PUBLIC HEALTH

A Major Environmental Cause of Death

Exposure to indoor air pollution from household burning and solid fuels affects nearly half of the world's population.

William J. Martin II,* Roger I. Glass,* John M. Balbus, Francis S. Collins

Cookstove pollution in a Peruvian home. Better understanding of the health risks could drive demand for cleaner stoves.

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The World Health Organization (WHO) lists indoor air pollution (IAP) (*1*) from primitive household cooking fires as the leading environmental cause of death in the world, as it contributes to nearly 2.0 million deaths annually (*2*)—more deaths than are caused each year by malaria. Almost half of the planet lives in poverty, and those households generally use biomass (wood, crop residues, charcoal, or dung) or coal as fuel for cooking and heating. The primitive fires typically fill homes with dense smoke, blackening walls and ceilings and sickening those within.

Women and children living in extreme poverty are at highest risk for adverse health outcomes from IAP. Whereas men tend to be physically removed from household smoke exposures during the day, women and children suffer high exposures, which lead to many of the same disease risks as if they were lifelong smokers of tobacco. Mortality estimates from IAP are primarily based on risk for acute pneumonia in children under age 5 and chronic obstructive pulmonary disease (COPD) (*3*) (see the chart, page 181).

The consequences of primitive household cooking also extend to the global environment. For those at the bottom of the energy ladder, reliance on biomass fuels and coal contributes to local and regional environmental degradation and deforestation. A 2011 World Bank report underscores health benefits as a rationale for cookstove interventions but also emphasizes evidence for environment and climate benefits (*4*). Improved and efficient stoves reduce fuel use (reducing CO_2 release) and, if sufficiently advanced, decrease black carbon emissions.

Although implementation of improved stoves or fuels has been tried for decades, success has been limited by a number of factors, including a lack of awareness of the problem, limited research into the health risks, lack of affordable improved stoves or fuels that reduce exposures to safer levels, and the logistical challenges of solving a problem that affects almost 3 billion of the poorest people on the planet.

To address these needs, the United Nations Foundation launched the Global Alliance for Clean Cookstoves (http://cleancookstoves.org). It is a public-private partnership aimed at creating a global market for clean and efficient cookstoves and fuels in the developing world. The interim target of the alliance is "100 by 20," for 100 million homes to adopt clean and efficient stoves and fuels by 2020, with the ultimate goal of universal adoption. The U.S. government has committed more than $50 million, including about $25 million of the NIH's ongoing research funds, to mitigate the impacts from IAP. Secretary of State Hillary Clinton has made the Global Alliance a centerpiece of her Global Partnerships Initiative. The Alliance has enrolled more than 175 countries, foundations, corporations, and other nongovernmental organizations (NGOs) as partners.

Role of Women

Women and girls typically gather fuel, a task that is time-consuming and often places them at risk of gender-based violence, as they are forced to walk several miles from the safety of their villages (*5*). More efficient stoves can reduce fuel consumption and thereby decrease the attendant risks associated with its collection. By freeing up time, efficient stoves can even expand the opportunities for education and economic development of women and girls in these impoverished areas.

Promoting sustained changes in the way food is cooked to reduce IAP requires a fundamental understanding of traditions, social interactions, and family dynamics, which differ widely across cultures. Successful implementation invariably involves women in designing the stove, training, use in the home, and follow-up in the community.

Role of the Market

A successful strategy to enable poor individuals or households to adopt stoves or fuels requires the creation of market demand. A stove purchased by the consumer is inherently more valued than one that is received without charge, especially if the free stove was designed without consumer input. Prior large-scale implementation programs have frequently been supply-driven, with decisions about need and stove design driven from the top. This has begun to change, as evidenced by recent successes, such as the national stove program in Peru (*6*).

Ideally, a thriving global market in improved stoves and fuels would spur local economic development. Such a market-driven strategy is likely the only feasible way to meet the enormous task of supplying improved stoves or fuels, ultimately to as many as 600 to 800 million households. But there are challenges in creating sufficient demand. There are many competing needs for those in extreme poverty, and awareness of the risks posed by cooking methods is limited.

An important factor to the user in purchasing an improved stove is that it can consume much less fuel, offering an economic return that can eventually offset the cost of a stove (*4*, *7*). Whether this and other motivating factors will be enough to create the global

National Institutes of Health, Bethesda, MD 20892, USA.

*Author for correspondence. E-mail: wjmartin@mail.nih.gov (W.J.M.); glassr@mail.nih.gov (R.I.G.)

