Time for clean energy? Cleaner fuels and women's time in home production

Farzana Afridi Sisir Debnath Taryn Dinkelman Komal Sareen

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Abstract

In much of the developing world, cooking accounts for the largest share of women's time in home production. Does relying on solid fuels drive this time burden? This study revisits a clean energy information experiment in rural India to assess the time savings' potential of cleaner cooking technologies. Treatment villages were randomly assigned to receive information about negative health effects of cooking with solid fuels and about public subsidies for cleaner Liquid Petroleum Gas (LPG). Time use data indicate that primary cooks spend almost 24 hours cooking each week. Cleaner fuel use is correlated with about 140 minutes less cooking time each week. Yet households only reduce their weekly cooking time by about 35 minutes in response to the randomized clean energy information nudge. Factors limiting the impact of clean energy nudges on the choice of home production technologies and time use are discussed and an avenue for future research is suggested. [152 words]

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*Taryn Dinkelman (corresponding author) is a professor at the University of Notre Dame, a research associate at NBER and a research fellow at IZA and CEPR; her email address is `tdinkelm@nd.edu`. Farzana Afridi is a professor at the Indian Statistical Institute (Delhi) and the National University of Singapore, Lead Academic at the IGC's India Program, and a research fellow at IZA; her email address is `fafridi@isid.ac.in`. Sisir Debnath is a professor at the Indian Institute of Technology (Delhi); his email is `sisirdebnath@iitd.ac.in`. Komal Sareen is a graduate student at the Indian Institute of Technology (Delhi); her email is `ksareen18@gmail.com`. Afridi acknowledges financial support from the Bill and Melinda Gate Foundation's Initiative for What Works for Women and Girls in the Economy (IWWAGE-IFMR). This study is registered with the American Economic Association's registry for randomized controlled trials AEARCTR-0003774. Excellent research assistance was provided by Akriti Dureja and Abhishek Arora. A supplementary online appendix for this article can be found at *The World Bank Economic Review* website.

1 Introduction

Cooking is the most time-intensive aspect of home production in developing countries today (Dinkelman and Ngai, 2022). This essential activity still relies on solid fuels such as wood, charcoal, and animal dung. Much advocacy exists around freeing women in low-income countries from the drudgery of home production through the use of cleaner stoves and cleaner fuels.[1] Yet there is limited direct evidence on how much time women (and households in general) spend using solid versus clean fuels, and how much time might be saved from a switch to cleaner energy (Krishnapriya et al., 2021). Quantifying potential and actual time savings from a move towards clean energy cooking is important for considering the welfare gains to women of clean energy transitions in the home (Cecelski, 2000). Such time savings would augment any health gains from lower exposure to indoor air pollution facilitated by clean energy cooking.[2]

This paper explores whether nudging households towards cleaner fuel use for cooking could generate significant time savings in home production in a developing country context. It revisits the information experiment in Afridi et al. (2021) in which rural Indian households were nudged away from solid fuel use and towards cleaner bottled Liquid Petroleum Gas (henceforth LPG) for cooking. The information nudge was designed to draw the household's attention to the severe negative health consequences of relying on solid fuels for cooking. Households were randomized (at the village-level) to either receive information about the health benefits of using LPG and health costs of using firewood and dung in their homes (*Health* treatment); to receive this information along with information about available public subsidies for LPG (*Health and Subsidy* treatment); or to receive no information.

Using household survey data collected from almost 3,000 households in 150 villages across Madhya Pradesh in India and a rich set of baseline and endline data on time use, the paper examines

[1]For example, see the Clean Cooking Alliance `https://www.cleancookingalliance.org/home/index.html` or Clean Cooking `https://cleancooking.is/`

[2]See Hanna et al. (2016) for an example of a clean stove intervention that had no long-term impacts on health, and Verma and Imelda (2021) for an example of expansion of LPG cooking that did result in health improvements at population-level

the impacts of the two information treatments on fuel use, fuel collection, and potential and actual time savings among primary cooks, almost all of whom are women. The analysis paper builds on Afridi et al. (2021), who use the experiment to measure impacts on LPG consumption and other household adaptations (e.g. use of chimneys and a separate room as kitchen) to mitigate indoor smoke.

The first set of results in the paper provides new evidence that the time demands of home production in rural India are substantial. Primary cooks in the sample spend on average 60 hours per week in home production activities. Almost 24 of these hours are in cooking-related activities, the equivalent of a part-time job. Despite these significant time demands of home production, the baseline data suggest somewhat modest *potential* time savings from switching to cleaner fuels. Regardless of how observable characteristics of households are controlled for, total home production time is 30–40 minutes lower and cooking time is 11-36 minutes lower each day in households using only clean fuels, relative to those using only solid fuels. Moving towards cleaner cooking fuels could potentially save 5.8–7.7% of total home production time across the week.

The main results on fuel use and *actual* time use exploit the randomized information intervention. Treated households are 6% less likely to collect solid fuel, and 4–5% less likely to exclusively use solid fuels for cooking. These estimates match results in Afridi et al. (2021), who found that the intervention led households to adjust their fuel use patterns at the margin: treated households that were existing LPG users purchased more LPG cylinders each month, and treated households also increased electric induction cooking to some extent. The information nudge shifted household fuel use in the direction of cleaner energy, although mixed fuel use is still common after the experiment.

These changes in fuel use at the household-level were not accompanied by large, or even moderate, shifts in total home production time. Experimental estimates indicate a five minutes per day time savings in home production, driven by a five minute reduction in cooking time for primary cooks exposed to the full information treatment (*Health and Subsidy* information). This represents about a 2.5% reduction in cooking time each week.

Calculating the market value of actual time saved through the experiment helps to unpack the muted household response to the information intervention. Using the rural minimum wage as the opportunity cost of women's time, the monthly time savings from making a marginal switch towards LPG use, as was induced by the experiment, is about 1.2% of monthly household income.[3] The subsidized cost of a marginal increase in LPG use in the home is about 0.9% of household income. This suggests that households – at least those with existing LPG access – are not making vastly sub-optimal decisions about LPG use on the intensive margin. The final section of the paper discusses several factors that limit more fundamental shifts in how cooking is organized in rural India. Specifically, the paper highlights the roles of credit constraints that limit LPG adoption, liquidity constraints that limit LPG use on the intensive margin, and the low opportunity cost of female time inhibiting adoption and use.

This study contributes to the large environmental literature that focuses on more efficient and cleaner cooking technologies, most notably the adoption and use of improved cookstoves (ICS) in developing countries. Research in this area typically measures the impact of ICS on indoor air pollution and the health of primary cooks, either in lab or in real-world settings (e.g., see Gould and Urpelainen (2018) and Beltramo et al. (2019) for a discussion of this literature; and Hanna et al. (2016) and Bensch and Peters (2015) as specific examples of ICS studies). Improved cookstoves still use solid fuels for cooking, but less of it, and they direct smoke away from the primary cook. In contrast, the focus here is on a clean cooking fuel, one which does not require any biomass collection and does not produce smoke.

To the best of our knowledge, this is the first study to examine the effect of randomized nudges towards clean fuel on time use in the household. Only a handful of studies in the improved cookstoves literature estimate the effects of these stoves on time use in cooking and fuel collection. Krishnapriya et al. (2021) provides a comprehensive review of this literature, noting that only two of 24 studies (Bensch and Peters (2015) and Hanna et al. (2016)) collect time use data within a

[3]These back-of-the-envelope calculations do not account for any health benefits from moving towards cleaner fuels.

randomized evaluation (of improved cookstove methods) design (Berkouwer and Dean (2022) is a new addition to this list). Among the studies that do capture time use, both larger and smaller reductions in cooking time have been estimated in response to the new cookstove, compared with the time savings estimated from the experiment in this paper. Similar to the ICS literature, studies of the impact of LPG have also often focused on the health impacts of moving to cleaner fuels (e.g. see Verma and Imelda (2021)). Williams et al. (2020) is an exception – that study measures time use impacts of moving to LPG in a randomized study in Peru with 180 women who received free unlimited LPG for a year. The experimental results show that free unlimited access to LPG saves on the order of 3.3 hours of cooking time per week - a substantially larger effect than found here, but still a small share of total cooking hours per week (23 hours in their sample). The main takeaway is that, against a backdrop of 24 hours per week spent in cooking, technologies that lead to small time shifts each week cannot have transformational impacts on how time is organized in the home.

Financial constraints to adoption and use of new technologies (in general) and clean cookstoves (in particular) have been well-studied in the development literature. For example, Bensch et al. (2015) find that liquidity constraints may dampen adoption of ICS in Burkina Faso. Berkouwer and Dean (2022) randomly subsidize adoption of energy efficient stoves in urban Kenya and find low adoption rates in response to the subsidy, concluding that credit constraints prevent profitable adoption of the improved cookstove. In Uganda, Levine et al. (2018) show that timely credit payments that address liquidity constraints, along with reducing information asymmetries, increases efficient cookstove adoption by 40 – 50 percentage points. And in Hanna et al. (2016), while adoption of (highly subsidized) improved cookstoves was large, consistent use of the new technology tapered off over time partly due to recurring costs of stove maintenance. This paper shows that, despite the fact that LPG access and use is highly subsidized in low-income Indian households (see Section 2), the impact of switching to cleaner fuels on time use is limited. Credit and liquidity constraints likely still inhibit household responses to randomized information nudges.

Finally, the result from this information experiment can be tied to the broader literature on female labor force participation over the development process, as it has been observed in currently developed countries. Time use of American women changed dramatically over the twentieth century, with large reductions in home production time and importantly in food production time. These shifts were accompanied by new cooking technologies in the home. As a point of comparison, one hundred years ago, American farmwives spent about 23 hours per week in food preparation and 52 hours each week in home production (Ramey, 2009). This is very similar to the time use of the sampled primary cooks in our paper. And, as is the case in the current paper's setting, cooking in the US one hundred years ago was still heavily reliant on solid fuel (Bose et al., 2022). Yet over decades, households in the US adopted time-saving new cooking technologies that depended on cleaner fuels, as the cost of these technologies fell and as growing employment opportunities for women made it easier to adopt these new technologies (e.g., Greenwood et al. (2005); Ngai and Pissarides (2008); Vidart (2022)). By 1965, every household in America had an electric or gas stove, and by the 2010s, women in the US spent fewer than 8 hours per week cooking. As Bose et al. (2022) notes, an important part of the dramatic energy transition in the US was the availability of market work for women. In rural India (and in the specific setting of this paper), female labor force participation fallen over time even as levels of education have risen (Afridi et al. (2018); Fletcher et al. (2017). While financial constraints may contribute to the low responsiveness of households in our experiment, the lack of employment opportunities for women in rural India could be another key barrier to increased clean energy use. One suggestion for future research might usefully test whether a combination of relaxing financial constraints and providing new access to female employment could support a more robust transition to clean cooking fuels, with larger impacts on women's time use.

The paper begins by describing the context of the clean cooking fuel (LPG) subsidy in India. Section 2.2 describes time use patterns in the baseline survey data and links these time use patterns to patterns of solid or clean fuel use, examining how much time might be saved if households switch to cleaner energy. Section 3.1 outlines the information treatments provided in the randomized experiment and presents the impacts of the experiment on fuel choices and time allocation in the home. Section 3.2 discusses results and places the estimates in context. Section 4 describes key remaining constraints to cleaner fuel adoption.

2 Context

2.1 Subsidies to expand access and use of LPG in India

Access to LPG for household use in India has increased substantially in the last decade. Since 2011, access to bottled LPG (or LPG cylinders) has risen from 28.5% Census (2011) to 79% (PPAC Report, 2018). This expansion in access was facilitated by the *Pradhan Mantri Ujjwala Yojana* (PMUY) program which began in April 2016. The largest program in the world to facilitate access to clean fuel, the PMUY reached 72 million low-income Indian families between April 2016 and June 2019.

Under the PMUY, a woman in a rural, socio-economically disadvantaged household can obtain an LPG connection (henceforth, account) at no upfront cost.[4] The total cost of registration for an LPG account is equivalent to about two weeks of monthly household income in rural areas.[5] Of this total cost of INR 3375, the government covers the INR 1875 security deposit and administrative charges under the PMUY. PMUY-eligible households, in addition, are mandated to receive an interest-free loan of INR 1500 from the Oil Marketing Companies (OMCs) to purchase a stove and the first cylinder.

