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

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Abstract

In much of the developing world, cooking accounts for most of women's time in home production. Does reliance on biomass for cooking drive this time burden? To assess time-savings from shifting towards cleaner fuels, we revisit a clean energy information experiment in rural India. 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). Using rich time use data and a propensity score matching approach, we estimate that switching towards cleaner cooking fuels could potentially save 19-20 minutes of home production time per day. Exploiting the randomized information nudge and endline data collected one year after the intervention, our intent-to-treat estimate of actual time saved is 5 minutes per day. We discuss why nudges towards cleaner energy use at home are unlikely to generate transformative shifts in women's home production time.

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1 Introduction

One third of the world's population – 2.5 billion people – still relies on solid biomass to cook meals (IEA, 2017). Cooking over firewood, charcoal, or dung cakes exposes at least half of these individuals to indoor air pollution. This health burden falls particularly hard on women, who tend to be the primary cooks for their households. Efforts to shift households towards cleaner, more energy-efficient fuels have gained momentum since the 2000s and some countries are now seeing marked improvements in health outcomes (for evidence from Indonesia, see Verma and Imelda (2021)).

In addition to the important health impacts of moving away from cooking with solid fuels, some argue that a switch to cleaner energy could generate important time savings in home production. Cooking time is the most time-intensive part of home production in developing countries today (Dinkelman and Ngai, 2022). This was historically true in developed countries. For example, one hundred years ago, American women spent 23 hours per week cooking (Ramey, 2009). Yet over time, households adopted time-saving new cooking technologies as these technologies became cheaper, and as growing outside opportunities for women in the labor market made it rational to adopt these new technologies (e.g., Greenwood et al. (2005); Ngai and Pissarides (2008)). By the 2010s, women in the US spent fewer than 8 hours per week cooking. This dramatic shift of time away from home production is a key feature of the structural transformation of labor markets.

Much advocacy exists around freeing women from the drudgery of home production through the use of cleaner fuels.[1] What will the experience of a shift towards cleaner energy be in developing countries? As households rely less on solid fuels and switch towards greater clean fuel use, can we expect a "double dividend" whereby households benefit from health improvements related to clean energy sources and also enjoy large time savings? These questions are particularly important for considering the welfare gains to women of clean energy transitions in the home (Cecelski, 2000). How realistic are these claims?

In this paper, we explore time savings from moving towards clean fuel use in the home. In a cluster-randomized experiment conducted in rural India, households were provided with

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

information to nudge them away from solid fuel and towards using cleaner bottled liquid petroleum gas (henceforth LPG) for cooking. Households were randomized (at 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. About 3,000 households across 150 villages were targeted, with 50 villages in each of the two treatment and control villages. Afridi et al. (2021) first analyze the impacts of this information intervention on first-stage fuel use outcomes. We revisit the experiment, and use a rich set of baseline and endline data on time use to explore potential and actual time savings related to cleaner fuel use.

We begin by showing that the time demands of home production in rural India are substantial, and that a reliance on solid fuels is associated with more time spent cooking. Primary cooks in our sample (almost 100% of whom are women) spend on average 60 hours per week in home production activities; 23 of these hours are in cooking-related activities. We show that cooking with cleaner fuels uses less time than dirty fuels: women spend about 18 fewer minutes preparing meals with exclusive use of cleaner fuels, relative to using dirty fuels. This amounts to 4.2 fewer hours of cooking each week (18 minutes $\times$ 2 meals per day $\times$ 7 days), or an 18% reduction in cooking time.

Yet, this correlation between fuel used in cooking the last meal and time spent preparing the last meal may not accurately represent potential time savings from switching to cleaner fuels. A household's choice of fuel mix for cooking likely depends on a range of observable and unobservable individual- and household-level characteristics (e.g., education of the primary cook, income level of the household, etc.) which may themselves be correlated with decisions about time spent cooking.

To better quantify potential time savings from moving towards clean fuels while taking observable characteristics into account, the second part of our analysis uses a propensity score matching approach to estimate differences in fuel use and time allocation across observably similar households with more versus less *access* to cleaner fuel technology.[2] In the baseline

[2] Krishnapriya et al. (2021) conduct a similar exercise using World Bank Multi-Tier Framework data for Ethiopia, Zambia, Rwanda, Myanmar, Nepal, and Cambodia. They estimate pooled propensity-score matched impacts of a variety of improved cookstoves (ICS) on time savings and other outcomes.

survey, 67% of households already have an LPG connection, which is a prerequisite for being able to use LPG. We predict whether a household has LPG access (a connection) at baseline using a rich set of household- and village-level controls. Using this predicted propensity score, we estimate the average treatment effect of having *access* to an LPG connection on time spent in home work among primary cooks. This approach yields a significant average time savings in home production of around 19 to 21 minutes per day, or 2.2 to 2.5 hours per week (9.5-11% reduction in cooking time). Adjusting for differences in observable characteristics across households with and without LPG access shrinks the potential time savings from cleaner fuels.

