reducing exposures are discussed.

The table on page 7, not intended to be comprehensive, illustrates the range of current activities explicitly promoting a combined environment and health approach. Other research and development groups working in this way can be contacted through EHP's ARILIST.

Some Current Household Energy/IAP Activities Linking Health and the Environment

Organization	*Activity*
U.S. Agency for International Development (USAID) through the Environmental Health Project (EHP)	EHP convened a Technical Advisory Group to examine ARI and priorities for action in 1996, conducted an evidence-based review of priorities for action, developed ALRI indicators for prevention programs, reviewed successful stove programs, and established an e-mail discussion list (ARILIST) to link research, development, and policy groups.
World Health Organization (WHO)	WHO is developing studies on the effects of reducing IAP exposure on ALRI incidence and other health outcomes, leading work on women's health and household energy, providing technical support for more widespread exposure assessment, developing indicators, and evaluating intervention initiatives.
Household Energy Program (HEP) of GTZ (German Aid Agency)	HEP seeks to develop integrated programs to achieve energy saving and resource conservation, lighter workloads, better health, and higher income. HEP is involved in a number of programs in Africa, including a large-scale biofuel energy and conservation project in Ethiopia.
Intermediate Technology Development Group (ITDG)	ITDG works in Asia, Africa, and South America to develop skills and technologies that give people more control over their lives and contribute to the sustainable development of their communities. Projects include work on housing materials and design, stoves, and exposure reduction. In collaboration with GTZ, ITDG produces *Boiling Point*, a stove and household energy journal, which has promoted awareness of health aspects.
Lund Center for Habitat Studies, Sweden	The Lund Center's work in rural and urban parts of Vietnam provides a good example of the relationship among architecture, the living environment, health, and household energy.
Household Energy Development Organization Network (HEDON)	HEDON, an association of development organizations, research groups, and individuals, promotes an integrated approach involving health, sustainable development, housing conditions and design, fuel supply, education, and policy and emphasizes the importance of inter-sectoral collaboration.

Recommendations

As with policy in other aspects of environment and health, action on IAP needs to be taken on the basis of imperfect evidence. Given the current state of scientific evidence and practical experience with interventions, the appropriate action is a coordinated program of research *and* development.

What Research Is Now Required?

Applied health research. In most situations where unprocessed biomass is the primary domestic fuel it is unlikely that low levels of IAP—for example those meeting EPA air quality standards—will be achieved in the short or medium term. Although some studies comparing pollution levels of traditional fires with "improved" stoves have shown substantial reductions in IAP, the levels remain high by current standards. In a number of Indian and Nepalese communities where this has been studied, mean personal TSP values during use of open fires ranged between 3,140 and 6,400 $\mu g/m^3$ while means for improved stoves lay between 1,113 and 4,600 $\mu g/m^3$ (Smith 1989). A 1996 WHO-supported study in western Guatemala showed that a quality stove with a flue (the *Plancha),* well constructed and installed, can achieve IAP levels as low as 100-150 $\mu g/m^3$ PM_{10} (24 hour mean), although observational studies of stoves that had been in use for a number of years yielded levels around 500 $\mu g/m^3$ PM_{10} (Naeher *et al.* 1996). In summary, from the evidence currently available, it is not possible to judge whether typical "improved" stoves or other interventions will result in any useful health gain, and in particular whether the incidence of ALRI will be reduced.

Thus, in addition to encouraging the more widespread monitoring of air quality in household energy work (see next section), it is important to study the relationship between the risk of key health outcomes, especially ALRI, and levels of exposure—the so-called "exposure-response" relationship. Such studies need to be carried out across a realistic range of exposure levels, from those typically encountered with traditional fires and stoves to those achievable using feasible, sustainable interventions that have been in daily use for months or years.

Operational research. It is important to conduct operational research on key topics discussed below in conjunction with the health outcome studies in order to identify effective, affordable, and sustainable methods of reducing exposure.

Good quality stoves, such as this *Plancha* wood stove being used in western Guatemala, can yield large and sustainable reductions in exposure to IAP and may be highly cost-effective—but evidence is lacking.

Reduction of exposure: Technical development and evaluation of stoves, chimneys, and hoods to improve ventilation and reduce IAP; investigation of the potential for education about the health risks of IAP and behavior change interventions; investigation of the potential for reducing exposure by adopting cleaner fuels; and development and promotion of valid, robust exposure measures to encourage more widespread and routine monitoring and evaluation of household energy projects.

Cost-effectiveness: A good case can be made for expecting that a sustainable, community-based intervention on household energy and the home environment would bring a range of benefits to key stakeholders, and would be cost-effective. However, evidence of cost-effectiveness is lacking. Information on the health effects of reducing exposure is relatively poor and methods of assessing costs need to take into account the multi-sectoral nature of integrated, community-based interventions. Where interventions are designed to bring about improvements in the whole home environment, the relationship between specific inputs and health outcomes may be difficult to define.

Roles and responsibilities of the various institutions: Case studies are required on the roles of public and private organizations that can play a vital role in the production, distribution, and maintenance of stoves and other household energy appliances, and at the national level, the ministry of health and other ministries with responsibilities for housing, environment, agriculture (forestry), and energy.