Between 2013 and 2020, all households (i.e. both PMUY and non-PMUY households) were

[4]An LPG 'connection' is the official term that refers to registration for obtaining the pressure regulator and consumer booklet along with the first LPG cylinder. To register for an LPG account, a consumer must provide proof of identity and address and submit a security deposit equivalent to INR 1875, unless they quality for the PMUY connection subsidy. The security deposit is for the empty 14.2 kg capacity cylinder and the pressure regulator. The consumer then has to pay the market price separately for the gas in the cylinder (INR 750) and a stove (INR 750). While the stove can be purchased in the open market, the regulator and refill cylinders are supplied only by the Oil Marketing Companies (OMCs) through their LPG dealers.

[5]Average rural household income was approximately INR 7215 per month in 2011, the latest year for which reliable estimates are available (IHDS-II, 2011). The USD-INR exchange rate is approximately 1 USD = INR 75.

subsidized for up to 12 standard (14.2 kg) LPG cylinders annually. The subsidy was implemented as an electronic cash-back scheme – a consumer bought a refill cylinder at the market price and the subsidy was credited to her bank account as cash-back within the next 2-3 days. Assuming that a household with 4–5 members requires one standard LPG cylinder per month to facilitate exclusive cooking with LPG, the LPG cost post-subsidy was no more than INR 20 per day or about INR 500 – 600 per month.[6] This translates into a not-insubstantial LPG fuel cost of about 7% of monthly household income, post-subsidy (i.e. 500/7215 = 6.93%).[7]

Not surprisingly, despite rapid increases in LPG access in rural areas, and subsidized LPG refill consumption, regular LPG *use* in India remains low. The mean LPG refill consumption in rural areas is about four cylinders per year, compared to eight cylinders per year in urban areas.[8] This study takes place in an environment of widespread access, but relatively low intensive-margin use.

2.2 The technology of home production in rural India

2.2.1 Home production is extremely time intensive

The focus of this study is rural Madhya Pradesh (MP), one of the largest northern states in the country, where about 67% of households had an LPG account in 2018. At the baseline of a cluster RCT that is further described in Section 3, a time use survey was administered to the primary cook (the member of the household with the primary responsibility of cooking food for the family, identified by household members during the survey) of 3000 randomly sampled households (with and without LPG accounts) in 150 villages that were were also randomly sampled in the district of Indore in MP during November-December 2018. With few exceptions (i.e., 0.07% of the total

[6] The market price of LPG refills varies each month in tandem with the international market price of crude petroleum. The refill subsidy varied with the market price to keep the post-subsidy refill price in the range of INR 500 - 600 per cylinder during the period of this study.

[7] The expenditure estimate is in line with a recent report (Council on Energy, Environment and Water), which indicates that if LPG were used exclusively for cooking, the proportion of household expenditure on cooking fuel would vary from 9.2% for the bottom wealth decile to 3.9% for the top wealth decile in India (at post-subsidy LPG refill price of INR 580 in March 2020).

[8] Authors' estimates from data shared by OMCs for the study area and media reports (Hindu Businessline). LPG refill data are not available publicly. See also Pillarisetti et al. (2019).

baseline sample), all primary cooks were women. (Further details of the experimental design and implementation are provided in Supplementary Online Appendix S1., available at *The World Bank Economic Review* website.)

Primary cooks reported their time use over the 24 hours prior to the survey day (or the last 'normal' day).[9] To get a sense of the time intensity of different types of activities, weekly hours spent on each activity are calculated by multiplying the unconditional average time spent per day in each activity by seven (variation in time use across activities by week and weekend days was minimal).

Several features of the primary cook's (henceforth PC's or women's) time use stand out. First, in Figure 1(a) almost 60 hours per week are classified as rest, and just over 60 hours per week are spent in home production (domestic work). Time in home production is greater than time spent in a full-time job. In addition to these home production hours, some women are also engaged in market work. The average amount of time in market work among these women is about one-third of the time spent in home production (19.3 hours).

Figure 1(b) further sub-categorises the time spent on home production. Cooking and cleaning are the most time-intensive components of home production. Cooking occupies almost 24 hours each week, or 3.4 hours per day. Cleaning is also very time-intensive, at almost 20 hours per week. In contrast, the time spent on fuel collection is only a small share of total time in domestic work, at under 2 hours per week. This is because collecting fuel (primarily firewood) is a household activity - of the 2.2 trips (on average 117 minutes per trip) made by the household to collect firewood in the previous month in our sample, the primary cook made 1.3 trips (67 minutes per trip), either alone or with other household members. Fuel collection is an occasional, rather than daily, activity.

A remarkable characteristic of the pattern of women's time use across home production categories (especially cooking time) in Figure 1(b) is that it closely matches time use among rural

[9]The surveyor first asked the respondent what time they woke up on the last regular day. The respondent was then asked to recall their activities throughout the day in 15-minute intervals until they went to sleep. This is one standard way to collect time diary information. These activities were then coded using the 24-hour time use recall. See Appendix S1. for details on the design of the survey and time use classification.

Indian women recorded in national (Afridi et al., 2018) and other surveys (Anderman et al., 2015; Maji et al., 2021); time use patterns among women recorded by studies in other developing countries (e.g., Peru (Williams et al., 2020) and Malawi (Cundale et al., 2017); and time use patterns of rural housewives in the historical US (Dinkelman and Ngai, 2022; Ramey, 2009).[10] Average weekly time in cooking in the US in the 1920s was 23.5 hours, with cleaning and laundry reaching almost 21 hours - almost identical to the time Indian women in our sample spent cooking and cleaning.

2.2.2 Fuel stacking is prevalent

Although primary cooks in the sample survey rely on traditional wood/charcoal stoves *(chulha)* for cooking, mixed fuel use is common, as it is in other developing countries. The baseline survey data indicate that households collect, purchase, and use a mixture of clean and dirty fuels. Complete reliance on clean fuels is unusual.

Table 1 shows households' access (Panel A), use (Panel B), collection (Panel C), and purchase (Panel D) of cooking fuels in the previous month. Consistent with the discussion of widespread access to LPG in the previous section, over two-thirds of households have an LPG account. Yet, while 67.5% of the sample reported using LPG for cooking in the previous month, a large share of households report also using dirty fuels (74.8% firewood, 87.8% dung cakes, and 11.3% crop residue) for cooking. Over 70% of households reported collecting solid fuels in the previous month (Panel C), while a lower proportion (14.3% - 29.1%) purchased them (Panel D).

Households tend to use solid fuels frequently and regularly for cooking regardless of LPG account status, as shown in Table 2. Primary cooks in the households were asked to list all the fuels used in cooking over the last month (column 1) and in preparing the most recent meal (column 2). Only 7.3% of households used clean fuels exclusively in the last month, with LPG making up the bulk of clean fuel use. In the last meal, only 29% of households report using LPG exclusively.

[10] Figure S2.1 in Appendix S2. shows the distribution of time use by rural women in India in the nationally representative Time Use survey of 2019, for the sample restricted to the same age group and season as in our study.

Fuel stacking is prevalent: over half of all households used a mix of clean and dirty fuels in the month before the survey.

2.2.3 Fuel mix is correlated with home production time

Table 3 uses the entire sample to show the association between time spent in cooking and in home production with the household's use of mixed fuels and clean LPG. The outcomes – minutes spent cooking the last meal (column 1), cooking over the last day (column 2), and in total home production activities the day before the survey (column 3) – are regressed on controls for the type of fuel used in the reference period (last meal or last day), and a set of household-level observables that may affect fuel and time use. The indicator variable for only clean fuels captures households that use either LPG or electricity (or both) in their cooking. Mixed fuels captures households that use a mix of some clean and some solid fuels. The omitted category is exclusive use of solid fuels in cooking. The first column shows that if a primary cook used only clean fuels in preparing the last meal, they reported spending a statistically significant 18.5 fewer minutes in meal preparation, relative to primary cooks using only solid fuels. This time saving is about the same (17.8 minutes) for meal preparation in the prior day. Aggregating these estimates over a week implies that exclusive use of clean fuels entails about 2 hours (18 minutes x 7 days = 126 minutes) less cooking time each week, or about 3.6 hours less home production time each week. These correlations between fuel use and cooking time use captured in the baseline survey correspond with studies that test for efficiency in cooking with LPG and non-LPG fuels.[11]

Conditional on household-level observables (as in Table 3), households with different patterns of fuel use may still differ in unobservable ways that affect time use patterns. Implementing a propensity-score matching estimator more flexibly controls for observable differences across households that do and do not use LPG in their most recent meal preparation. Using the rich baseline data, adjusted time use gaps are compared across matched households that did and did not use

[11] For example, Budya and Arofat (2011) note that LPG is 2.5 times more efficient than kerosene: 1 litre of kerosene can be replaced by 0.4 litres of LPG.

LPG in cooking the last meal.[12]

Table 4 shows that primary cooks in LPG-using households spend less time in fuel collection and production than primary cooks in non-LPG using households. Column (1) indicates that primary cooks spend about 23 fewer minutes each trip collecting firewood, while columns (2) and (3) show 45-66 fewer minutes on dung collection and dung making activities in the last month.[13] These are fairly minimal weekly time savings.

Primary cooks in LPG-using households also tend to spend less time in home production on average, and more time on leisure activities as shown by the propensity-score matched estimates in Table 5. The outcomes in this table are captured from the time use reports of the primary cook measured for the day prior to the baseline survey (in contrast to time spent in the last month and on the last trip reported in Table 4). Panel A, column (1) of Table 5 indicates that primary cooks in LPG-using households spend 38 fewer minutes per day on home production, and the majority of this time gap shows up as additional minutes spent in leisure (Panel A, column 4). About 7 minutes of the potential time savings come from less time in fuel collection on the prior day (Panel

[12] Matching the households that used LPG and those that did not use LPG to cook their last meal was done using observed characteristics at baseline: village, household, and primary-cook characteristics. Household characteristics include - household size, dummy for household head's education above primary level, head's occupation, primary cook's age, dummy for primary cook's education above primary level, dummy for non-Hindu households, household caste, indicators for ownership of agricultural land, house, vehicles, animals, and durable consumer goods. Village-level controls include - dummies for a private primary school, access to health sub-centres, all-weather road, the proportion of irrigated land, and distance to block headquarter. The specification also controls for seven deprivation indices required for PMUY eligibility - indicator for households having one room, *kucha* walls and *kucha* roof, indicators for female-headed households without adult male member and SC/ST households. Figure S2.2 in Appendix S2. shows that this matching exercise selects a set of non-LPG-using households that resemble the LPG-using households more closely on a large group of observables.Figure S2.3 shows the reduction in standardized bias in covariates post-matching. All of our results are robust to alternative matching methods, e.g. kernel-based matching.

[13] Note that information on fuel collection time used in this table is not from the time diary, but from the main household survey. Time spent in firewood collection was asked for all household members (including the PC) who undertook this activity in the previous month, and time spent by the PC is reported only in column (1) of the table. Dung collection/making was asked for the household as a whole (although this activity is almost always undertaken by the PC alone).

B, column 1), while 11 minutes of time each day was saved in cooking and 9 minutes of time was saved in the 'Others' category (the majority of which was in making dung cakes; Panel B, column 5). None of this potential time saved appears to be allocated towards the market (Panel A, column 2). As one might expect, using LPG does not directly impact time spent on home production activities like childcare (Panel B column 4). Adding up columns (1), (2) and (5) in Panel B, the matching estimates suggest that LPG use in the last meal could save around 28 minutes per day for the primary cook, or 3.3 hours per week in home production; or 4.4 hours if the estimate from column (1) of Panel A is used. This equates to a 5.5 – 7.3% reduction of weekly time in home production.

Taken together, the baseline time use survey demonstrates that home production is generally very time-intensive. Specifically, it is cooking and cleaning, rather than fuel collection or fuel (dung cake) production that uses the most time among primary cooks' daily activity; and cooking with dirty fuels takes somewhat more time per meal than using cleaner fuels. The patterns here suggest some scope for limited time savings as households increase their use of LPG and reduce their reliance on solid fuels for cooking. Potential time savings suggested by the observational data are still small, relative to the 24 hours of total time spent on cooking each week. The next set of results examines the causal effect of a shift towards cleaner fuel use, by estimating how time use changes across households that are randomly nudged to adopt and use the clean fuel.

