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How much do alternative cookstoves reduce biomass fuel use? Evidence from North India

N. Brooks [a], V. Bhojvaid [b], M.A. Jeuland [c,d,*], J.J. Lewis [e,1], O. Patange [f], S.K. Pattanayak [c,d,e]

[a] School of Earth, Energy & Environmental Sciences, Stanford University, Stanford, CA 94305, USA
[b] Department of Sociology, Delhi School of Economics, Delhi University, Delhi 110007, India
[c] Sanford School of Public Policy, Duke University, Durham, NC 27708, USA
[d] Duke Global Health Institute, Duke University, Durham, NC 27708, USA
[e] Nicholas School of the Environment, Duke University, Durham, NC 27708, USA
[f] Energy and Resources Group, Deloitte Touche Tohmatsu India Pvt. Ltd., Gurgaon, Haryana 122002, India

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ABSTRACT

Despite widespread global efforts to promote clean cookstoves to achieve improvements in air and forest quality, and to reduce global climate change, surprisingly little is known about the degree to which these actually reduce biomass fuel consumption in real-world settings. Using data from in-house weighing of fuel conducted in rural India, we examine the impact of cleaner cookstoves – most of which are LPG stoves – on three key outcomes related to solid fuel use. Our results suggest that using a clean cookstove is associated with daily reductions of about 4.5 kg of biomass fuel, 160 fewer minutes cooking on traditional stoves, and 105 fewer minutes collecting biomass fuels. These findings of substantial savings are robust to the use of estimators with varying levels of control for selection, and to alternative data obtained from household self-reports. Our results support the idea that efforts to promote clean stoves among poor rural households can reduce solid fuel use and cooking time, and that rebound effects toward greater amounts of cooking on multiple stoves are not sufficient to eliminate these gains. We also find, however, that households who have greater wealth, fewer members, are in less marginalized groups, and practice other health-averting behaviors, are more

* Corresponding author at: Sanford School of Public Policy, Duke University, Durham, NC 27708, USA. Tel.: +1 919 613 4395; fax: +1 919 681 8288.
E-mail address: marc.jeuland@duke.edu (M.A. Jeuland).
[1] Present address: Geneva, Switzerland.

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likely to use these cleaner stoves, which suggests that socio-economic status plays an important role in determining who benefits from such technologies. Future efforts to capture social benefits must therefore consider how to promote the use of alternative technologies by poor households, given that these households are least likely to own clean stoves.

1. Introduction

Nearly 40% of the world's population relies on solid biomass fuel for cooking purposes (Bonjour and Adair-Rohani, 2013) while in India as much as 70% of the population cooks with biomass fuels (Government of India, 2011). Traditional cooking with solids fuels and inefficient stoves contributes to numerous health problems (Adrianzen, 2013), releases climate-warming greenhouse gases and black carbon emissions (Bond, 2004; Ramanathan and Carmichael, 2008), and exacerbates local air quality and other environmental problems. In particular, unsustainable harvesting of fuelwood for cooking can lead to local forest degradation and accelerate deforestation, especially in densely-populated areas (Geist and Lambin, 2002; Ghilardi et al., 2009; Heltberg, 2004).

Cleaner and more efficient cookstoves have the potential to address these negative impacts of traditional cooking if they allow more efficient combustion of biomass fuel or use cleaner-burning fuel, such as liquefied petroleum gas (LPG).[2] Yet surprisingly little is known, and empirical evidence is mixed, about whether such improved technologies actually deliver their purported benefits, in health, time savings, and air quality and forest stock under real-world conditions (Jeuland et al., 2015; Sambandam et al., 2015). Low rates of adoption and use of improved stoves, as well as stove and fuel stacking, imply that adopting a new stove may not reduce overall consumption of biomass fuel or alleviate the adverse effects of traditional cooking as much as would be suggested by simple engineering estimates using relative stove efficiencies.

This paper contributes to a relatively sparse literature that examines how the use of non-traditional stoves is linked to lower reliance on traditional stoves and biomass fuels. Our analysis uses data from rural households in two states of northern India: Uttar Pradesh (UP) and Uttarakhand (UK), and mainly considers the effects of LPG use, since 94% of non-traditional stove owners in our sample have gas stoves. We hypothesize that using such improved stoves is negatively associated with each of three key outcomes – (1) daily consumption of biomass fuel, (2) cooking time on traditional stoves, and (3) time spent collecting biomass fuels – and quantify the extent of these reductions. Because households that choose to purchase and use an alternative cookstove may be systematically different from those that do not in ways that also affect these outcomes (Pattanayak, 2009), our preferred estimates of the impacts of clean stoves are derived from a Heckman two-step estimator that aims to correct for differential selection into improved stove ownership. We compare the results obtained from this Heckman model with those obtained using propensity score matching (PSM), which also aims to adjust for selection, and simple Ordinary Least Squares (OLS) estimation, which does not, and discuss differences across these specifications.

Also unique for this literature, we assess the sensitivity of our results to measurement error by relying on data collected using different methods. Our preferred outcome variables are based on measures derived using objective measurements (24-h fuel weighing) or corresponding to shorter recall periods (reporting for the past 24 h, rather than "average" use). On the one hand, self-reported measures are subject to recall error and respondents' lack of understanding of questions (Blum and Feachem, 1983), while recall periods even as short as a week can challenge respondent memory (Byass and Hanlon,

[2] We use the terms "cleaner or improved cookstoves" to describe any stoves that are theoretically more efficient than a traditional stove. "Non-traditional/alternative stoves" describe anything that is not a traditional stove (but may not necessarily be clean). Finally, the term "clean cookstove" is reserved for a stove that is sufficiently efficient to provide health benefits, according to current literature (Grieshop et al., 2011; Sambandam et al., 2014).