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demand for hundreds of millions of stoves is a hypothesis that the Global Alliance is willing to test. Carbon financing or governmental subsidies can encourage demand by offsetting some of the initial costs of stoves. But there is a need to balance the efforts to reach the "bottom billion," who require some mechanism of subsidy, with those who are less poor, for whom the reduced fuel costs will be sufficient motivation.

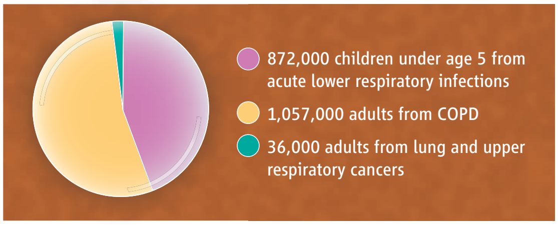
Need for More Health Research

Beyond the three diseases associated by WHO with IAP mortality (*3*), there are additional known and suspected health risks associated with IAP as diverse as low birth weight, burn injuries, cataracts, cardiovascular disease, asthma, and tuberculosis (*8*). There is a great opportunity to determine whether interventions that reduce IAP can prevent them. Major implementation programs under way around the world offer opportunities to delineate the critical exposure-response relations that underlie disease risk, and such research is essential to provide evidence for the health benefits of improved stove or fuel strategies.

Although problems of IAP are well established, it remains unclear just how much emissions must be reduced by cleaner cookstoves and fuels to provide substantial health benefits. This has led to some controversy about how best to proceed. One view is that the health benefits need to be well documented before major implementation programs move forward. The alternative view is that cookstove and fuel implementation programs by NGOs, multinational companies, and governments are increasingly under way, driven in part by social and environmental concerns and by the recent availability of new and improved technologies on the market. These programs are moving forward whether or not the research is available to document the health benefits of a specific type of intervention.

To date, the only completed randomized controlled trial (RCT) using improved stoves with chimneys to study the impact of reduced IAP on child pneumonia is the RESPIRE study in Guatemala (*9*). Preliminary exposure-response data from RESPIRE suggest that exposure reductions of as much as 90% are needed to achieve substantial reductions in pneumonia risk; even modest risk reduction requires exposures to be lowered by at least 50% (*10*).

It is not known if other health risks require such a marked reduction in exposures. If the results of RESPIRE are replicated in future RCTs for pneumonia and other health outcomes, one of the challenges will be to implement improved stove and fuel programs that can achieve enough exposure reductions to improve health, yet remain affordable and acceptable to the poor. Simply providing stoves to a user is not enough. The user must also receive training about and support for stove and fuel use to assure proper and sustained operation of the stoves and attendant, risk-reducing behavioral changes among all members of the family.



Annual deaths attributed to IAP (*3*).

We need both: more research trials to document rigorously the amount of reduction in IAP necessary to improve health, and also new approaches to evaluate the health benefits of major implementation programs already under way.

New Approaches

New approaches to program evaluation from other disciplines are being examined for possible adaptation to the study of the proposed stove implementation programs. These are as diverse as matched-pair randomization design used in the universal health insurance program in Mexico (*11*), causal inference assessment of a preexisting water and hygiene intervention study in India (*12*), and the use of the national evaluation platform for assessment of large-scale implementation programs (*13*).

An important related need is for continued technology advancements in exposure assessment. Virtually all of the proposed research studies require access to personal, household, and outdoor exposure monitoring instruments that are accurate for monitoring air pollutants associated with disease risk. Such instruments must be affordable and adaptable for use in community settings of lower-income countries. Field testing of these monitors to measure the very high exposure levels from IAP is needed, as well as the continued advancement of the technology that is available for investigators conducting both RCTs and program evaluation.

Leveraging Existing Infrastructure

The costs for the high-priority research related to health and IAP would be roughly between $150 and $200 million (*14*). Although such numbers may seem high for an emerging field, they are typical of investments required to develop the evidence base to combat leading sources of global mortality. Use of existing centers or networks that dovetail with the mission of IAP health research could reduce costs and improve the quality of research.

There is value in establishing a global inventory of relevant research sites and implementation programs that would potentially share interest in IAP health research. Access to such information might be facilitated by creating an interactive global map showing project sites or partners, much like the one already developed for participating NGO's by the Partnership for Clean Indoor Air (www.pciaonline.org/partners/map).

Next Steps

To be successful in reaching 100 million households by 2020, governments, funders, manufacturers, and NGOs must commit to implement large-scale solutions and also to support essential research. The challenges are great, but the potential to use a relatively low cost intervention to save millions of lives, improve the environment, and encourage economic development is compelling.

References and Notes

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