3 Information nudges towards clean fuel: The RCT

3.1 Experimental design and sampling

Afridi et al. (2021) designed two information campaigns to nudge households to use cleaner fuels at home. The cluster-randomized RCT was conducted in the same 150 villages selected randomly to be part of the baseline study discussed above, with 50 villages (and the 20 randomly sampled households within each village) randomly assigned to one of two treatment groups, or a control group. See Appendix S1. and Afridi et al. (2021) for further details on sampling and design of the experiment.

In November and December 2018, the baseline survey was administered to the 3000 households selected for inclusion in the study. The information intervention was then conducted in the first nine months of 2019, and a follow-up survey was conducted in the last three months of 2019. The information campaign was designed to increase the adoption and regular use of LPG. It consisted of an awareness campaign on the health and financial benefits of switching to regular use of LPG for cooking. The campaign centered around improving households' understanding of – the adverse health impacts of solid fuels and measures to mitigate inhalation of indoor smoke (*Health*) and the government subsidy to LPG consumers (*Subsidy*). The information intervention had two treatment arms: the health awareness arm (*Health* treatment) and the health awareness and LPG subsidy (*Health and Subsidy* treatment) arm. Government health workers delivered information under either arm to sampled households in the relevant randomized villages. Information was delivered in a series of video vignettes by a health worker following a written script.[14] The goal was to get households to understand the health cost of continued biomass use for home cooking, the benefits of alternatives like using chimneys or LPG, and how households can reduce the costs of using LPG through the government-run, cash-back subsidy program. No information was provided in the control group of villages.

Both baseline and follow-up surveys collected detailed time-use data from the primary cook in the household. Time-use data was self-reported in a typical time diary fashion: with women reporting all activities conducted 24 hours prior to the date of the survey. A description of how the time use modules were administered is in the appendix and Table Appendix S1.1. See Tables S2.1 - S2.4 in Appendix S2. for balance on observable characteristics across treatment arms at baseline. There are no differences in average time spent in personal care and domestic work across treatment and control arms; there are some differences in leisure and work time at baseline. However, the

[14] Implementation of the experiment leveraged the existing public health system by engaging Accredited Social Health Activists (ASHAs) to deliver the information – female residents of the village, who had at least secondary schooling, were between 25–45 years of age, and were employed by the state government to provide public health services. ASHAs were paid INR 50 per visit per household, comparable to their regular remuneration.

joint significance test of all of the time use variables across treatment group status has a p-value of 0.38 and 0.26 on *Health* treatment and *Health and Subsidy* treatment arms, respectively.

3.2 Empirical strategy

Two related empirical specifications are used to causally estimate the reduced-form effects of the information awareness campaign on fuel use and the primary cook's time use.

First, exposure to the *Health* treatment or *Health and Subsidy* treatment campaign is combined into a single indicator of treatment status that takes a value of one if a household was exposed to either treatment, and zero otherwise (control group), as follows:

$$Y_{iv}^1 = \beta_c + \beta_T T_v + \beta_0 Y_{iv}^0 + \beta_X' \mathbf{X}_{iv} + \beta_Z' \mathbf{Z}_v + \varepsilon_{iv}, \tag{1}$$

where Y_{iv}^1 is fuel use or minutes per day spent by the primary cook in the ith household in village v at endline. Y_{iv}^0 is the baseline fuel/time use by the same primary cook in the previous year, in approximately the same season (October – December). T_v is a dummy variable indicating whether village v is assigned to either treatment and $\mathbf{X}_{iv}$ are a set of baseline characteristics for household i in village v. These controls include household size and assets, education and primary occupation of the household head, education and age of the primary cook, indicators for household religion and caste.[15] Village characteristics are also included: $\mathbf{Z}_v$, the proportion of irrigated land, and indicators for the presence of private primary schools, health sub-centre, distance to block head-quarter and all weather road access.[16] To account for variation in the administration of the local

[15]Since the ownership of different household assets is likely to be highly collinear, a first principal components analysis over several indicators is used to measure the economic status of a household. These indicators include ownership of land and farm animals, *pucca* house, and a list of consumer durables. Education of the head of the household and the primary cook is measured by an indicator that takes value one for more than primary education and zero otherwise.

[16]Census data on 'distance of village to block headquarters' is missing for 260 households (13 villages). Instead, traveling distance is imputed using Google Map's Distance Matrix Application Programming Interface (API). The correlation between this imputed traveling distance and census data is 0.84 (mean census (Google API) distance is 18.07 (20.01) km, as against the mean straight-line distance of 13.70 km) for the 137 villages with Census distance data. The results do not vary

health department, which may have impacted the delivery of the intervention across sub-districts, the specification also include sub-district fixed effects.

The main parameter of interest is β_T, representing the impact of the awareness campaign (either *Health* or (*Health and Subsidy*)) on the outcomes of interest. Since the treatment status was randomly assigned to the sampled villages, households' exposure to treatment was exogenous. The OLS estimate of β_T from equation (1) represents the intention to treat effect of the awareness program.

The second specification distinguishes between the two types of treatments and estimates and compares the impact of the two arms on each outcome.

$$Y^1_{iv} = \beta_c + \beta^h_T T^h_v + \beta^{hs}_T T^{hs}_v + \beta_0 Y^0_{iv} + \beta'_X \mathbf{X}_{iv} + \beta'_Z \mathbf{Z}_v + \nu_{iv}, \tag{2}$$

where T^h_v is a dummy for assignment of village v to the *Health* treatment and T^{hs}_v a dummy for assignment to the *Health and Subsidy* treatment. The other variables are as explained above. Standard errors in both equation (1) and (2) are clustered at the village level.

3.3 Results

3.3.1 *Fuel use impacts*

The first set of results in Table 6 presents the impact of the information treatments on solid fuel collection for home production: specifically, firewood and dung. Over half of the control households spend any time collecting firewood and around one-quarter of control households spend time collecting dung for making dung cakes for home energy use. For each outcome, results are first presented for the combined treatment first, and then for the two separate treatments. All columns contain the full set of additional controls.

Across the board, exposure to the *Health and Subsidy* treatment reduced the incidence of solid fuel collection for household use. Firewood collection declines by 6.1 percentage points and dung

if a dummy for missing distance data for the 13 villages is added into the regression analysis.

collection declines by 5.9 percentage points, respectively.[17] Although the point estimates on the *Health* treatment are not statistically significant, they also suggest that exposure to information moved households away from solid fuel use. The point estimates suggest that one cannot reject that the two information treatments had the same impact on reducing household activity towards collection of solid fuels for energy use.

Next, the paper looks at how primary cooks use fuels in the most recent or last meal cooked. table 7 shows the impacts of randomized treatment nudges on how primary cooks use fuels in the most recent last meal cooked. The three outcomes are: only clean fuels, that bundles LPG with electricity (columns 1-2), a mix of clean and solid fuels (columns 3-4), and only solid or dirty fuels (columns 5-6).[18] Exclusive use of solid fuels falls by around 4 percentage points (or 7.5% of the mean of the control group), while exclusive use of clean fuels rises by about the same magnitude. The point estimates on *Health* treatment and *Health and Subsidy* treatment are statistically the same. Note that the point estimates on mixed fuel use in the last meal are negative, but not statistically significantly different from zero. One reason why it may be difficult to detect a change in mixed fuel use is that composition of households changes in each group: some households move from exclusive solid fuel use into the mixed fuel category, while other households move from mixed fuels into the clean fuels only category.

Tables 6 and 7 show that the experiment marginally shifted household choice of cooking fuels. This move away from solid fuel use towards cleaner energy sources is in line with results in Afridi et al. (2021), who find that the intervention significantly increased consumption of LPG refills. Using administrative LPG refill consumption data, that paper shows that monthly LPG consumption (unconditional on household's LPG access) increased by 12.5% in the combined treatment arm

[17]These results are similar to the results from Tables 11 and 12 presented in Afridi et al. (2021). Sample size varies slightly between Afridi et al. (2021) and this paper due to 7 missing observations on time use.

[18]Women typically report two meal cooking times - morning (before 1 PM) and evening (after 1 PM). There are no systematic differences in the types of fuel used between morning and evening meals, either at baseline or endline as shown in Figure S2.4 in Appendix S2., although there is a significant increase in 'only clean fuels' at endline.

(*Health and Subsidy* treatment) as shown in Table S2.5 in Appendix S2. (reproduced from Afridi et al. (2021)).[19]

3.3.2 *Time use impacts*

Table 8 shows the intent to treat impacts of the information intervention on average time used by primary cooks in the day before the endline survey. Panels A through D present outcomes for different categories of time use: Total Home Production (including childcare), Market Work, Personal Care, and Leisure. For each outcome, results are shown for the combined treatment effect in column (1), and then effects for *Health* treatment and *Health and Subsidy* treatment separately in column (2).

Exposure to treatment does not have a large impact on total time allocated to any category. In almost all columns, the point estimates are small. In Panel A, the coefficient on the *Health and Subsidy* treatment is larger, indicating a reduction of about 14 minutes of home production time per day among this treated group relative to controls. However, none of the point estimates are significantly different from zero.

Table 9 investigates whether the composition of total home production time changed after exposure to the information nudge. Results for minutes per day spent on Fuel Collection, Cooking, Cleaning, Childcare, and Others are reported. In Panel B column (2), the *Health and Subsidy* treatment reduces time spent in cooking by a marginally significant 5 minutes per day, with no significant change in any other category.

It is worth noting that the first stage (in Table 7) for whether the treatment moved households towards more clean fuels is not sufficiently strong to pursue an IV strategy. While exposure to the *Health* and *Health and Subsidy* information nudged households towards using cleaner fuels in cooking, it did not have significant impacts on time use of primary cooks in exposed households.

[19]Besides LPG, the RCT identified a significant shift towards another clean fuel - electricity or induction cooking. Self-reported electric stove cooking increased by over 50% in the *Health and Subsidy* treatment group, but off a very low base.

4 Discussion

4.1 Valuing time savings from cleaner cooking at home

The analysis using baseline survey data demonstrated that home production as a category, and cooking in particular, is time-consuming work in rural Indian households. The patterns of fuel use in these data suggested modest potential time savings from changing the technology of cooking, i.e. by using clean fuels rather than dirty fuels. The experimental results indicated that the information nudge towards clean fuels resulted in marginal shifts towards cleaner energy in the home and only minimal time savings in the home. What is the market value of these time savings? How does this value compare with estimates from other clean cooking initiatives in the literature? And, how does the market value of time saved compare with the costs of switching to cleaner fuel within the context of the experiment, and in this Indian setting?

What was the market value of the actual time saved? Assuming that the government-mandated unskilled wage rate of INR 280 per day (INR 35 per hour) captures the opportunity cost of women's time in the labor market, then the 5 minutes per day of actual cooking time savings for households estimated through the experiment in Table 8 is worth about INR 86 per month. This represents a saving of about 1.2% of rural monthly household income.[20] This estimate may be a lower bound on the market value of time saved in the entire household, since non-primary cooks (for whom daily time use data was not collected) may also have saved some time in fuel collection (see Table 6).[21]

It is useful to compare these estimates of the market value of time savings estimates from studies that measure how improved cookstoves affect time use. While cookstoves do not use cleaner fuel, consistent use of improved cookstoves (ICS) may yield time savings from more efficient (quicker) cooking over charcoal and/or from lower demand for fuel collection. Even in the large

[20]The market value of this time saved is calculated as (35/60) x 5 minutes x 7 days x 4.2 weeks per month. Rural monthly household income of INR 7215 is taken from the 2011 IHDS, widely regarded as the most careful and most recent survey of household income in India (IHDS-II, 2011)

[21]70% of households report spending 44 hours in the previous month, on average, collecting firewood.

improved cookstove literature, though, Krishnapriya et al. (2021) note that few studies capture time use from surveys embedded in a randomized design.