It is also important to identify those aspects of programs and networks that lead to sustainable commercial production, distribution, and maintenance of improved stoves.

The nature of what each organization can most usefully contribute will differ among countries, districts, and localities. An evaluation across a wide range of settings should be carried out to identify organizational roles and responsibilities that are common to most settings, as well as those aspects best developed in response to local circumstances and opportunities. A recent review of institutional, financial, and organizational issues involved in the dissemination of renewable energy technologies in Africa provides a good example of this approach (Karekezi and Ranja 1997).

What Action Can Now Be Taken?

Strategy development. Programs to raise awareness of the health risks of IAP, especially for ALRI in young children, are important and particularly appropriate for those involved with child health policy, services, community development, and research. Strategies for reducing IAP exposure within a household energy context could be developed. These should involve women as much as possible and should be implemented as one component of community-based programs aimed at improving health through action on the home environment. Funders need to acknowledge that much of this work cannot be achieved in the short term, especially among communities with limited resources for change.

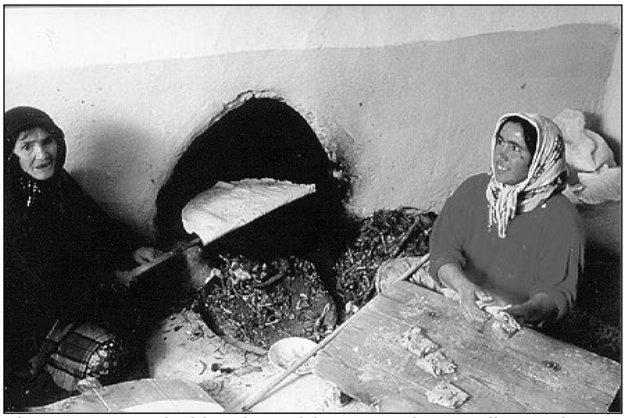
Linking development and research. Research initiatives should be linked wherever possible to opportunities provided by development projects. A key priority for research is to establish the health gain, including the reduction in ALRI incidence, that can be achieved by reducing IAP exposure. Specifically, the "exposure-response" curve requires studying, as this will provide the guidance needed to assess whether household energy interventions yielding a known reduction in exposure are likely to have a useful impact on ALRI and other health problems associated with IAP. The complex inter-relationships between IAP exposure and social and environmental conditions mean that one or more intervention studies are needed to provide scientifically reliable information.

Primary prevention. Programs and committees working to coordinate the control of ALRI and other key childhood illnesses have an important role to play in raising the priority of primary prevention. Since much of this work requires a multi-sectoral approach, these committees can adopt a coordinating and support function, which includes:

- building collaboration at national and local levels with other ministries (for example, energy, forestry, housing, environment, education), NGOs, and others offering training and financial and technical support;
- ensuring that environmental risk factors, including IAP, are included on the agendas of all relevant sectors and that action appropriate to each sector (including health workers) is identified; and
- supporting the development and sharing of better information, including the monitoring of IAP and other environmental risk factors, and of progress with implementation.

If health-sector specialists are to influence existing programs, raise awareness of the problem, and reduce exposure, all of the actions above must be initiated.

Policy. Research to support policy change would include identification of models for collaboration at national and local levels that have achieved the desired policy changes; defining the role of fiscal policy (fuel pricing and other measures that influence the availability, consumption, and distribution of cleaner fuels); and selection of appropriate indicators. The Environmental Health Project has begun developing a set of indicators to help guide policy on preventing ALRI through control of environmental risk factors, especially IAP, and to provide the basis for monitoring and evaluation. To guide the development of appropriate indoor air quality standards based on internationally accepted guidelines and to support monitoring and evaluation, these indicators could be developed further and utilized as widely as possible.



These women baking bread in Central Anatolia, Turkey, like most women in developing countries, have the main responsibility for obtaining fuel and cooking. They should be fully involved in developing and evaluating stoves and other measures to reduce exposure to IAP.

Stove programs. In communities where polluting fuels, and unprocessed biofuels in particular, are likely to remain the principal source of household energy well into the 21st century, the design and production of higher quality stoves could be linked with forestry (production), environmental protection, and economic productivity. Since all of these areas are connected in various ways to health, collaboration with the health sector should be sought and encouraged. In addition, in developing countries, support should be given for sharing technical expertise and for building capacity in optimizing stove efficiency and emissions.

Cleaner fuels. Adoption of cleaner fuels such as LPG, electricity, and cleaner biomass products (biogas, etc.) should be encouraged where they can meet the needs of households and are economically realistic and sustainable. However, it is important to recognize that because of the relatively high cost of these fuels and appliances, households will often continue to use a mixture of fuels with the result that IAP levels may remain a threat to health.

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Development initiatives in the environment, energy, and health sectors, such as those described above, should be encouraged to proceed in coordination with the necessary health, operational, and policy research. In this way, practical experience gained through development will lead to substantial health improvement.

— Nigel Bruce, Senior Lecturer in Public Health, Department of Public Health, University of Liverpool

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