BRIEFCASE

POLICY BRIEFCASE [JULY 2012]

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TRANSLATING RESEARCH INTO ACTION

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UP IN SMOKE

Improved cookstoves in India did not reduce smoke exposure, improve health, or reduce fuel usage of recipients because they were not used regularly and recipients did not invest to maintain them properly.

Nearly half of the world's population continues to rely on solid fuels, including wood, dung, agricultural waste, and coal, for its energy needs. The smoke released from using such fuels has been shown to lead to respiratory diseases and lung cancer. The World Health Organization (WHO) lists indoor air pollution as the "leading environmental cause of death in the world," stating that it contributes to two million deaths annually. Cooking with biomass fuels also contributes to climate change: Using biomass fuels releases carbon dioxide (CO_2) and black carbon into the atmosphere and also plays a role in deforestation.

Improved cooking stoves have been promoted as a simple solution to these problems. Based on their technical design, improved stoves have the potential to reduce emissions, fuel use, and the incidence of pneumonia and other lung diseases. The stoves have gained considerable international attention, and the Global Alliance for Clean Cookstoves has announced a goal of having 100 million households adopt clean cooking technologies by 2020. A randomized evaluation in Guatemala found substantial reductions in smoke exposure indicators when free improved cooking stoves were distributed to 500 women and children, as well as improvements in some dimensions of health (Smith-Sivertsen et al. 2009). However, those results derived from a controlled setting in which households' usage was closely monitored and repairs were provided weekly at no cost. The evaluated stove was also too expensive for households to purchase or for it to be practical for large-scale distribution. Evidence was still needed from real-world conditions: **How much would households use and maintain the stoves? Given that level of use, what impact would these stoves have on household health?**

To answer these questions, J-PAL affiliated professors Rema Hanna (Harvard University), Esther Duflo (MIT), and Michael Greenstone (MIT), working in conjunction with a local NGO, Gram Vikas, evaluated the impact of inexpensive, improved cooking stoves on household well-being in Orissa, India.

- **Though many households accepted the stoves when offered, they did not use them regularly or maintain them properly, and use declined over time.** Households initially cooked about 3.4 more meals per week using a good condition, low-pollution stove than those in the comparison group, out of an average of about 14 meals per week. By year three, this difference had fallen to 1.8 meals per week.
- **Low usage limited the impact of the stoves on smoke exposure.** In the first year of the program, when use was at its highest, there was a 7.5 percent reduction in carbon monoxide (CO) in the breath of the primary cooks in the households, but no meaningful change for other household members. By the second year, as use fell further and the stoves experienced normal wear and tear, there was no longer a significant effect.
- **The stoves had no effect on household health.** There were no improvements in measureable health outcomes (e.g., lung functioning, blood pressure, child body mass index, infant mortality rates), nor in self-reported symptoms such as coughs and colds.
- **The improved stoves did not decrease the amount of fuel households used, fuel costs, or time spent cooking.** Lab testing showed that when used properly, the improved stoves required less wood and heated up faster. Households indeed reported that they thought the stoves required less fuel. However, measured fuel usage and costs did not actually change. Treatment households spent more time repairing their stoves than comparison households did.

EVALUATION

According to the 2001 Indian Census, as many as 90 percent of households in poorer, rural regions used traditional fuels: firewood, crop residue, or cow dung. Indoor air pollution levels from these fuels are high: one study measured indoor particulate matter (PM10) concentrations twenty times in excess of the limit recommended by India's Central Pollution Control Board for ambient air quality. Health tests in the study area in Orissa found that women had an average carbon monoxide (CO) reading of 7.55 parts per million (ppm), while children had an average reading of 6.48 ppm—CO levels similar to what would result from smoking about seven cigarettes per day. Almost all households had a traditional stove, with 23 percent also having some variation of a "clean stove" (e.g. kerosene, biogas, liquid petroleum gas).

The researchers evaluated an actual program that was being run by a local NGO without assistance from the research team. In 2005, Gram Vikas (GV), an NGO operating in Orissa, obtained funding to subsidize the construction of 15,000 improved stoves in the state. The stoves (called *chulhas* in Oriya and Hindi) had been developed by a local NGO, the Appropriate Rural Technology Institute (ARTI). They were made primarily of mud and used traditional biomass fuels, but they featured two pots (for simultaneous cooking), an enclosed flame (for greater efficiency), and a chimney to redirect smoke outdoors.