Time savings in our study are lower than estimated time savings from the ICS literature, and the market value relative to household income is also somewhat lower. Bensch and Peters (2015) estimate that households in a sample of rural Senegalese villages randomized into receiving a free ICS saved approximately 75 minutes per day in cooking time, the market value of which represents about 5% of rural median household income.[22] In a more urban setting, Berkouwer and Dean (2022) estimate a significant 54 minutes of cooking time saved per day in response to randomly assigned subsidies for ICS in Nairobi, Kenya. The market value of the cooking time saved is calculated to be about 4.8% of monthly household income. In both studies, the larger impact on cooking time makes sense, since the free/subsidized ICS facilitated a much larger change in cooking technology than information nudges towards clean fuel.

Are households in the sample making optimal choices at the margin, given the price of using cleaner fuels? Recall that access to an LPG account in India is subsidized for PMUY households while LPG refills are subsidized for all households, and the out-of-pocket price of a cylinder is approximately INR 500 (at the time of our study). Afridi et al. (2021) estimates that among households with an existing LPG account, monthly LPG consumption increases by 12.5% in nudged households in the combined *Health and Subsidy* treatment (see Appendix Table S2.5). The cost of this increased consumption is about 0.125 x 500, or INR 62 per month, which equates to about 0.9% of monthly household income (INR 62/INR 7215). At the margin, the market value of time saving only slightly outweighs the cost of using a little more LPG.

A complete transition to LPG cooking would be considerably more expensive. Assuming that one LPG cylinder would allow a small family (4 - 5 members) to cook all meals over gas for a one month, the cost of one additional LPG cylinder entails expenditures of about 7% of monthly

[22] The national minimum wage for unskilled workers in Senegal was CFA 182.95 per hour in 2011, so 75 minutes of cooking time saved each day is valued at around CFA 227 (or CFA 6,956 each month). Median rural household income in Senegal is estimated at CFA 139,000 in Houweling et al. (2012).

household income (at the subsidized price). To make it worthwhile to exclusively cook over LPG, a household would need to save 14.5 hours of cooking time per week, or over two hours of time per day, and put all of it into the market to earn the minimum wage. [23]

4.2 Constraints on clean energy use and time saving

At the heart of these results is the fact that the marginal shift in fuel mix generated by exposure to the clean energy information nudge is insufficient to generate transformative changes in cooking practices, and hence time use of primary cooks. Researchers have documented that the transition to cleaner energy in developing countries is often slow, due to mixed fuel use. Households rarely switch from exclusive solid fuels to exclusive clean fuels. As households grow richer, they tend to climb a step at a time towards cleaner and more efficient fuels (Van der Kroon et al., 2013): a concept commonly known as the energy ladder. In our setting, the awareness campaign nudges allowed some households to take one tiny step on this ladder - but not sufficiently high to generate substantial time savings.

Several factors likely constrain how far up the energy ladder the households could plausibly have moved in response to the nudge, thereby limiting time savings. Financial constraints affect adoption and use of LPG on both intensive and extensive margins (e.g. see Puzzolo et al. (2016); Alem and Ruhinduka (2020); Sharma et al. (2020)). Because of the way the Indian LPG subsidy works – households must pay full price up-front, and wait 2-4 days for a refund of the subsidy portion – a lack of liquidity limits intensive margin use of LPG. Ongoing work by Afridi et al. (2022) estimates that when the out-of-pocket price for an LPG cylinder rises by 1% (even when the post-subsidy price remains unchanged), LPG use in low-income or PMUY households falls by 0.2%. That these households are sensitive to variation in the *pre-subsidy* price suggests they are liquidity constrained. In addition, credit constraints in the poorest households likely affect LPG uptake on the extensive margin (e.g. as in Berkouwer and Dean (2022) who find that credit

[23] These calculations ignore the cost and time savings for households to stop purchasing or collecting wood.

constraints retard adoption of cleaner cookstoves in Nairobi).

A second factor limiting the impact of information nudges relates to the lack of a market for women's time. Recent studies of the historical US suggest that the availability of women's formal employment in the labor market played an important role in facilitating household adoption of new technologies for cooking and cleaning (Bose et al., 2022; Vidart, 2022). Greater opportunities for women to work outside the home changed the opportunity costs of female time at home, and raised family income. Yet in our study villages, the average female employment rate is very low, at 15.3%. The puzzle of low female labor force participation in India has been noted elsewhere in the literature (see Afridi et al. (2018); Fletcher et al. (2017)). Even if credit and liquidity constraints can be overcome, limited labor market opportunities for women may not make it worthwhile for households to try to move 35 minutes of primary cook time into the market each week. Moreover, clean fuel adoption and use decisions may be subject to intra-household bargaining constraints. Since women bear the main burden of cooking (Parikh, 2011) and have lower returns to market work relative to men (Gronau, 1973), men may not internalize the benefits of cooking using cleaner fuels (Bloomfield, 2015; Beltramo et al., 2015) because these benefits do not accrue to them directly. The ability of women to negotiate the intra-household allocation of resources can be another challenging constraint on households' transition to clean fuels (Doss, 2013; Gould and Urpelainen, 2018; Miller and Mobarak, 2013; Duflo et al., 2008) and one which may be alleviated by greater female labor market participation.

5 Conclusion

This paper asks whether reliance on biomass for cooking fuel contributes to the large amount of time women spend cooking across the developing world. While exclusive use of solid fuels is associated with greater time in fuel collection and cooking, the evidence from this clean energy information experiment in rural India suggests that more than a nudge is needed for households to shift their mix of cooking fuel use towards cleaner cooking fuels.

The main result is that there are very small impacts on time spent in home production in response to the information nudge. The value of the time saved does not seem to vastly outweigh the costs of using LPG at the margin, even at highly subsidized prices. However, these results should not be interpreted as evidence that clean energy is unable to reduce the drudgery of home production among women in low-income settings. Rather, expecting transformative changes in time allocation from informational nudges towards cleaner fuels alone seems unrealistic. Future research might usefully test whether a more robust transition to clean cooking fuels could be supported by combining a relaxation of financial constraints with new access to female employment and income-earning opportunities.

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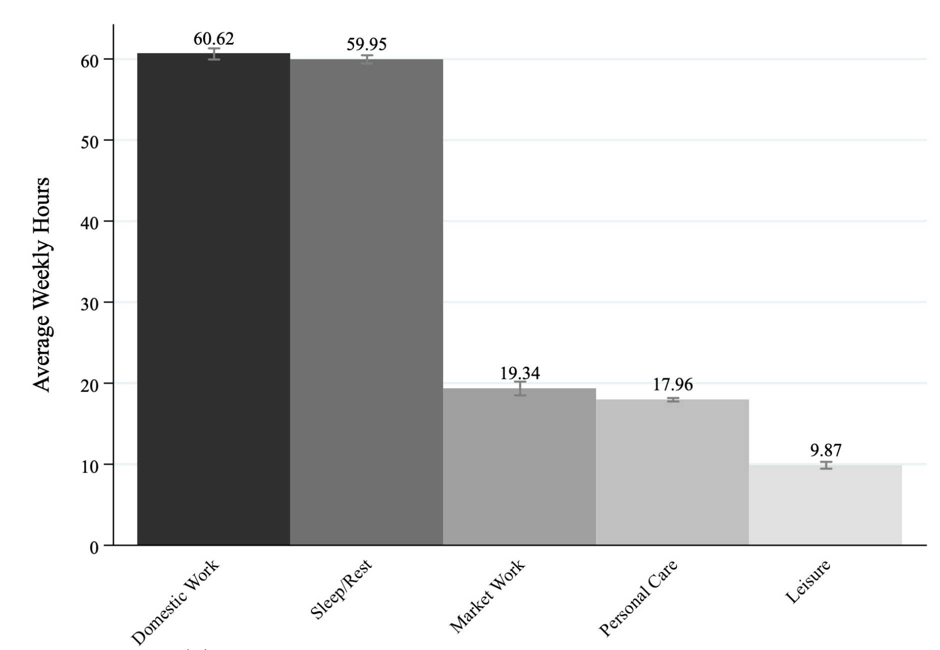
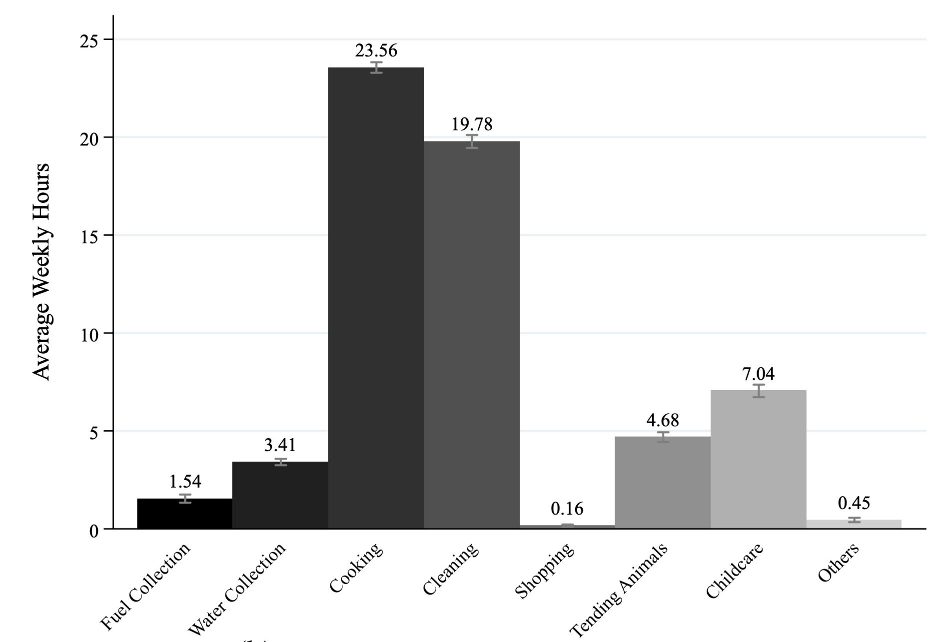
FIGURE 1: **Time Use of Primary Cooks (at Baseline)**



(a) Time spent on home production and other activities



(b) Time spent on home production activities

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The figure reports average weekly hours spent in different activities, calculated using self-reported time use survey of primary cooks at baseline in 2018. Time use reported for a regular day prior to the survey is aggregated to weekly totals. Average hours in Figure(a) sum to 168 weekly hours. The category 'Others' in Figure(b) represents the remaining time on domestic work after excluding time spent on fuel and water collection, cooking, cleaning, childcare, shopping and tending animals. The sample is restricted to 2942 households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes.

TABLE 1: **Fuel Use, Collection and Purchase (at Baseline)**

	Mean (1)	Std. Error (2)	Obs. (3)
Panel A: Fuel Access			
Has LPG Account	0.672	0.009	2784
Panel B: Fuel Use last month			
Firewood	0.748	0.008	2784
Dung Cake	0.878	0.006	2784
Crop Residue	0.113	0.006	2784
LPG	0.675	0.009	2784
Electric Stove	0.062	0.005	2784
Panel C: Fuel Collection last month			
Firewood	0.704	0.010	2083
Dung Cake	0.697	0.009	2444
Crop Residue	0.726	0.025	314
Panel D: Fuel Purchase last month			
Firewood	0.143	0.008	2083
Dung Cake	0.291	0.009	2441
LPG Refills	0.322	0.011	1880

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The sample is restricted to households where the total reported time spent by the primary cook (PC) equals 24 hours or 1440 minutes, and excludes 8 villages that did not comply with assigned treatment status. The mean and standard errors in Panel A and B are computed using this sample. The sample is further restricted to households that *use* the respective fuels in panels C & D. For Panel B, the households were asked 'Did you cook with the *fuel* in the last month?', where *fuel* refers to firewood, crop residue (including twigs and leaves), dung cakes, LPG and electric stove, respectively. In Panel C, the respondents were asked to list all household members who collected firewood or crop residue (including twigs and leaves) in a typical week in the last month. The question for dung cakes was 'Did you or anyone in the household either collect or make dung cakes in a typical week in the last month?'. For Panel D, the households were asked 'Did you buy firewood or dung cake in the last month?'. The purchase of LPG in panel D is calculated for 30 days prior to the survey. The LPG refill data is missing for 74 households at baseline. Fuels excluded from each panel - LPG and electricity cannot be collected (Panel C); crop residue cannot be purchased, no data available on electricity purchase (Panel D).