In the third piece of our analysis, we use experimental results from the information intervention to generate actual (randomization-induced) changes in the use of clean versus dirty fuel within the home. We show that treated households are 6% less likely to collect solid fuel, and around 4–5% less likely to exclusively use solid fuels for cooking. These results match those from Afridi et al. (2021), who found that the intervention led households to adjust their fuel use patterns at the margin: more LPG canisters are purchased monthly among those who are treated and who already use LPG. Building on these fuel use results, we look at reduced form experimental effect on time use among primary cooks. We find that the changes in fuel use at the household-level are not accompanied by shifts in overall time spent on home production. There is a small 5 minutes per day time savings in domestic work (and cooking in particular) for primary cooks exposed to the full information treatment (health and subsidy information). This is about a 2.5% reduction in cooking time each week (35 minutes per week relative to 23 hours total in cooking each week).

Our paper contributes to several strands of work in development and environmental economics. First, we present high-quality time use data collected from time use diaries administered to a large sample of women in rural India to demonstrate that cooking is, indeed, time-intensive work.

Data on time use in home production in the developing world is scant. [3] This lack of appropriate time use data remains one of the key constraints to understanding how transitions

[3] http://www.oecd.org/dev/development-gender/MEASURING-WOMENS-ECONOMIC-EMPOWERMENT-Gender-Policy-Paper-No-16.pdf

to cleaner energy will affect work in the home. Nationally-representative time use diaries are one of the best ways to capture patterns of time use for individuals, but such surveys tend to exist for only a handful of developing countries (Charmes, 2015). Even fewer countries have time use diaries captured for multiple years.

A handful of smaller studies measure the impact of improved cookstoves (ICS) by collecting time use in cooking and fuel collection. Krishnapriya et al. (2021) provide a comprehensive review of this literature. They find that of the 24 studies that collect some form of time use data, only six studies use time use diaries to collect the data. Only two of these six studies embed the collection of time use data within a randomized evaluation (of improved cookstove methods) design. Our study contributes to this sparse literature by providing new findings on time use in rural India, how this time use is related to energy use in cooking, and how this time use responds to a randomly-induced movement towards clean energy.

Second, rather than rely on cross-sectional correlations between fuel use and time savings to make a case for potential time savings from switching to cleaner fuels, we present convincing causal estimates of how a nudge towards cleaner fuel use affects actual time allocation for primary cooks.[4] The sobering lack of impact on time use in home production estimated from our experiment should give us pause in inferring that a shift towards clean energy will have transformative effects on women's time use. Nudging households towards cleaner energy at the margin is likely to have only small time savings benefits for women. Put differently, to make a real difference in how women use their time in the home, fundamental shifts in how cooking is organized are required.

Third, we can understand our results in light of recent work highlighting financial constraints as a barrier to take-up of energy efficient and/or cleaner cooking technologies. Small shifts towards cleaner energy use, and muted impacts on time use in the home are likely related to constraints on take up on the extensive margin. For instance, Afridi et al. (2021) show that the experiment affects LPG use only among households that already have an LPG connection. Given the high upfront costs of obtaining a connection, the inability to afford clean energy capital goods constrains household fuel use (and hence limits actual time

[4]Based on an Indian household energy survey in 1996, Barnes and Sen (2004) find that women spent, on average, 40 minutes collecting fuels and almost three hours cooking every day. On average, women worked for 12 hours, of which only 2 hours were spent pursuing paid work.

savings) on the extensive margin. Berkouwer and Dean (2021) reach a similar conclusion in their experiment that randomly subsidized adoption of energy efficient stoves in urban Kenya. Despite the cost of dirty fuel absorbing about 20% of household budgets, their study finds low adoption rates in response to the subsidy, They present evidence that credit constraints bind. Even with a sizeable subsidy, households cannot afford to invest in the more efficient stove that could save them money, improve health, and potentially save time.

Finally, even if financial barriers to obtaining cleaner-energy capital goods can be overcome (as in the case of our households that already have an LPG connection), it is unclear whether market conditions are conducive to shifting female time from home to market. This issue is particularly salient in rural India, where female labor force participation has been documented to be remarkably low, and falling (Afridi et al., 2018; Fletcher et al., 2017) over the last several decades, despite increasing levels of education. If the opportunity cost of women's time in the home is low, as it appears to be in rural India, an efficient choice for households may be to continue using cheaper, solid fuel. A lack of market demand for women's labor may therefore constrain fuel mix choices on the intensive margin, adoption of new technologies on the extensive margin, and related time reallocation within the home.

Our paper begins by describing the context of the clean cooking fuel (LPG) subsidy in India. We discuss the subsidy program and how it works and then we describe the information treatments provided in the randomized experiment. Section 3 describes time use patterns in our baseline survey data and links these time use patterns to patterns of solid or clean fuel use. Section 4 presents the propensity score estimates for the impact of access to LPG on time use and Section 5 discusses the impacts of our experiment on fuel choices and time allocation in the home. We discuss our results and place our estimates in context, before concluding.

2 Context: Expanding Access to Clean Fuels in India

The federal government of India subsidizes access to liquid petroleum gas (LPG). Over the last ten years, access to liquid petroleum gas (LPG) cylinders in India rose from 28.5% Census (2011) to 79% (in 2018, PPAC Report (2018)). This expansion in access 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 families between April 2016 and June 2019.