In laboratory settings, this stove burns more efficiently than a traditional stove, leading to lower biofuel requirements and less indoor smoke. But these gains are achieved only when the stoves are maintained appropriately, which involves repairing cracks and regularly removing chimney obstructions. Additionally, households must place the pots on the stove openings correctly and cover the second opening when it is not in use to prevent smoke from escaping.

The researchers partnered with Gram Vikas to evaluate the impact of distributing these stoves. In 44 villages, 2,651 participating households were randomly assigned (through public lotteries) to receive a stove in one of three waves.

INTERVENTION

Gram Vikas provided the materials and paid for the construction of the stoves. Households provided the mud for the base, labor, and a payment of Rs. 30 (about US$0.75) for the mason who assisted in building and maintaining the stoves. The total cost of the stove was approximately $12.50. Gram Vikas also provided training sessions on proper use and maintenance of the stoves and hired "good users" in each village to help promote the use of the stoves and alert the NGO if any stove was in need of repair.

TREATMENT GROUP

Wave 1 received a stove at the start of the evaluation.
Wave 2 received a stove after two years.

COMPARISON GROUP

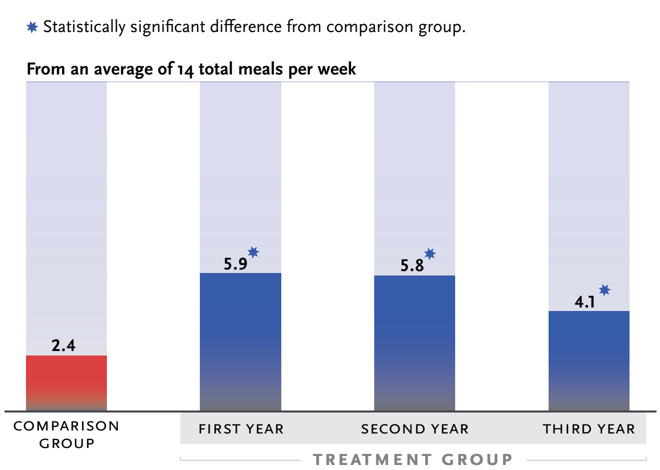
Wave 3 received a stove at the conclusion of the evaluation.

Households were followed for four years, and surveys conducted throughout the study period gauged stove use, stove breakages and repairs, fuel use, and perceptions of the stoves. In addition, specially trained surveyors conducted physical health checks for each household member. Smoke exposure was measured by the concentration of carbon monoxide in exhaled breath, and respiratory health was assessed with a spirometry test, which measures how much air the lungs can hold and how well the respiratory system can move air in and out of the lungs.

Many households accepted the (almost free) stoves, but they did not use them regularly, failed to maintain them properly, and used them even less over time. In the two years after the first wave, households that were offered stoves were 65 percentage points more likely than comparison households to have a GV improved stove. (About 6 percent of households in the comparison group obtained improved GV stoves on their own.) By year three, however, the difference in GV stove ownership between the two groups had fallen to 44 percentage points as many of the clean stoves fell into disrepair.

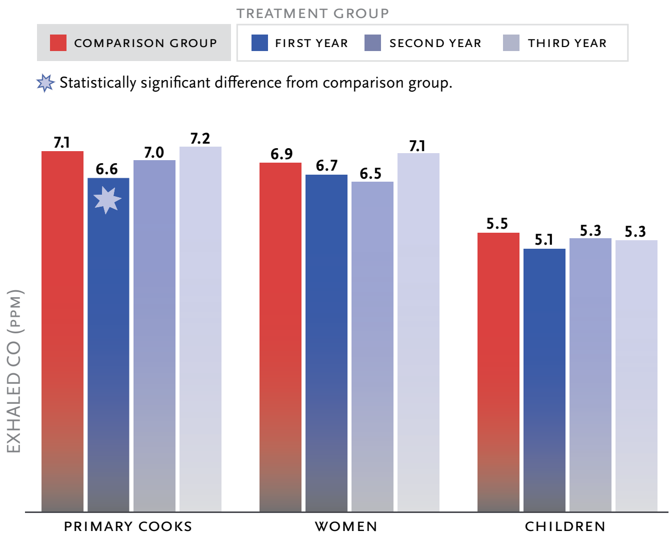
Usage of the new stoves was low. Treatment group households who received the GV stove still continued to use their traditional stoves in conjunction with the new ones, even early on when the majority of stoves were still functional. Initially, households cooked about 3.4 more meals per week using any type of low-polluting stove than the comparison group (Figure 1). Given that households cooked about 14 meals per week on average, the additional meals cooked on a clean stove represent only one-fifth of total meals. By year three, the difference in meals cooked on improved stoves had declined to 1.8 meals per week.