TABLE 2: **Fuel Use for Cooking (at Baseline)**

Share using:	Last Month (1)	Last Meal (2)
Only Clean Fuels	0.073	0.306
	(0.005)	(0.009)
Only LPG	0.064	0.290
	(0.005)	(0.009)
Only Electricity	0.001	0.008
	(0.001)	(0.002)
Only Solid Fuels	0.302	0.542
	(0.009)	(0.009)
Mixed Fuels	0.543	0.138
	(0.009)	(0.007)
Observations	2784	2784

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The table reports mean (standard errors) fuel use in cooking last month and last meal in columns (1) and (2), respectively. The sample is restricted to households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes, and excludes 8 villages that did not comply with assigned treatment status. The variable 'Only Clean Fuels' takes the value 1 if the household uses LPG or/and electricity, and 0 otherwise. The variable 'Only LPG' takes value 1 if the household reports using LPG exclusively for cooking and 0 otherwise. The variable 'Only Electricity' takes the value 1 if the household uses only electric/induction stove and 0 otherwise. The variable 'Only Solid Fuels' equals 1 if the household solely uses solid fuels such as firewood, dung, crop residue and *sigdi*, *chulha*, *kande* and 0 otherwise. The variable 'Mixed Fuels' takes the value 1 if the household uses both LPG and solid fuels (as detailed above), and 0 otherwise. Each column does not add up to 100 because other fuels like *gobar gas*, bio-gas, consumed by approximately 0.3% of households, are excluded.

TABLE 3: **Fuel Use and Time in Home Production (at Baseline)**

	Cooking Last Meal	**Cooking Yesterday**	**Home production Yesterday**
	(1)	(2)	(3)
Only Clean Fuels	-18.540***	-17.806***	-31.014***
	(1.19)	(4.99)	(9.94)
Mixed Fuels	-6.400***	-7.543***	-12.138**
	(1.67)	(2.64)	(5.90)
#Trips by PC to Collect Firewood		-0.169	4.689***
		(0.72)	(1.75)
#Times Dung Made and Collected		0.653**	2.615***
		(0.32)	(0.72)
Sub-District FE	Yes	Yes	Yes
R^2	0.181	0.105	0.074
N	2784	2773	2773

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The dependent variable is the daily time spent in cooking last meal, cooking yesterday and home production yesterday in columns (1), (2) and (3), respectively (in minutes). The sample is restricted to households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes, and excludes 8 villages that did not comply with assigned treatment status. The independent variable i.e. fuel use in column (1) corresponds to use in last meal, whereas fuel use during last month is considered for columns (2) and (3). 'Only Clean Fuels' and 'Mixed Fuels' are defined in Table 2. 'Only Solid Fuels' is the reference category and has been excluded from the regression. We measure the trips for firewood collection made solely by the PC, however, dung collection and dung making (in a typical week in last month) is recorded for all the household members, including the PC. Further, there are 11 missing observations for total trips to collect firewood at baseline. Controls include household size and assets, education and primary occupation of the household head, education and age of the primary cook, indicators for household religion and caste and indicators for the presence of private primary schools, health sub-center, distance to block headquarters, all-weather road access and proportion of irrigated land. The standard errors, clustered at the village level, are reported in parentheses. * p<0.10, ** p<0.05 and *** p< 0.01.

TABLE 4: **Fuel Use and Time in Fuel Collection (at Baseline): Propensity Score Matched Estimates**

	Firewood (in mins, last trip) (1)	**Dung Making** (in mins, last month) (2)	**Dung Collection** (in mins, last month) (3)
LPG Use (Last Meal)	-23.28***	-66.70***	-45.21***
	(4.73)	(15.70)	(15.99)
Control Group Mean	86.25	301.17	156.94
Observations	1973	1973	1973

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The dependent variable in column (1) is the total time spent by the primary cook in firewood collection (in minutes) during the last trip for fuel collection. There are 11 missing observations for total trips to collect firewood at baseline. The dependent variable in columns (2) and (3) records the total time taken (in minutes) to make and collect dung in the last month by household, including PC. The propensity score matched estimates for LPG use at last meal are calculated using nearest neighbour matching on observations with identical propensity scores between households 'using' LPG at last meal and households 'not using' LPG at last meal. Control variables include household size, education and primary occupation of the household head, education and age of the primary cook, indicators for household religion and caste and indicators for the presence of private primary schools, health sub-center, distance to block headquarters, all-weather road access and proportion of irrigated land. We also control for seven deprivation indices for PMUY eligibility, i.e., dummies for households with only one room, *kucha* walls and *kucha* roof, female-headed households with no adult male member, SC/ST households. Controls also include dummies for ownership and lease of agricultural land, ownership of house, animal-drawn cart, scooter/motorcycle, bicycle, watch, refrigerator, sewing machine, TV, cooler, pressure cooker, tractor, thresher, water pump, car and dummy for ownership of animals. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

TABLE 5: **Fuel Use and Primary Cook's Total Time Use (at Baseline): Propensity Score Matched Estimates**

Time Use of Primary Cook (mins/day)				
Panel A: Overall Time Use				
	Home Production (1)	Market Work (2)	Personal Care (3)	Leisure (4)
LPG Use (Last Meal)	-38.01***	-5.19	7.06**	33.07***
	(7.92)	(9.57)	(2.94)	(7.34)
Control Group Mean	527.93	185.56	152.77	572.68
Observations	1973	1973	1973	1973

Panel B: Time Spent in Home Production					
	Fuel Collection (1)	Cooking (2)	Cleaning (3)	Childcare (4)	Others (5)
LPG Use (Last Meal)	-7.65***	-11.02***	-8.15	-1.52	-9.67**
	(2.04)	(3.45)	(5.12)	(3.79)	(4.26)
Control Group Mean	19.03	204.38	166.65	56.96	80.89
Observations	1973	1973	1973	1973	1973

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The dependent variable is the daily time spent by the primary cook in different activities (in minutes per day). The category 'Domestic Work' in Panel A includes childcare and the category 'Leisure' includes sleep. The category 'Others' in Panel B is the residual for domestic work that includes time spent on water collection, shopping, tending animals and remaining activities. For both Panels A and B, the matched propensity score estimates of LPG use at last meal is calculated using nearest neighbour matching on observations with identical propensity scores between households using and not using LPG at last meal. Controls include household size, education and primary occupation of the household head, education and age of the primary cook, indicators for household religion and caste and indicators for the presence of private primary schools, health sub-center, distance to block headquarters, all-weather road access and proportion of irrigated land. We also control for seven deprivation indices for PMUY eligibility, i.e., dummies for households with only one room, *kucha* walls and *kucha* roof, female-headed households with no adult male member, SC/ST households. Controls also include dummies for ownership and lease of agricultural land, ownership of house, animal-drawn cart, scooter/motorcycle, bicycle, watch, refrigerator, sewing machine, TV, cooler, pressure cooker, tractor, thresher, water pump, car and dummy for ownership of animals. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

TABLE 6: **Effect of Information Treatment on Fuel Collection: Experimental Results**

	Firewood		Dung	
	(1)	(2)	(3)	(4)
Overall Treatment	-0.039		-0.060*	
	(0.025)		(0.033)	
Treatment - H		-0.019		-0.061
		(0.027)		(0.041)
Treatment - H+S		-0.061**		-0.059*
		(0.029)		(0.035)
Baseline collection	0.210***	0.209***	0.073***	0.073***
	(0.020)	(0.020)	(0.025)	(0.025)
Sub-District FE	Yes	Yes	Yes	Yes
H=H+S [p value]		[0.115]		[0.950]
Control Group Mean	0.540	0.540	0.255	0.255
R^2	0.100	0.101	0.077	0.077
N	2545	2545	2784	2784

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The dependent variable takes value 1 if the household collected firewood (columns (1) and (2)) and collected dung cakes (columns (3) and (4)) in the last month, respectively, and 0 otherwise. The sample is restricted to households where the total time spent by the primary cook equals 24 hours, and excludes 8 villages that did not comply with assigned treatment status. **H** denotes only health information and **H + S** refers to both health and subsidy information treatment arms, respectively. There are 239 missing observations for firewood collection at the endline. Controls include household size and assets, education and primary occupation of the household head, education and age of the primary cook, indicators for household religion and caste and indicators for the presence of private primary schools, health sub-center, distance to block headquarters, all-weather road access and proportion of irrigated land. Standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

TABLE 7: **Effect of Information Treatment on Fuel Used in Cooking Last Meal: Experimental Results**

	Only Clean Fuels		**Mixed Fuels**		**Only Solid Fuels**	
	(1)	(2)	(3)	(4)	(5)	(6)
Overall Treatment	0.048*		-0.025		-0.040*	
	(0.026)		(0.019)		(0.023)	
Treatment - H		0.049*		-0.022		-0.046*
		(0.029)		(0.020)		(0.026)
Treatment - H+S		0.047		-0.029		-0.033
		(0.030)		(0.023)		(0.028)
Baseline Usage	0.333***	0.333***	0.059**	0.058**	0.306***	0.306***
	(0.022)	(0.022)	(0.023)	(0.023)	(0.019)	(0.019)
Sub-District FE	Yes	Yes	Yes	Yes	Yes	Yes
H=H+S [p value]		[0.970]		[0.721]		[0.652]
Control Group Mean	0.314	0.314	0.140	0.140	0.533	0.533
R^2	0.169	0.169	0.019	0.019	0.170	0.171
N	2784	2784	2784	2784	2784	2784

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The dependent variable is the type of fuel used in cooking the last meal. The sample is restricted to households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes, and excludes 8 villages that did not comply with assigned treatment status. **H** denotes only health information and **H + S** refers to both health and subsidy information treatment arms, respectively. 'Only Clean Fuels', 'Mixed Fuels' and 'Only Solid Fuels' are defined in Table 2. Controls include household size and assets, education and primary occupation of the household head, education and age of the primary cook, indicators for household religion and caste and indicators for the presence of private primary schools, health sub-center, distance to block headquarters, all-weather road access and proportion of irrigated land. Standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

TABLE 8: **Effect of Information Treatment on Time Use of Primary Cook: Experimental Results**

Panel A: Home Production	(1)	(2)
Overall Treatment	-5.072	
	(7.284)	
Treatment - H		3.815
		(9.105)
Treatment - H+S		-14.433
		(8.843)
Baseline Time Use	0.127***	0.126***
	(0.021)	(0.021)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.089]
Control Group Mean	513.145	513.145
R^2	0.097	0.099
N	2784	2784

Panel B: Market Work	(1)	(2)
Overall Treatment	5.201	
	(9.286)	
Treatment - H		2.143
		(11.518)
Treatment - H+S		8.419
		(11.214)
Baseline Time Use	0.153***	0.152***
	(0.022)	(0.022)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.634]
Control Group Mean	165.922	165.922
R^2	0.096	0.096
N	2784	2784

Continued on next page

TABLE 8: **Effect of Information Treatment on Time Use of Primary Cook: Experimental Results**

Panel C: Personal Care	(1)	(2)
Overall Treatment	-4.103	
	(2.757)	
Treatment - H		-4.959
		(3.212)
Treatment - H+S		-3.200
		(3.285)
Baseline Time Use	-0.001	-0.001
	(0.018)	(0.018)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.611]
Control Group Mean	152.162	152.162
R^2	0.050	0.050
N	2784	2784
Panel D: Leisure	(1)	(2)
Overall Treatment	4.030	
	(6.034)	
Treatment - H		-0.724
		(7.168)
Treatment - H+S		9.068
		(6.679)
Baseline Time Use	0.143***	0.145***
	(0.017)	(0.017)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.158]
Control Group Mean	606.527	606.527
R^2	0.107	0.108
N	2784	2784

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The dependent variable is the time spent daily in different categories (in minutes). The sample is restricted to households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes, and excludes 8 villages that did not comply with assigned treatment status. 'Domestic Work' includes childcare and 'Leisure' includes sleep. **H** denotes only health information and **H + S** refers to both health and subsidy information treatment arms, respectively. The controls remain the same as in Table 7. The standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