Under the PMUY, a woman in a rural, socio-economically disadvantaged household can obtain an LPG account at no upfront cost. The government covers the USD 25 security deposit and administrative charges associated with obtaining an LPG connection. In addition, the oil marketing company (OMC) provides an interest-free loan of USD 20 to purchase the stove and the first cylinder. For eligible households, the 100% subsidy of the USD 45 cost of registration is equivalent to about two weeks of monthly household income in rural areas.[5] PMUY was successful in raising access to LPG, especially in rural areas, although with some geographic variation.[6]

Until 2020, the cost of using LPG was also universally subsidized for domestic consumption.[7] Irrespective of income, every consumer of LPG must register with their OMC's distributor and pay the market price of a cylinder of LPG (about 10 USD). Since 2013, each customer receives a subsidy for up to 12 LPG cylinder refills in a year.[8] The subsidy works as an electronic cash-back scheme – a consumer buys a refill cylinder at the market price and the subsidy is credited to her bank account as cash-back within the next 2-3 days.

There is considerable variation in the market price of a cylinder, which is pegged to the international petroleum market, and therefore exogenous to Indian consumption demand. For instance, between November 2017 and October 2018 the LPG refill market price varied between INR 654 and INR 879. During the period of our study, the Indian government maintained a stable subsidized price at around INR 500. Consequently, the corresponding subsidy was substantive (24% - 32% of the market price) and varied with the market price. Taking the subsidy into account, households using LPG faced a daily cost of no more than INR 20, assuming one cylinder is used per month by the household (of 4-5 members) when cooking exclusively with LPG. With an average monthly, rural household income of about

[5]Average rural household income of approximately INR 7215 (100 USD) per month in 2011, the latest year for which these estimates are available (IHDS-II, 2011).

[6]North Indian states (e.g., 44% coverage in Jharkhand) continue to lag behind the southern states (e.g., 100% coverage in Kerala)

[7]In early 2020, international petroleum prices fell dramatically due to the pandemic; before this time, the federal government provided a universal LPG refill subsidy.

[8]Throughout, we refer to 14.2 kgs of LPG cylinder, the standard size in the Indian market.

INR 7,215 (from 2011 data), this translates into LPG fuel cost of approximately 7% of monthly household income post-subsidy (i.e. $500/7215 = 6.93\%$).[9]

Despite the fact that rural LPG access has increased substantially over time and that LPG consumption is subsidized, LPG use remains low. The mean annual LPG refill consumption in rural areas is about four cylinders in contrast to eight in urban areas.[10]

3 How Time-intensive is Home Production?

Our study focuses on rural Madhya Pradesh (MP), one of the largest northern states in the country, where LPG access was about 67% in 2018. At the baseline of a cluster RCT (refer to Appendix. A for details) that we describe in detail later, we conducted a time use survey of 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 3,000 randomly selected rural households in the district of Indore in MP during November-December 2018. With a few exceptions (i.e., 0.07% of full baseline sample), all primary cooks were women.

Primary cooks reported their time use 24 hours prior to the survey day (or the last 'normal' day).[11] To get a sense of how time-intensive home production activities are, we computed the unconditional average time spent per day in all activities for primary cooks and then multiplied these averages by seven to compute weekly hours on each activity (we found little variation in time use across activities by week and weekend days).

Several features of the primary cook's (henceforth women's) time use stand out. First, in Figure 1(a) we see that almost 60 hours per week are classified as rest, and just over 60 hours per week are spent in 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

[9] This expenditure estimate is in line with a recent CEEW Report, 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 out-of-pocket LPG refill price of INR 580 in March 2020).

[10] These are authors' estimates from data shared by OMCs for the study area and media reports (Hindu Businessline). LPG refill data are not available publicly.

[11] 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. These activities were coded during the 24-hour time use recall. See Appendix. A for details on the design of survey and time use classification.

engaged in (market) work. The average amount of time in market work among these women is one-third of the time spent in home production, or about the equivalent of a part-time job.

Figure 1(b) further sub-categorises the time spent on home production (domestic work).[12] A significant majority of time in domestic work is spent in cooking and cleaning. 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. Notice that the time spent on fuel collection is under 2 hours per week. This could be 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. Thus, fuel collection is not undertaken daily but occasionally - about 2-3 times a month. On the other hand, time spent on water collection is almost double of that for fuel collection.

One remarkable characteristic of these data is that the distribution of women's time across home production categories, and specifically the weekly time spent in cooking, matches time use among rural Indian women recorded in national (Afridi et al., 2018) and other surveys (Anderman et al., 2015; Maji et al., 2021); time use 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 among rural housewives in the historical US (Dinkelman and Ngai, 2022; Ramey, 2009).[13] The average weekly time in cooking in the US in the 1920s was 23.5 hours, with cleaning and laundry together reaching almost 21 hours - almost exactly the same time women are spending cooking and cleaning in our survey. Changing the demands of time for cooking and cleaning will likely have the largest impacts on women's time use.

[12] See corresponding Tables B.1 and B.2 in Appendix. B.

[13] Figure B.1 in Appendix. B 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. Note the similarity with the distribution of time across activities in our sample. Furthermore, there exists a significant gender gap in time allocation for the same sample - men spend only 10.17 hours in domestic work and 33.50 hours in market work, per week.

