RESEARCH BRIEF

March 2024

Topic

Based on EfD Discussion Paper titled "Electric stoves as solution for household air pollution: Evidence from rural India" by E. Somanathan, M Jeuland, E Gupta, U Kumar, T. V. Ninan, R Kamdar, V Chowdhury, S Chandna, M H Bergin, K Barkjohn, C Norris, T R Fetter, S Pattanayak

Reseach questions: How does electric power reliability and induction stove use affect household air pollution amongst a sample of rural Indian households that own both traditional solid fuel cookstoves and electric induction stoves?

Key Messages

- Household air pollution due to solid fuels for cooking- a major health concern in developing countries can be addressed with electric cooking
- Electric cooking is versatile and rural Indian households prefer cooking three out of four staples on it
- Electricity availability reduces household air pollution by 10-20 percent of mean peak kitchen concentrations.
- Induction stove use reduces household air pollution by an amount equivalent to mean peak kitchen concentrations.
- Electric cooking is a viable alternative to traditional cooking. Improvement in electricity reliability along with the promotion of electric cookstoves appear to be a promising policy for reducing household and ambient air pollution

Background and Methodology

Air pollution from cooking with solid fuels continues to be a major health problem in the developing world. Even though, many developing countries like India have achieved or have targeted universal electricity access they suffer from a highly unreliable power supply especially in rural areas. The role of electricity reliability on adoption and sustained use of technologies like induction cookstoves that could affect household air pollution is not clear. In addition, even though technological progress has made electric cooking appliances affordable for many developing country households, it is not

clear whether these households are willing to substitute it for traditional polluting cookstoves or whether they end up only replacing other non polluting stoves like gas stoves. Our project answers these questions by examining the effect of electric power reliability on household air pollution amongst a sample of households that own both traditional cookstoves and electric induction stoves (most also own Liquified petroleum gas (LPG) stoves).

We collected minute-by-minute data on electricity availability, induction stove use and particulate matter concentration in 50 households in the Sultanpur district of Uttar Pradesh for a period of one year. For each hour, and within each household and month, we compare PM2.5 concentrations (which measures particulate matter smaller than 2.5 micrometers) across days with varying shares of electricity availability in that hour while controlling for ambient PM2.5 concentrations. Using within household and hour of day variation ensures that we are estimating the causal effect of electricity reliability on pollution and not confounding with other household level or hour of the day level factors.

We also use electricity availability as an instrument for induction stove use to see how the use of induction stoves impacts household air pollution. We provide several reasons for why this is a valid indentification strategy.

Results

First, as shown in Figure 1 we find that induction owning households cook lentils, rice and vegetables more frequently on induction stoves compared to LPG stoves and traditional *chulhas*. Only *rotis* (Indian unleavened bread) are cooked more frequently on stoves other than induction stoves. This shows that the common assertion that induction stoves are not as versatile as stoves with an open flame as untrue.

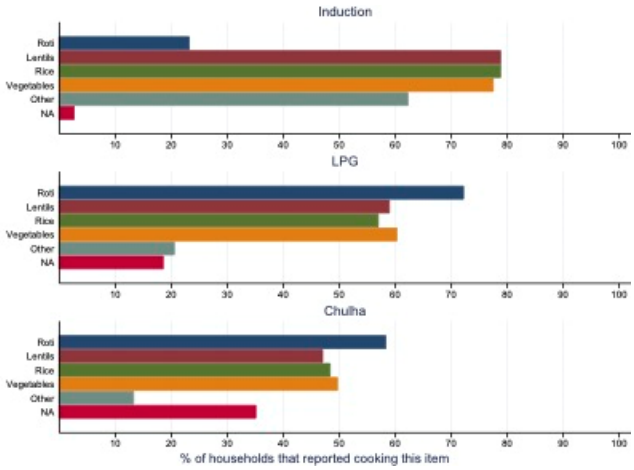

Figure 1: Food items cooked by induction owning households

Second, electricity reliability is poor. Outages are common and households cannot predict the time or duration of outage. Third, using this variation in power outages, we find that electricity availability reduces kitchen PM2.5 by upto 50 ug/m3 during morning and evening cooking hours as shown in figure 2. This is between 10% and 20% of morning and evening mean peak concentrations.

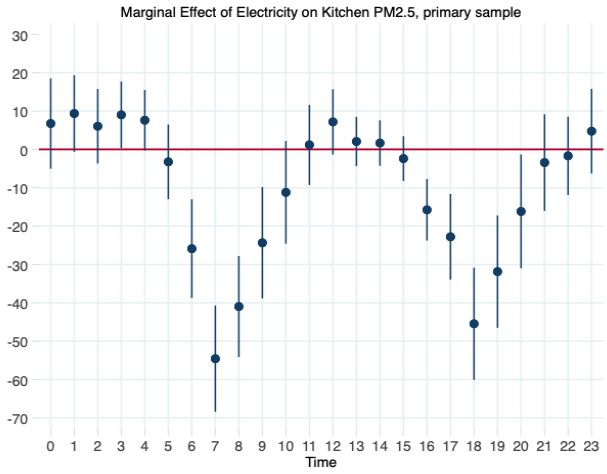

Figure 2: Effect of electricity reliability on kitchen PM2.5 for induction stove owning households with a chulha

Fourth, as in figure 3 using electricity availability as an instrument for induction stove use, we find large reductions of between 220 to 450 ug/m3 in kitchen PM2.5 concentrations. These are comparable to the average peaks during morning and evening cooking hours. In other words, on an average households seem to be willing to fully substitute traditional chulhas with induction stoves when electricity is available.

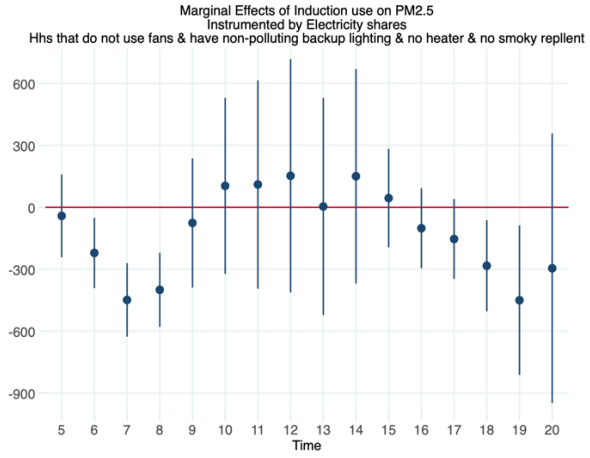

Figure 3: Effect of induction stove use on kitchen PM2.5 in a subsample where the exclusion restriction holds

Policy Implications

Our study was conducted in a setting of extremely high pollution in a sample of rural household kitchens in northern India that also contribute substantially to ambient pollution. We provide novel evidence for how electricity reliability in addition to electricity access can improve household welfare. We find that electricity availability substantially reduces household air pollution during cooking hours in this setting, and that use of induction stoves greatly reduces air pollution. Thus, improvements in the reliability of electricity together with promotion of electric cooking appears to be a promising policy for reducing household and also ambient air pollution.

We also provide a case for governments to reimburse a substantial portion of the household's monthly electricity bills so as to not deter households from adopting electric cooking.

The Environment for Development initiative is a capacity-building program in environmental economics focused on international research collaboration, policy advice, and academic training. It consists of centres in Central America, Chile, China, Colombia, Ethiopia, Ghana, India, Kenya, Nigeria, South Africa, Sweden (University of Gothenburg), Tanzania, Vietnam, Uganda, and the US (Resources for the Future). Financial support is provided by the Swedish International Development Cooperation Agency (Sida).