TABLE 9: **Effect of Information Treatment on Home Production Time of Primary Cook: Experimental Results**

Panel A: Fuel Collection	(1)	(2)
Overall Treatment	-1.539	
	(2.043)	
Treatment - H		-0.689
		(2.193)
Treatment - H+S		-2.435
		(2.290)
Baseline Time Use	0.011	0.012
	(0.013)	(0.013)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.344]
Control Group Mean	16.153	16.153
R^2	0.020	0.020
N	2784	2784
Panel B: Cooking	(1)	(2)
Overall Treatment	-2.721	
	(2.412)	
Treatment - H		-0.233
		(2.971)
Treatment - H+S		-5.344*
		(2.866)
Baseline Time Use	0.058***	0.057***
	(0.017)	(0.017)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.124]
Control Group Mean	197.756	197.756
R^2	0.073	0.074
N	2784	2784

Continued on next page

TABLE 9: **Effect of Information Treatment on Home Production Time of Primary Cook: Experimental Results**

Panel D: Cleaning	(1)	(2)
Overall Treatment	-0.079	
	(4.334)	
Treatment - H		1.879
		(5.181)
Treatment - H+S		-2.136
		(4.806)
Baseline Time Use	0.094***	0.093***
	(0.018)	(0.018)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.428]
Control Group Mean	165.676	165.676
R^2	0.046	0.046
N	2784	2784

Panel D: Childcare	(1)	(2)
Overall Treatment	2.784	
	(3.537)	
Treatment - H		5.156
		(4.100)
Treatment - H+S		0.281
		(4.238)
Baseline Time Use	0.240***	0.239***
	(0.027)	(0.027)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.272]
Control Group Mean	60.984	60.984
R^2	0.184	0.185
N	2784	2784

Continued on next page

TABLE 9: **Effect of Information Treatment on Home Production Time of Primary Cook: Experimental Results**

Panel E: Others	(1)	(2)
Overall Treatment	-3.400	
	(3.713)	
Treatment - H		-2.285
		(4.609)
Treatment - H+S		-4.578
		(4.319)
Baseline Time Use	0.112***	0.112***
	(0.018)	(0.018)
Sub-District FE	Yes	Yes
H=H+S [p value]		[0.646]
Control Group Mean	72.577	72.577
R^2	0.058	0.058
N	2784	2784

Source: Authors' analysis based on data in Afridi et al. (2021) and the related experiment.
Notes: The dependent variable is the time spent daily in different categories (in minutes) of domestic work. The category 'Others' is the residual for domestic work that includes time spent on water collection, shopping, tending animals and residual activities. The sample is restricted to households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes, and excludes 8 villages that did not comply with assigned treatment status. **H** denotes only health information and **H + S** refers to both health and subsidy information treatment arms, respectively. The controls remain the same as in Table 7. The standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

Supplementary Online Appendices for ***"Time for clean energy? Clean fuel use and time use in home production"*** **by Afridi, Debnath, Dinkelman, and Sareen.**

Appendix S1. Experimental Design

A cluster-RCT was implemented by Afridi et al. (2021) in the rural areas of Indore district in Madhya Pradesh (MP), the second-largest Indian state by area and the fifth largest by population with over 75 million residents. The baseline survey was conducted between 1st November - 22nd December, 2018. In 150 randomly sampled villages in the district, a household qualified for the study if it had a currently residing member either less than 10 years or more than 55 years of age or both – demographic groups which are typically more vulnerable to adverse health effects due to indoor air pollution.[24] 20 eligible households were randomly sampled in each of these villages by systematic random sampling during the baseline survey. Detailed information on household composition, fuel use, and collection, health awareness, primary cook's time use, and well-being were gathered. In each household, the main respondent was the household head, and the primary cook needed to be present too since many of the questions related were specific to her activities.

Households were then randomized into three arms - (1) health awareness **(H)** (2) health and financial subsidy awareness **(H+S)** (3) no awareness campaign or the control group **(C)** with 50 villages in each. However, during the training of the public health workers who were carrying out the intervention, we were informed that four villages in each of the two treatment arms either did not currently have an officially appointed health worker (three villages) or the current worker had a health emergency (unrelated to indoor air pollution, one village) or could not be contacted for the training (four villages).

In January 2019, the intervention to increase adoption and regular use of LPG was initiated for nine months, until September 2019. It consisted of an awareness campaign, aimed at the randomly sampled households, on the health and financial benefits of switching to regular use of LPG for cooking. The campaign centered around improving households' understanding of -– (1) the adverse health impacts of solid fuels and measures to mitigate inhalation of indoor smoke

[24] The lowest level of local government in India is the *Gram Panchayat* or village council, typically consisting of 2-3 villages. We randomly sampled 150 of the 250 village councils (*Gram Panchayats* or GPs) in the rural census blocks of Indore district (excluding 11 GPs with a population of less than 10 or more than 5000 households) and selected the largest village, by population, from each sampled GP.The data for mapping villages into GPs was obtained from the Local Government Directory (https://lgdirectory.gov.in/downloadDirectory.do). All population estimates and other village-level data were based on the 2011 Census of India.

(2) the government subsidy to LPG consumers. We leveraged the existing public health system by engaging Accredited Social Health Activists (ASHAs) to deliver the information – female residents of the village, who had completed at least 10th grade, were between 25–45 years of age, and were employed by the state government to provide public health services.[25] During six household visits over nine months, the information provided in the health treatment arm (H) centered around the adverse health effects only, both the health and financial LPG subsidy information in the *Health and Subsidy* treatment arm. No information was provided in the control group of villages. See Afridi et al. (2021) for details of the intervention.

The sampled households were revisited at endline between 24th October and 31st December 2019, during the same season approximately a year later, and the same survey was conducted as at baseline. Only 54 of the 3000 households could not be re-interviewed at endline; hence attrition is negligible (1.8%).[26]

The timeline of the study is summarised below:

Date	***Round***	***Data***	***Sample***
Nov-Dec, 2018	Baseline	Household survey	150 villages 3000 households
Jan-Sept, 2019	***Information campaign***		92 villages 1840 households
Oct-Dec, 2019	Endline	Household survey	150 villages 2946 households

[25]ASHAs of the treatment villages were trained by the NGO, Madhya Pradesh Voluntary Health Association (MPVHA), which has been conducting ASHA training modules on behalf of the state administration for several years, along with the research team. The training was conducted over two days in the sub-district headquarters. ASHAs were paid 50 rupees per visit per household, comparable to their regular remuneration.

[26]Our final household sample is as follows: 3000 at baseline + three that split at endline = 3003; of the compliant villages (160 households in eight non-compliant villages are dropped), 52 attrited. From the remaining non-attrited and compliant sample, 1 and 6 households were dropped where the total time at baseline was missing and did not equal 24 hours, respectively.

Appendix S1.1 Time Use Survey

The survey questionnaire recorded the time spent by the primary cook of the household on different activities on a previous regular day. The format of the survey was similar to a recall diary. Typically, the respondents were asked to recall how each minute of yesterday was spent, from waking up until going to bed. However, if the previous day was observed as a festival, birth, death, travel, etc., they were asked to describe time spent on the day before yesterday, and so on.

A day was divided into three parts of 8 hours each.[27] Each surveyor had to enter a table (see illustrative table attached below), that reported the time spent on each activity code. For example - the information for a respondent who woke up at 6:15 AM, went to the toilet for 15 minutes and then prayed for 30 minutes, will be recorded as given in the table below.

The surveyors were instructed to keep the discussion as conversational as possible and note down the activities as the respondent narrated every moment of her previous day from memory. Note that the PC was isolated for this section of the survey from other members of the household.

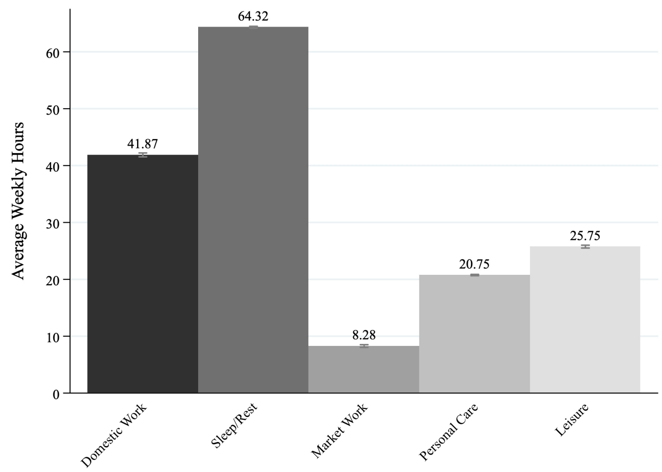
5 - 8 AM / 1 – 4 PM / 9 Pm – 12 am			8 – 11 AM / 4 – 7 PM / 12 – 3 am			11 – 1 PM / 7 – 9 PM / 3 – 5 am		
Time	Code	Minutes	Time	Code	Minutes	Time	Code	Minutes
5:00	05/04	75	8:15	02/03	90			
6:15	01/01	15						
6:30	01/03	30						
7:00	02/03	5						
7:05	01/02	10						
7:15	02/04	60						
TOTAL MINUTES		195						

[27]These were morning (5 AM – 1 PM), afternoon (1 PM – 9 PM) and evening (9 PM- 5AM), making a total of 24 hours in the day.

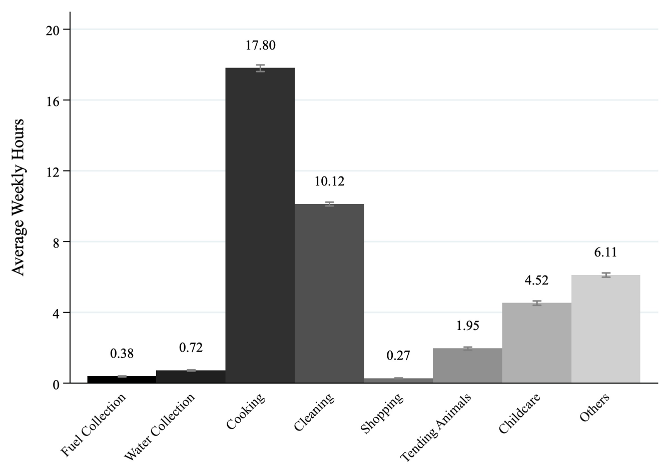
We classify the primary cook's time into five broad categories of activities (see Figure 1(a)). First, domestic work includes time spent on fuel and water collection, cooking, cleaning, shopping, tending animals and childcare as specified in Figure 1(b). Childcare further includes time spent on grooming and feeding children, completing school homework, and elderly care. The second category includes time spent in sleeping or resting. Third, work comprises of any type of remunerative or income generating activity, including own-agriculture or business and daily labor for wages (agriculture or non-agriculture). Fourth, personal care covers personal hygiene, eating or drinking, praying, and other such activities. And finally, leisure involves activities such as watching television, reading book or newspaper, social and community interactions.