3.1 Are Solid Fuels Less Efficient than Cleaner Fuels?

As in other developing countries, mixed fuel use is common in rural areas of India, and we see this in our baseline survey data. Table 1 shows households' access (Panel A), use (Panel B), collection (Panel C), and purchase (Panel D) of cooking fuels in the previous month. Indeed, when asked whether the household had used either firewood or dung cakes or crop residue in the last month, 74.8%, 87.8% and 11.3% of all households in the sample, respectively, responded 'yes', even though 67.2% of the sample had also used LPG for cooking in the previous month. More than 70% of households report collecting solid fuels in the previous month (Panel C), while a lower proportion purchases them (Panel D). Households also tend to use solid fuels frequently and regularly for cooking, irrespective of having an LPG account, as shown in Table 2. We asked the household's primary cook to list all the fuels used in cooking over the last month (column 1) and preparing the most recent meal (column 2). Only 29% of households report using LPG exclusively in preparing the last meal, despite two-thirds of them having access to an LPG connection.

In Table 3, we show the association between time spent in cooking and home production with the household using traditional biomass versus clean LPG. We regress the outcomes – minutes spent cooking the last meal, cooking over the last day, and total domestic work activities the day before the survey – on controls for the type of fuel used in the cooking reference period. The omitted category is only solid fuels. 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 fewer minutes in meal preparation. The comparison group here is all primary cooks using only solid fuels. If women are cooking two meals a day (which is the norm in this setting), the sole use of clean fuels reduces cooking time by around 36 minutes a day, or 4.2 hours per week. The observed relationship between fuel use and time use captured in the baseline survey corresponds with studies that test for efficiency in cooking with LPG and non-LPG fuels.[14]

This gap in time use across different fuel sources is also reflected in the reported time spent cooking all meals the day before the interview. In households using only clean fuels for

[14]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.

cooking in the last meal, primary cooks report spending 17.8 fewer minutes in cooking the day before the survey. Overall domestic work is also 31 minutes lower on the previous day in households where only clean fuels were used; while more trips to collect firewood or make dung cakes raise time spent on domestic work by 2-5 minutes per day. The small coefficients on the number of visits for wood and dung collection (or manufacture) are likely driven by the fact that these collection activities only happen a few times a month, whereas cooking happens each day.

Taken together, the baseline time use survey demonstrates that home production, in general, is extremely time-intensive; more specifically, it is cooking and cleaning, rather than fuel collection or fuel (dung cake) production that uses the most time daily; and that 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.

Of course, the differences in LPG use across households shown in Table 3 could be driven by differences in incomes, with richer households making different decisions about fuel, and about time use of the primary cook. Next, we turn to a propensity-score matching approach to generate estimates of the predicted time savings from moving from no-LPG to LPG use, accounting for differences in observables across households.

4 Potential Time Savings from Clean Fuel: Propensity-Score Matched Estimates

To assess the impact of LPG use on women's time spent in cooking and other activities, we must observe their time use when they use both clean and solid fuels. Since the use of clean versus dirty fuels is an endogenous choice, we could try to tease out this relationship between clean fuel use and time use by focusing on whether a household has the ability to use clean fuel at all. Since having an LPG connection is a prerequisite for using LPG, we can compare time use across households with and without an LPG connection.

As one might expect, households with an LPG connection are different from those without such a connection, on a number of variables that might be correlated with time use in the home. Table B.3 in Appendix. B shows the average baseline differences in observable households characteristics by access to an LPG connection. LPG-connected households have more household members, a higher average level of education, and a higher value on the wealth index. However, they are also more likely to belong to the socio-economically disadvantaged scheduled caste (SC) or tribe (ST) community, and are less likely to have improved roofs and walls. Because households without an LPG connection look significantly different from those with an LPG connection, they are unlikely to form a valid counterfactual group.

To construct a more appropriate counterfactual group, we use propensity-score matching methods (Rosenbaum and Rubin, 1983, 1985; Heckman et al., 1997). We match households with and without LPG connections based on their observed characteristics at baseline. To reduce the dimensionality of the matching problem, matches are based on the predicted probabilities of having access to an LPG connection. We use baseline village, household, and primary-cook characteristics and a probit model to predict access to LPG at baseline.[15] An important predictor of LPG access is whether the household has a PMUY beneficiary. As described earlier, the PMUY program subsidized the upfront cost of an LPG connection and provided an interest-free loan to eligible women to purchase the first cylinder and stove. Eligibility for PMUY was based on the Socio-Economic Caste Census conducted in 2011. The census collected data on seven deprivation indices to identify households below the poverty line.[16] We use our baseline data to construct direct measures or indirect proxies for the seven PMUY-eligibility criteria and also include these as controls in the probit model.

[15]The 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, household wealth index. 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.

[16]These seven measures include households with only one room, *kucha* (not using concrete materials, e.g. made of mud) walls and *kucha* roof; no adult member between the ages of 16 and 59; female-headed households with no adult male member; no able-bodied adult member, SC/ST households, no literate adult above 25 years; and landless households deriving a major part of their income from manual casual labor.