FIGURE 1: MEALS COOKED ON ANY GOOD CONDITION, LOW-POLLUTION STOVE (PER WEEK)



Low usage resulted in little overall improvement in smoke exposure. For the households' primary cook, CO exposure fell by 7.5 percent during the first year, when usage of the clean stoves was at its highest, but there was little change for other women or children (Figure 2). However, this effect for the primary cooks disappeared after the first year and was not detected for other household members.

FIGURE 2: SMOKE INHALATION DECREASED ONLY FOR PRIMARY COOKS IN THE FIRST YEAR



The improved stoves had no effect on health status. Given that there was little to no change in smoke exposure, health benefits from the GV stoves were unlikely. There were no improvements in measured health outcomes, such as respiratory functioning, blood pressure, infant mortality and child body mass index. Moreover, there were no changes in self-reported health outcomes, such as coughs and colds.

Improved stoves did not increase standards of living. The clean stoves were meant to decrease fuel usage and cooking time. They do not appear to have done either. Instead, households spent more time repairing stoves. By contrast, in the surveys, households perceived that the stoves performed well on both measures, and they were generally satisfied with their new stoves.

POLICY LESSONS

Improved cooking stoves that are affordable, desirable, and sustainable need to be identified. This study has shown that households do not value the stoves enough to use them regularly or maintain them properly. For stove programs to have the potential to succeed at a large scale, identifying the right technology will be of vital importance.

Potential stoves need to be rigorously tested in real-world conditions over extended periods of time before they are widely distributed, since household behavior will determine their ultimate effectiveness. Laboratory and efficacy studies are needed to understand the full potential of new technologies under ideal usage. However, this study illustrates the importance of field testing stoves—and health and environmental technologies more generally—in the context of a real program where people may not use the technology regularly or efficiently. The technology must be tested over a long enough time horizon to see how this behavioral effect evolves over time.

Low willingness to pay for improved stoves in Bangladesh

Another randomized evaluation with over 2,200 households in rural Bangladesh found low demand for two types of improved cooking stoves. At full price (approximately $5.80 or $10.90, depending on the stove type) only about 2–5 percent of households purchased the stoves, and at half price, the purchase rate increased only by 5–12 percentage points. The researchers found that women in rural Bangladesh do not perceive indoor air pollution as a significant health hazard, prioritize other basic developmental needs over improved stoves, and overwhelmingly rely on a free traditional cookstove technology and are therefore not willing to pay much for a new clean cookstove (Mobarak et al. 2012).

Featured Evaluation: Hanna, Rema, Esther Duflo, and Michael Greenstone. 2012. "Up in Smoke: The Influence of Household Behavior on the Long-Run Impact of Improved Cooking Stoves." MIT Department of Economics Working Paper No. 12-10.

For Further Reading: Mobarak, Ahmed Mushfiq, Puneet Dwivedi, Robert Bailis, Lynn Hildemann, and Grant Miller. 2012. "Low Demand for Nontraditional Cookstove Technologies." *Proceedings of the National Academy of Sciences* 109(27): 10815-20.

Briefcase Author: Dina Grossman **Editor:** Shawn Powers **Design:** Leah Horgan

Suggested Citation: J-PAL Policy Briefcase. 2012. "Up In Smoke." Cambridge, MA: Abdul Latif Jameel Poverty Action Lab.

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