Appendix S2. Additional Figures and Tables

FIGURE S2.1: **Time Use of Rural Women in India: NSS Survey**



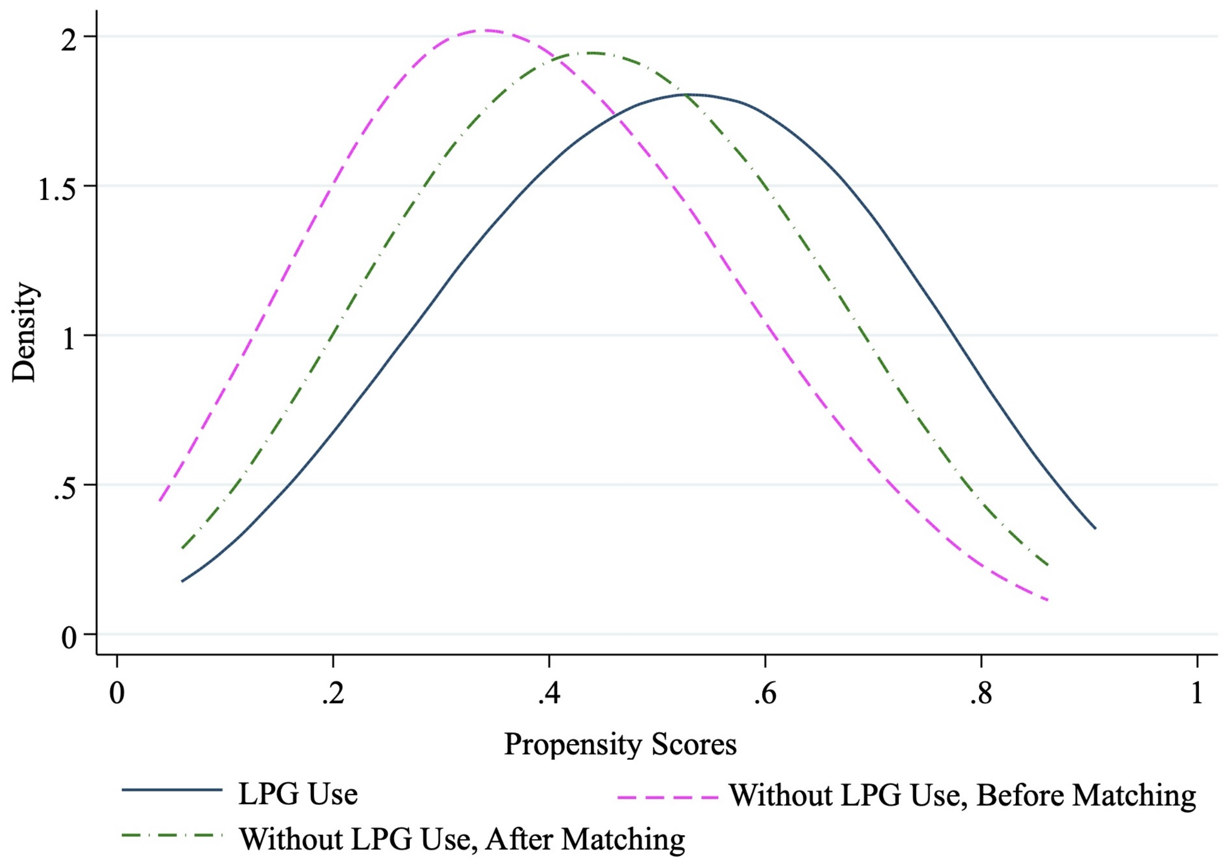
(a) Time spent on home production and other activities



(b) Time spent on home production activities

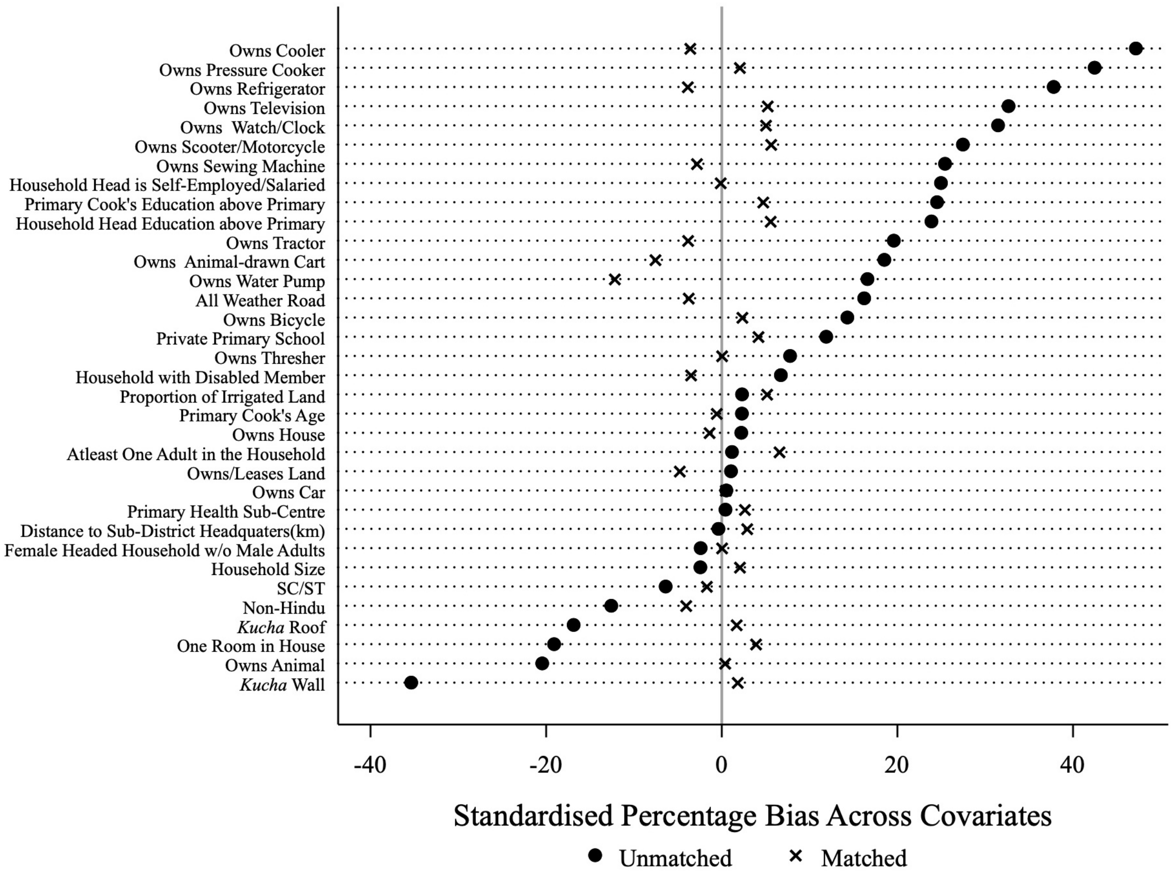
Notes: The weighted average weekly hours spent in different categories is calculated using the NSS Time Use Survey (TUS) data, collected between January 2019-December 2019. The reported month of the survey is October-December (same as our sample survey) and the sample is restricted to 31,291 females who are 12-86 years old and living in the rural areas. Panel (a) excludes time spent on additional activities like learning and volunteer work. 'Others' in panel (b) includes time spent in growing crops for final use, fishing, aquaculture, making and processing goods for final use, decoration, maintenance and repair of house and household goods, travelling related to domestic services, etc.

FIGURE S2.2: **Predicted Propensity Score of LPG Use by Actual LPG Use in Last Meal**



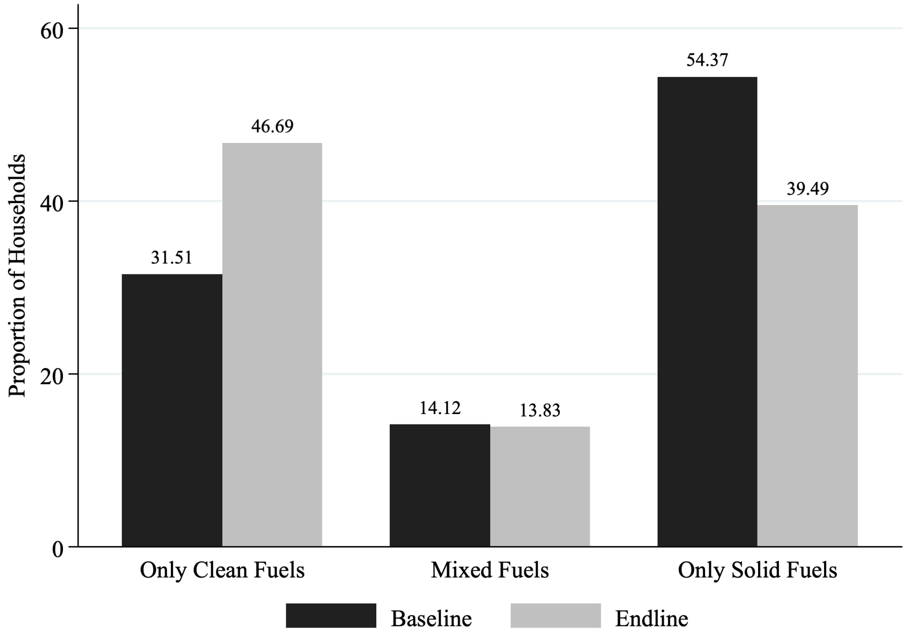
Notes: The figure plots the densities of propensity scores for LPG use at last meal of the household, before and after matching. The line-chart for LPG use post-matching excludes the weights assigned to each score. The null of equal distributions between 'LPG Use' and 'Without LPG Use' distributions is rejected using the Kolmogorov-Smirnov test before matching (p-value of 0.000). Post-matching, 'LPG Use' and 'Without LPG Use' distributions are equal (p-value of 1.000). The sample is restricted to 2942 households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes before matching and is restricted to the matched observations, post-matching.

FIGURE S2.3: **Standardized Bias in Covariates, Pre- and Post-Matching**

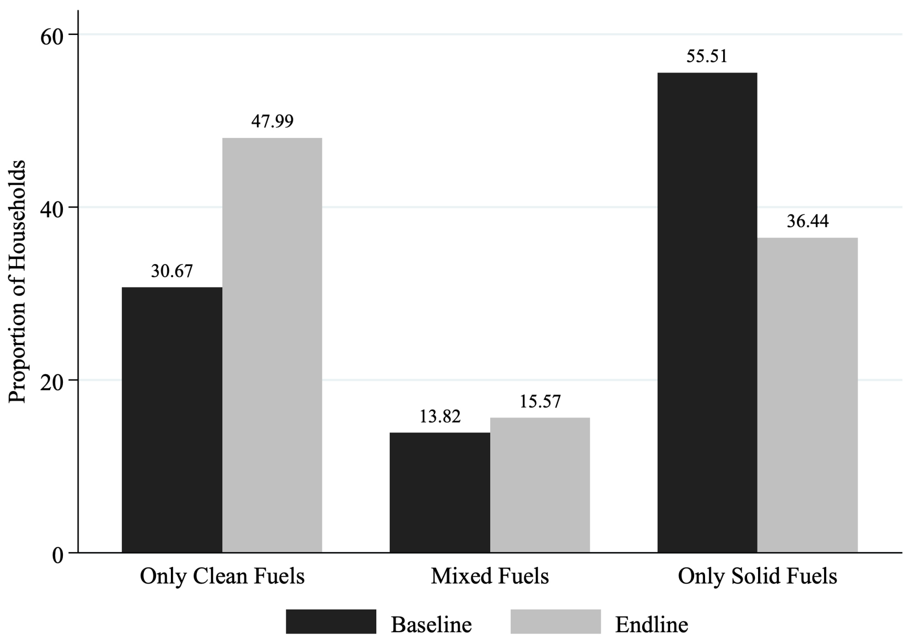


Notes: The standardized percentage bias is the percentage difference of the sample means in the treated (with LPG Use) and non-treated (without LPG Use) sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups (Rosenbaum and Rubin, 1985). The sample is restricted to 2942 households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes before matching and is restricted to the matched observations post-matching.

FIGURE S2.4: **Fuel Use by Time of Cooking Last Meal: Experimental Sample**



(a) Morning (before 1 PM)



(b) Evening (at and after 1 PM)

Notes: The figure records fuel use for cooking last meal at baseline in the morning (defined as cooking last meal before 1 PM) and evening (defined as cooking at and after 1 PM) respectively. Out of the 2942 households at baseline, 1244 households report cooking last meal in the morning and remaining 1698 households report cooking last meal in the evening. 'Only Clean Fuels', 'Mixed Fuels' and 'Only Solid Fuels' are defined in Table 2.