4.1 Balance on Matched Covariates

Figure 2 shows that this matching exercise selects a set of non-LPG-connected households that resemble the LPG connected households more closely on a large group of observables. The solid line plots the distribution of the predicted probabilities of having an LPG connection, for households that have a connection at baseline. The dashed line plot the predicted probabilities for households without access at baseline. Since the covariates of each type of household were not balanced, the distributions of propensity scores by access to LPG are also statistically significantly different from each other (on a Kolmogorov-Smirnov test). Once we restrict the distribution of the propensity score for households without LPG to the matched sample (dash-dotted line) using nearest neighbor matching, the difference between the two distributions reduces substantially, and is no longer statistically significant (p-value of 1.00 on the Kolmogorov-Smirnov test of equal distributions). We use this matched sample to estimate potential time savings from using LPG.

Matching estimates will be reliable if the households with and without LPG have the same distribution of unobserved and observed characteristics, and both groups of households were administered the same questionnaire in a similar economic environment (Dehejia and Wahba, 2002). This latter fact is true, given the nature of our experiment. We report the covariate balance between the matched sub-sample in Table B.4 in Appendix. B. On an average, none of the covariates are significantly different across the households with and without access to LPG. As depicted in Figure 3 the standardized bias in covariates reduce substantially after the matching.[17]

4.2 Propensity Score Matched Estimates of Access to Clean Fuel Technology

Table 4 presents the matched propensity score estimates of the average treatment effect of having an LPG connection on fuel and time use in the home. Note that the outcomes here are all measured in the baseline survey. These propensity score matched estimates give us

[17] The standardized percentage bias is the percentage difference of the sample means in the treated and non-treated sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups.

the predicted potential time saved from using cleaner fuel in the home.

Panels A and B of the table show that having access to an LPG connection at baseline reduces the time spent in firewood collection and dung cake production, and reduces the use of solid fuels in cooking. These estimates suggest that the largest time savings may come from manufacturing dung cakes, with a total time saving of over one hour per dung collection and making session.

Table 5, Panel A shows the potential time reallocation facilitated by having access to clean fuels. Households with an LPG connection are predicted to save about 20 minutes per day on domestic work (not just cooking). Over the course of a week, this amounts to about 2.3 hours. None of this saved time appears to be allocated towards the market. Instead, in households with an LPG connection, primary cooks appear to enjoy about 21 more minutes of leisure per day. Interestingly, the time saved in domestic work under the propensity score estimator is about the same magnitude as the difference in time spent in cooking among households exclusively using LPG in cooking (Table 3, column 2). Furthermore, the propensity score estimates show that primary cooks save about 5 to 6 minutes per day on fuel collection and cooking, respectively. As we might expect, an LPG connection does not directly impact time spent on home production activities like childcare.[18]

The results in Tables 3 and 4 indicate that access to and use of cleaner fuels is associated with relatively small time savings for women. One concern with both the correlations in Table 3, and the propensity-score matched estimates in Table 4 – both of which use only our baseline data – is that they may not provide causal estimates of the effect of switching to cleaner fuels. We may not have adequately controlled for differences in preferences over time use and home production, or differences in the opportunity cost of women's time, that could differ between LPG and non-LPG connected households, or between households that use different fuels at baseline. To get at the causal effect of a movement towards cleaner fuel use more accurately, we next look at how time use changes across households that are randomly nudged to adopt and use clean fuel.

[18]Our results are robust to alternative matching methods, e.g., kernel-based matching.

5 Information Nudges Towards Clean Fuel: The RCT

Afridi et al. (2021) designed two information campaigns to nudge households to use cleaner fuels at home. We revisit their experiment to estimate how this experimental nudge affected fuel collection and use, and time use of the primary cook. This section provides general information about the study and we refer the reader to Appendix. A for further details.

5.1 Experimental Design and Sampling

The cluster-randomized RCT was conducted in rural areas of Indore district in Madhya Pradesh (MP). 150 village councils were selected to be part of the study, with 50 village councils (or GPs) randomly assigned to one of two treatment groups, or a control group. The cluster-randomized trial included 20 households randomly sampled in each village.

In November - December 2018, a baseline survey was administered to the 3,000 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 during October - December 2019.

The information campaign was designed to increase the adoption and regular usage of LPG. It consisted of an awareness campaign on the health and financial benefits of switching to regular usage 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 (H) and the government subsidy to LPG consumers (S). The information intervention had two treatment arms: the health awareness arm (H) and the health awareness and LPG subsidy (H+S) 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 and with the health worker following a written script. 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 using LPG, and how households can reduce the costs of using LPG through the government-run, cash-back subsidy program.[19] No information was provided in the control group of villages.

[19] We leveraged the existing public health system by engaging Accredited Social Health Activists (ASHAs)

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. A.1. See Tables B.5 - B.8 in Appendix. B 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 joint significance test of all of the time use variables in determining treatment status has a p-value of 0.38 and 0.26 on H and H+S arms, respectively.

5.2 Empirical Strategy and Results

5.2.1 Empirical Strategy

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

First, we combine exposure to the H (health awareness) or H+S (health + subsidy awareness) campaign into a single indicator of treatment status that takes a value of one if a household was exposed to either treatment and zeroes otherwise (control group), as follows:

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

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 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

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. ASHAs were paid 50 rupees per visit per household, comparable to their regular remuneration.

for household religion and caste.[20] We also control for a set of village characteristics, $\mathbf{Z}_v$, the proportion of irrigated land, and indicators for the presence of private primary schools, health sub-centre, distance to block headquarter and all weather road access.[21]

The main parameter of interest is β_T, representing the impact of the awareness campaign (either H or H+S) 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 average treatment effect (ATE) of the awareness program.

