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Private Actions in the Presence of Externalities: The Health Impacts of Reducing Air Pollution Peaks but not Ambient Exposure

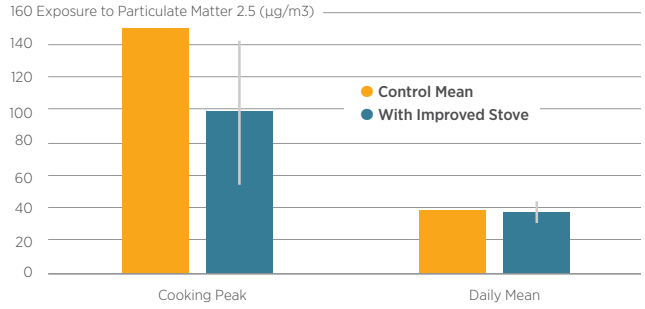
Based on BFI Working Paper No. 2023-127, "Private Actions in the Presence of Externalities: The Health Impacts of Reducing Air Pollution Peaks but not Ambient Exposure," by Joshua T. Dean, Chicago Booth; and Susanna B. Berkouwer, UPenn Wharton

Improved cookstoves reduce exposure to peak cooking emissions by 42%, though impacts on overall pollution exposure are muted by high ambient pollution. The reduction in peak emissions reduces self-reported respiratory symptoms but does not improve more quantitative diagnoses such as blood pressure or blood oxygen.

According to the World Health Organization, air pollution is "the single biggest environmental threat to human health." The Global Burden of Disease study estimates that it is responsible for 7–9 million premature deaths annually, or 10-15% of all deaths. While these figures suggest air pollution is a pressing public health problem, existing research does not distinguish between *temporary* exposure to *peak* pollution and *sustained* exposure to *ambient* pollution. Addressing the former would require targeted reductions in peak exposures driven largely by private activities such as cooking and work, while addressing the latter would require correcting the significant negative externalities that drive poor ambient air quality. This paper sheds light on this distinction by studying the impacts of reducing one of the most notorious sources of peak air pollution—charcoal cooking—in an urban environment where ambient pollution is also quite high.

The authors conduct a field study in Nairobi, Kenya, in which they offer participants randomized access (through varying subsidies and credits) to improved cookstoves. The improved cookstove, called a Jikokoa, is energy efficient and uses less charcoal and emits less pollution than the types of cookstoves common among households in Nairobi. The authors follow up with study participants after 3.5 years of daily stove use to analyze their impacts on pollution and health.

Figure 1 · Impact of Cookstove on Pollution Exposure



Note: This figure shows the impact of Jikokoa adoption on exposure to pollution. The blue bars show both average pollution exposure and peak pollution exposure during cooking among people who use a Jikokoa, while the yellow bars show the same two values for the control group. The vertical gray lines show the standard errors of the estimated coefficients.

To measure participants' exposure to pollution, each participant wears a backpack containing two devices that record exposure to particulate matter and carbon monoxide on a minute-by-minute basis for 48 hours. Such high-frequency monitoring allows the authors to separately identify impacts

on mean and peak pollution exposure. A complementary time use survey records each respondents' indoor or outdoor activity during each of those 48 hours. To measure health, the authors use measurements of blood pressure and blood oxygen levels, and as well as individual characteristics including height and weight. Finally, the authors use a socio-economic survey to measure behavioral and financial impacts. They find the following:

- The improved stove reduces peak emissions during cooking by 42%. For the control group (those who received smaller subsidies for their stoves), peak emissions while cooking are 125 micrograms per cubic meter (or, µg/m3) higher than their median daily exposure, but improved stove ownership reduces this by 52µg/m3. Average exposure while cooking is 50 µg/m3 among the control group and 33 µg/m3 for the treatment group; for comparison, average exposure while not cooking is 36 µg/m3 for both groups.

- These reductions in peak cooking emissions are largely offset by high levels of ambient pollution. Study participants report cooking for only two hours each day, on average, or 9% of their time. As a result, the large reductions in cooking pollution have only negligible impacts on participants' overall exposure to pollution.

- Adoption of the Jikokoa stove reduces self-reported respiratory symptoms such as sore throat, headache, cough, and runny nose. These are likely a direct result of reductions in peak emissions, and the authors find that these respiratory symptoms are correlated with peak levels of pollution, and not with average concentrations.

- Despite these improvements, the authors find that adoption of the Jikokoa had no impact on an array of clinical, quantitative health measurements (including blood pressure and blood oxygen), medical diagnoses (including pneumonia), or health-related expenditures. In other words, against a backdrop of high ambient air pollution, the large reductions in peak cooking emissions appear to have had negligible impacts on long term indicators of health.

- The $40 Jikokoa stove generates $86 in annual charcoal savings and reduces CO2 emissions at $4.9 per ton, suggesting government subsidies would generate large societal benefits.

These results suggest that the urban poor have only limited ability to improve their health through the private adoption of improved technologies. Instead, improving chronic and long-term health will depend on the reduction of ambient air pollution, which will require government intervention to address the negative pollution externality caused by economic activity. Despite this, these results support heavily subsidizing improved cookstove adoption as a cost-effective way of reducing carbon emissions.

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ABOUT OUR SCHOLAR

Joshua T. Dean
Assistant Professor of Behavioral Science and Economics, Chicago Booth

CHICAGO BOOTH
The University of Chicago Booth School of Business