TABLE S2.1: **Balance of Village and Household Amenities (Census 2011)**

	Control	*Treatment*		*Difference*		
	C (N=50)	**H** (N=46)	**H + S** (N=46)	**C - H**	**C - (H + S)**	**H - (H+S)**
	(1)	(2)	(3)	(4)	(5)	(6)
Village amenities						
Total Households	279.48	323.26	290.61	-43.78	-11.13	32.65
	(25.629)	(23.862)	(22.564)	(35.018)	(34.148)	(32.841)
Proportion SC/ST population	0.36	0.34	0.39	0.02	-0.03	-0.05
	(0.031)	(0.030)	(0.037)	(0.043)	(0.048)	(0.048)
Pvt. primary school	0.30	0.35	0.35	-0.05	-0.05	-0.00
	(0.065)	(0.071)	(0.071)	(0.097)	(0.097)	(0.100)
Govt. middle school	0.72	0.85	0.74	-0.13	-0.02	0.11
	(0.064)	(0.054)	(0.065)	(0.084)	(0.092)	(0.085)
Primary health sub center	0.26	0.33	0.26	-0.07	-0.00	0.07
	(0.063)	(0.070)	(0.065)	(0.094)	(0.091)	(0.096)
Treated tap water	0.16	0.22	0.11	-0.06	0.05	0.11
	(0.052)	(0.061)	(0.046)	(0.081)	(0.070)	(0.077)
Open drainage	0.66	0.63	0.63	0.03	0.03	-0.00
	(0.068)	(0.072)	(0.072)	(0.099)	(0.099)	(0.102)
Proportion of irrigated land	0.60	0.57	0.61	0.02	-0.02	-0.04
	(0.039)	(0.037)	(0.033)	(0.054)	(0.051)	(0.050)
All weather road	0.82	0.80	0.74	0.02	0.08	0.07
	(0.055)	(0.059)	(0.065)	(0.081)	(0.085)	(0.088)
Household amenities						
Own house	93.48	95.06	95.27	-1.58	-1.79	-0.21
	(1.099)	(0.971)	(1.071)	(1.467)	(1.535)	(1.445)
Use fire-wood	48.80	41.06	51.83	7.75	-3.03	-10.77
	(4.960)	(4.863)	(5.471)	(6.946)	(7.384)	(7.320)
Use LPG/PNG	13.05	13.47	11.36	-0.42	1.69	2.11
	(2.341)	(2.101)	(2.160)	(3.146)	(3.185)	(3.013)
Have treated tap water	4.81	5.42	5.07	-0.61	-0.26	0.35
	(1.520)	(2.010)	(2.230)	(2.519)	(2.698)	(3.002)
Have latrine within house	33.29	33.06	29.31	0.23	3.98	3.75
	(2.783)	(2.298)	(2.945)	(3.609)	(4.051)	(3.735)
Own television	45.58	46.28	42.20	-0.70	3.38	4.08
	(2.218)	(1.988)	(2.885)	(2.979)	(3.638)	(3.503)
Lighting Electricity	88.68	89.55	89.36	-0.87	-0.68	0.19
	(2.379)	(2.268)	(1.892)	(3.286)	(3.040)	(2.953)
p-values for joint significance	-	-	-	[0.95]	[0.99]	[0.72]

Notes: We use amenities data at the village and household level from the 2011 Census. Four villages from each treatment arm are dropped due to noncompliance to assigned treatment status. **H** denotes health only information and **H + S** denotes health and subsidy information. The *p*-values reported in the last row of the table corresponds to the F-test for joint significance of village- and household-level amenities in determining the treatment status in a linear probability model. Standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

TABLE S2.2: **Balance of Household Characteristics at Baseline**

	Control	*Treatment*		*Difference*		
	C (N=982)	**H** (N=907)	**H + S** (N=902)	**C - H**	**C - (H + S)**	**H - (H+S)**
	(1)	(2)	(3)	(4)	(5)	(6)
Household size	6.13	6.15	6.17	-0.02	-0.04	-0.02
	(0.076)	(0.075)	(0.072)	(0.134)	(0.132)	(0.133)
Female headed hh.	0.06	0.06	0.07	0.01	-0.01	-0.02
	(0.008)	(0.008)	(0.009)	(0.011)	(0.012)	(0.012)
Age of primary cook	34.16	33.89	33.57	0.27	0.59	0.32
	(0.377)	(0.373)	(0.369)	(0.723)	(0.678)	(0.642)
Household head edu. above primary	0.42	0.43	0.37	-0.01	0.05*	0.06*
	(0.016)	(0.016)	(0.016)	(0.031)	(0.029)	(0.033)
Primary cook's edu. above primary	0.37	0.36	0.34	0.01	0.03	0.02
	(0.015)	(0.016)	(0.016)	(0.031)	(0.029)	(0.032)
Household head is married	0.93	0.93	0.93	0.00	0.00	0.00
	(0.008)	(0.009)	(0.009)	(0.012)	(0.013)	(0.012)
Hh. head self-employed or salaried	0.51	0.53	0.49	-0.02	0.02	0.04
	(0.016)	(0.017)	(0.017)	(0.031)	(0.034)	(0.032)
SC/ST	0.39	0.41	0.43	-0.01	-0.03	-0.02
	(0.016)	(0.016)	(0.016)	(0.044)	(0.054)	(0.051)
OBC	0.43	0.42	0.44	0.01	-0.00	-0.01
	(0.016)	(0.016)	(0.017)	(0.048)	(0.051)	(0.051)
Hindu	0.93	0.93	0.89	-0.00	0.04	0.04
	(0.008)	(0.008)	(0.010)	(0.037)	(0.043)	(0.048)
Household wealth index	1.55	1.63	1.51	-0.08	0.04	0.13**
	(0.024)	(0.025)	(0.026)	(0.059)	(0.060)	(0.061)
Trust info. from ASHA	0.83	0.81	0.84	0.02	-0.01	-0.03
	(0.012)	(0.013)	(0.012)	(0.022)	(0.022)	(0.024)
p-values for joint significance	-	-	-	[0.866]	[0.757]	[0.394]

Notes: Sample is restricted to non-attrited households. Further, four villages have been dropped from each treatment arm due to noncompliance. Households that split at endline are included. **H** denotes health only information and **H + S** implies health and subsidy information; SC/ST (Scheduled Caste/Tribe); OBC (Other Backward Castes); ASHA (Accredited Social Health Activist). The *p*-values reported in the last row of the table correspond to F-test of joint significance of household characteristics in determining the treatment status in a linear probability model. 'Trust info. from ASHA' equals one if the household responds "yes" to the question "Do you think ASHA worker provides correct health information?" and zero otherwise. Standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p< 0.01$.

TABLE S2.3: **Balance of Household Fuel Consumption at Baseline**

	Control	*Treatment*		*Difference*		
	C	**H**	**H + S**	**C - H**	**C - (H + S)**	**H - (H+S)**
	(N=982)	(N=907)	(N=902)			
	(1)	(2)	(3)	(4)	(5)	(6)
Use firewood for cooking	0.75	0.73	0.76	0.03	-0.01	-0.04
	(0.014)	(0.015)	(0.014)	(0.031)	(0.031)	(0.031)
Use LPG for cooking	0.72	0.77	0.74	-0.05	-0.02	0.03
	(0.014)	(0.014)	(0.015)	(0.032)	(0.031)	(0.028)
Use dungcakes for cooking	0.87	0.89	0.87	-0.01	0.00	0.01
	(0.011)	(0.011)	(0.011)	(0.019)	(0.020)	(0.021)
Use induction stove for cooking	0.06	0.08	0.05	-0.02	0.00	0.02*
	(0.007)	(0.009)	(0.007)	(0.014)	(0.012)	(0.014)
Qty. of firewood purchased last month (kg)	9.43	15.76	12.41	-6.34	-2.99	3.35
	(1.702)	(3.999)	(2.388)	(4.553)	(3.259)	(4.763)
Qty. of dung cakes purchased last month	20.48	38.25	32.71	-17.77*	-12.23**	5.54
	(2.251)	(9.566)	(3.680)	(9.809)	(5.080)	(10.388)
Have LPG connection	0.64	0.70	0.67	-0.06*	-0.03	0.03
	(0.015)	(0.015)	(0.016)	(0.032)	(0.032)	(0.031)
Total no. of LPG refills (annual)	3.12	3.33	3.30	-0.21	-0.18	0.03
	(0.107)	(0.114)	(0.116)	(0.293)	(0.296)	(0.281)
No. of LPG refills per month (winter)	0.27	0.28	0.28	-0.01	-0.00	0.01
	(0.011)	(0.011)	(0.012)	(0.027)	(0.028)	(0.027)
No. of LPG refills per month (summer)	0.28	0.30	0.31	-0.02	-0.03	-0.01
	(0.012)	(0.012)	(0.012)	(0.026)	(0.026)	(0.025)
No. of LPG refills per month (monsoon)	0.30	0.32	0.32	-0.03	-0.02	0.00
	(0.011)	(0.012)	(0.012)	(0.029)	(0.030)	(0.029)
p-values for joint significance	-	-	-	[0.102]	[0.167]	[0.623]

Notes: Sample is restricted to non-attrited households. Further, four villages have been dropped from each treatment arm due to noncompliance. Households that split at endline are included. **H** denotes health only information and **H + S** implies health and subsidy information. The number of LPG (Liquid Petroleum Gas) refills (annual and per month) is reported for only those households who could be matched with OMC sales records (N=2729). The *p*-values reported in the last row of the table correspond to F-test of joint significance of household characteristics in determining the treatment status in a linear probability model. Standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

Table S2.4: **Balance of Time Use Variables at Baseline**

	Control	*Treatment*		*Difference*		
	C (N=976)	**H** (N=906)	**H + S** (N=902)	**C - H**	**C - (H + S)**	**H - (H+S)**
	(1)	(2)	(3)	(4)	(5)	(6)
Domestic Work	513.145	529.056	519.141	-15.911	-5.995	9.915
	(6.851)	(7.052)	(7.470)	(9.832)	(10.136)	(10.273)
Market Work	165.922	143.411	184.440	22.512*	-18.518	-41.030***
	(9.018)	(9.496)	(11.207)	(13.095)	(14.385)	(14.689)
Personal Care	152.162	155.480	154.446	-3.318	-2.284	1.034
	(1.996)	(2.599)	(2.387)	(3.276)	(3.111)	(3.528)
Leisure	606.527	609.603	579.878	-3.076	26.649**	29.725**
	(7.638)	(7.643)	(8.873)	(10.805)	(11.708)	(11.711)
Other	2.244	2.450	2.095	-0.206	0.149	0.355
	(1.196)	(1.584)	(0.856)	(1.985)	(1.471)	(1.801)
p-values for joint significance	-	-	-	[0.376]	[0.262]	[0.073]

Notes: The table reports average daily time spent on different categories (in minutes). The sample is restricted to non-attrited households where the total time spent by the primary cook (PC) equals 24 hours and the PC remains unchanged between baseline and endline data. Further, 8 villages that did not comply with assigned treatment status have been excluded. **H** denotes only health information and **H + S** refers to both health and subsidy information treatment arms, respectively. The p-values reported in the last row of the table correspond to F-test of joint significance of time-use variables in determining the treatment status in a linear probability model. Standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

TABLE S2.5: **Impact of Information Campaign on Monthly LPG Refill Consumption**

	(1)	(2)	(3)	(4)	(5)	(6)
Overall Treatment	0.023*		0.024*		-0.052	
	(0.014)		(0.014)		(0.081)	
Treatment - H		0.013		0.013		-0.051
		(0.017)		(0.017)		(0.096)
Treatment - H+S		0.034**		0.035**		-0.047
		(0.017)		(0.017)		(0.100)
Market Price (in 2019)			-0.036***	-0.036***	-0.043***	-0.043***
			(0.006)	(0.006)	(0.008)	(0.008)
Market Price × Overall Treatment					0.011	
					(0.011)	
Market Price × H						0.009
						(0.013)
Market Price × H+S						0.012
						(0.014)
Baseline Refill Consumption	0.264***	0.264***	0.263***	0.263***	0.263***	0.263***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Joint Significance of Treatments		[0.131]		[0.115]		[0.831]
H = H+S		[0.260]		[0.230]		[0.970]
Control Group Mean	0.28	0.28	0.28	0.28	0.28	0.28
R-Square	0.083	0.083	0.084	0.084	0.084	0.084
N	30019	30019	30019	30019	30019	30019

Source: Afridi, Farzana, Sisir Debnath and E. Somanathan. 2021. “A breath of fresh air: Raising awareness for clean fuel adoption.” *Journal of Development Economics* 151, 102674.
Notes: The dependent variable is monthly consumption of LPG refills between 1 Feb 2019 and 31 Dec 2019. Baseline refill consumption refers to monthly consumption of LPG refills between 1 Feb 2018 till 31 Dec 2018. The market price is of 14.2 kg LPG cylinder in hundreds of rupees (INR) in each month in 2019. p values of F-tests reported in square brackets. Standard errors, clustered at the village level, reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.