Our second specification distinguishes between the two types of treatments; we estimate and compare the impact of the two arms on each outcome.

$$Y_{iv}^1 = \beta_c + \beta_T^h T_v^h + \beta_T^{hs} T_v^{hs} + \beta_0 Y_{iv}^0 + \beta_X' \mathbf{X}_{iv} + \beta_Z' \mathbf{Z}_v + \nu_{iv}, \quad (2)$$

where T_v^h is a dummy for assignment of village v to the H treatment and T_v^{hs} a dummy for assignment to the H+S treatment. The other variables are as explained above. Standard errors in both equation (1) and (2) are clustered at the village level.

To account for variation in the administration of the local health department, which may have impacted the delivery of the intervention across sub-district (as mentioned in Afridi et al. (2021)), we include dummies for the sub-district to which the village belongs (sub-district fixed effects (FE)). This is a deviation from the pre-analysis plan associated with the study. However, our results are similar when we exclude these FE (results available on request).

[20]Since the ownership of different household assets is likely to be highly collinear, we use the first component of a principal component analysis over several indicators measuring 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.

[21]The specification includes all controls explicitly mentioned in the pre-analysis plan. However, Census data on 'distance of village to block headquarters' is missing for 260 households (13 villages). Using Google Map's Distance Matrix Application Programming Interface (API), we impute the traveling distance between the sampled villages and its block headquarters and use this variable as a control instead. 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. Our results do not vary if we use a dummy for missing distance data for the 13 villages in the regression analysis.

5.2.2 Results

A. Fuel Use

Our 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, we present the results for the combined treatment first, and then for the two separate treatments. All columns contain the full set of additional controls.

Across the board, we see that exposure to *Health and Subsidy* treatment reduced the incidence of biomass collection for household use. Firewood collection declines by 6.1 percentage points and dung collection declines by 5.9 percentage points, respectively. These results are similar to the results from Tables 11 and 12 presented in Afridi et al. (2021).[22]

Separating out the two different treatment arms, we see the point estimates are larger (more negative) for the combined H+S treatment. However, in all cases, we cannot reject that the two information treatments had the same impact on reducing household activity towards collection of solid fuels for energy use.

Next, we look at how primary cooks use fuels in the most recent or last meal cooked. Table 7 shows the impacts of randomized treatment nudges on three outcomes for choice of cooking fuel in the last meal: only clean fuels (columns 1-2), a mix of clean and solid fuels (columns 3-4) and only solid or dirty fuels (columns 5-6).[23]

Similar to the results in Table 9 of Afridi et al. (2021), we find that 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, whether LPG or LPG combined with electricity rises by about the same magnitude. Much of this switch in fuel use is driven by exposure to the health information treatment alone, although we cannot reject that the point estimates on H and H+S are statistically the same. The point estimates on mixed fuel use in the last meal are

[22]Sample size varies slightly between Afridi et al. (2021) and this paper due to 7 missing observations on time use.

[23]Women typically report two meal cooking times - morning (before 1 PM) and evening (after 1 PM). We do not find any systematic differences in the types of fuel used between morning and evening meals, either at baseline or endline as shown in Figure B.2 in Appendix. B, although there is a significant increase in 'only clean fuels' at endline.

negative, but not statistically significantly different from zero.

The results of Tables 6 and 7 show us that the experiment operated to marginally shift household choice of cooking fuels. Next, we turn to the impacts on time use.[24]

B. Time Use

Table 8 shows the 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: Domestic Work (including childcare), Market Work, Personal Care, and Leisure. For each outcome, we show results for the combined treatment effect in column (1), and then effects for H and H+S information treatments separately in column (2), with sub-district fixed effects.

Exposure to treatment does not have a big impact on time allocation in any category. In almost all columns, the point estimates are small and not statistically significant. In Panel A, the coefficient on the H+S treatment is larger, indicating a reduction of about 14 minutes of domestic work per day among this treated group relative to controls. However, this point estimate is not significantly different from zero in our full specification, after controlling for sub-district fixed effects.

When we disaggregate the time use results by category of home production in Table 9, we see that 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.

The absence of any large treatment effect on time use of primary cooks is striking, especially in light of the fact that these women spend many hours each week in home production, and using dirty fuel sources is correlated with a higher time-intensity of food production. Although our information treatment nudged households toward using cleaner fuels, and reduced the use of solid fuels, this did not translate into large ITT impacts on time savings for women, nor into a reallocation of time out of home production towards other market or non-market activities.[25]

[24] Our results are robust to restricting the sample to primary cooks who report the same time of cooking the last meal at baseline and endline.

[25] We do not instrument for the move towards clean fuel because the first stage is not sufficiently strong.

6 Discussion

6.1 Valuing time savings from cleaner fuel use at home

Valuing the time savings from a movement towards cleaner energy requires valid estimates of the time saved, and some estimate of the opportunity cost of that time. If women could shift all of this potential time savings from home to the market, what could they earn? We conduct this calculation using the government-mandated unskilled wage rate of INR 280 per day (35/hour) (last available income data are for 2011 from the India Human Development Survey).

We estimate 4.2 hours of potential time savings using the raw correlations of fuel use and time in cooking. The market value of this time saved is 147 INR per household each week, or 8.5% of rural monthly household income (147 per week $\times$ 4.2 weeks per month, rural monthly income is INR 7,215). Turning to the propensity-score matched estimates of potential time savings for LPG-connected households, we value the 2.5 hours per week of potential time savings around INR 87.5 per household each week. This is about 5% of rural monthly household income (87.5 per week $\times$ 4.2 weeks per month). Finally, we value the 35 minutes per week of actual time savings for households responding to the information nudge at INR 20 per week, or around 1.1% of rural monthly household income (not taking into account the cost of the treatment). Although cooking is tremendously time-intensive, occupying primary cooks for over 3 hours each day, the market value of actual time savings from moving towards cleaner fuel use are very small. Moreover, the value of this time does not seem to outweigh the costs of using LPG, even at highly subsidized prices: recall from section 2 that the subsidized cost of LPG was about 7% of monthly household income.

How do these estimates compare to the literature? (Krishnapriya et al., 2021) provide estimates of average time savings from using improved cookstoves, broadly defined. LPG use is one example of an ICS. Their review of the literature suggests an average of 43.5 minutes per day saved from using ICS, spread across more efficient cooking and less fuel collection. As Krishnapriya et al. (2021) point out though, these observational studies may be confounded by differences between households that choose and do not choose to use ICS. Their paper presents another set of estimates of time savings from ICS, using data from the

World Bank's MTF (Multi-Tier Framework) Surveys conducted in multiple countries and a propensity-score matching approach. Their propensity-score matched estimates suggest average time savings of about 34.3 minutes per day (s.d. 4.5) across six low-income countries. Valuing these time savings at one third of the unskilled wage in each country, they estimate the value of average time savings at 12 to 62 USD per year. If we instead use the mean unskilled wage, the lower bound on the market value of time savings from ICS would be 48 USD/year, or 5% of GDP per capita (no household income data are available for their MTF results).

In Berkouwer and Dean (2021), the authors use a randomized assignment of subsidies for ICS in Nairobi, Kenya, to estimate the impact of stove subsidies on time savings (instrumenting for adoption using the experimental variation). Among households that adopt improved stoves, households saved an average of 54 minutes of cooking time per day, off a control group mean of 192 minutes per day. Using median hourly earnings to value these large time savings, they compute the value of time savings from adopting the stove at 34 cents per day. This may sound small, but it amounts to about 124 USD per year, which is 5% of annual household income (2,485USD/year in their data).

Somewhat surprisingly, the value of time savings from our propensity-score matched estimates, relative to household income or GDP per capita, is about the same in rural Madhya Pradesh and in the six countries studied in Krishnapriya et al. (2021) (and, also surprisingly, from the RCT in Nairobi). However, our RCT estimates yield the lowest market value of time saved. We next discuss factors that may contribute to this.

6.2 Constraints to greater time use savings

As we showed in Figure 1, domestic work in general and cooking in particular are highly time intensive. Why don't we estimate larger potential and actual time savings from a move towards cleaner fuels?

First, even though we saw in Table 6 that the intervention reduced time spent collecting solid fuels, this time likely belongs to others in the household, not only primary cooks. Although primary cooks spend much of their day in home production activities, only a small amount of time is dedicated to collection of wood and dung. We saw this in Figure 1, where time spent by primary cooks in cooking and cleaning dwarfs time spent in fuel collection. If men and children do any solid fuel collection, they may benefit more from any time savings deriving from a switch to LPG. Our estimates do not capture these time savings because the time use module was only administered to the primary cooks.

Second, Table 3 showed that households using clean fuels alone save about 38 minutes of home production time each day, with about 18-20 minutes saved in cooking time. These magnitudes are echoed in our propensity-score matched results, where matched estimates of the impact of having an LPG connection are about 19-20 minutes per day. Aggregating these daily time savings up to the week means that potential time savings from switching to cleaner fuels amount to about 2.3 hours of time saved (7 days $\times$ 20 minutes). If we use the experimental estimates of time saved, aggregating the 5 minutes per day saved cooking up to a week, this is only 35 minutes of time saved. While this time could be useful in the market, it may not be feasible for women to bundle all of these small daily time savings into a single day. Moreover, low market wages for women and limited labor market opportunities may not make it worthwhile for households to move 35 minutes to 2.3 hours of primary cook time into the market.[26]

At the heart of our results is the fact that the marginal shift in fuel mix generated by exposure to the clean energy information treatment is insufficient to generate transformative changes in cooking practice, 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 usage. Households rarely switch from exclusive solid fuel use to exclusive clean fuel use. 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. Our experiment thus allowed some households to take one tiny step on this ladder - but not sufficiently large to generate substantial time savings.

Third, given the context of LPG subsidies in India, it does seem like some households are leaving money on the table – which suggests another reason for our limited time savings results. For households in our sample, the opportunity cost of using solid fuels can be substantial. For example, 14% of households report purchasing firewood worth INR 790 in

[26]In our study villages, the average female employment rate is very low, at 15.3%.

the previous month, which is more than the out-of-pocket (post-subsidy) spending on one LPG refill (INR 500). 70% of households report spending 44 hours in the previous month, on average, collecting firewood. Given the minimum daily wage for unskilled labor at INR 280 in Madhya Pradesh, this amounts to these households losing income from up to 5 days of work or INR 1400 in a month. Since solid fuel is, for these households, more expensive than LPG, they could save money by switching to gas, and save time – potentially making money – by moving their labor from fuel collection into market work.

We would households leave money on the table? We saw that providing households with information about the subsidy reduced solid fuel collection (Table 6, although not entirely. A key reason why households might be leaving money on the table is that they may be liquidity constrained. Even though LPG canisters are subsidized above INR 500, households may not be able to afford the up-front cost of a cylinder and wait the 2-4 days for a refund of the subsidy portion.

What does this mean for women's time use in the home, and the potential for clean energy to generate a double dividend? Much more than information nudges will be necessary to change home cooking technologies in a way that will have large impacts on time use. A systematic review of the literature provides evidence that LPG's initial cost is the most frequently reported barrier to adoption by people with limited resources (Puzzolo et al. (2016); Alem and Ruhinduka (2020)). Sharma et al. (2020) supports this finding and adds that the cost involved in accessing cleaner fuel is a major obstacle for switching to clean cooking fuels, especially for households with freely available firewood, and livestock ownership. Berkouwer and Dean (2021) finds that credit constraints get in the way of household adoption of cleaner cookstoves in Nairobi. In our setting, even the upper bound of 19-20 minutes per day of time saved in using clean energy for cooking would only be worth 5% of monthly household income, while the cost of using LPG on a daily basis amounts to about 7% of monthly household income. Thus, even when access is fully subsidized and use partially so, the potential economic savings from using more clean fuels are so small that low-income households in rural India may rationally choose to continue consuming cheap solid fuels.

Finally, since women bear the main burden of both cooking and fuel collection (Parikh,

2011) and given their lower returns to market work relative to men (Gronau, 1973), men may not internalize the benefits of cooking using cleaner fuels (Bloomfield, 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 constraint on households' transition to clean fuels (Doss, 2013; Gould and Urpelainen, 2018; Miller and Mobarak, 2013; Duflo et al., 2008).

7 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. If so, could households enjoy a double dividend – improved health as well as time savings – from switching to cleaner cooking fuel? Our evidence from a clean energy information experiment in rural India suggests that nudging households to shift their mix of cooking fuel use towards cleaner fuels is unlikely to have transformative impacts on the time allocation of primary cooks. We find very small impacts on time spent in home production as households shift their fuel mix towards LPG. The value of this time does not seem to outweigh the costs of using LPG, even at highly subsidized prices.

Our 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 seems unrealistic. Financial interventions that address credit and liquidity constraints are likely required to make access to clean technologies in the home more affordable, so that households can take more than just a tiny step up the energy ladder. Changes in the opportunity cost of female time in the market that accompany large changes in the structure of employment will also have a role to play in affecting household choices about fuel mix.

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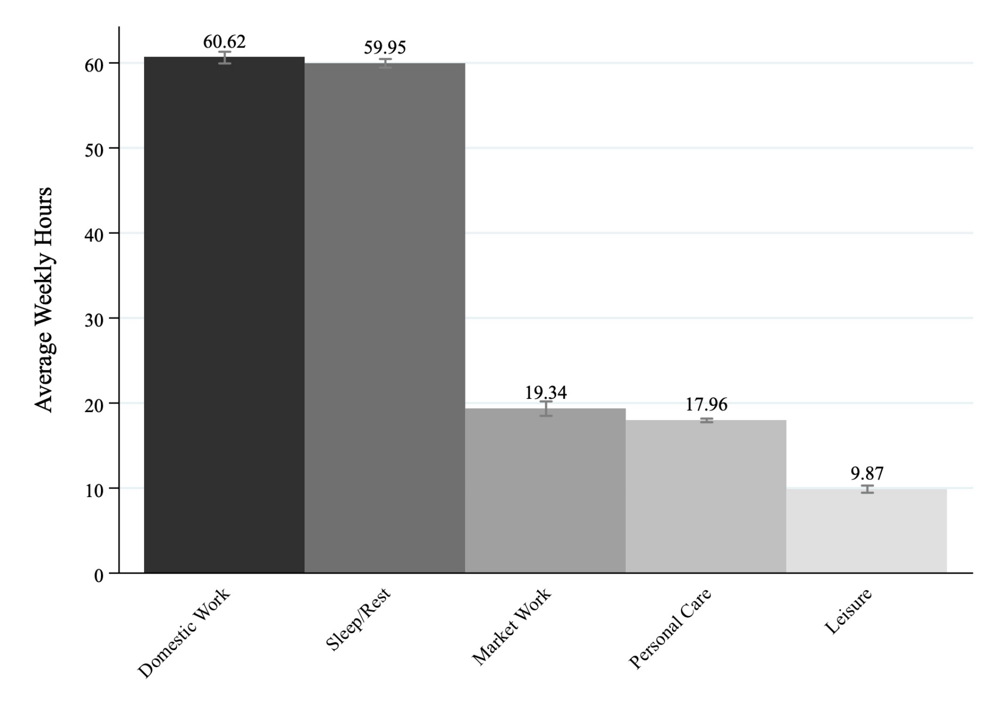
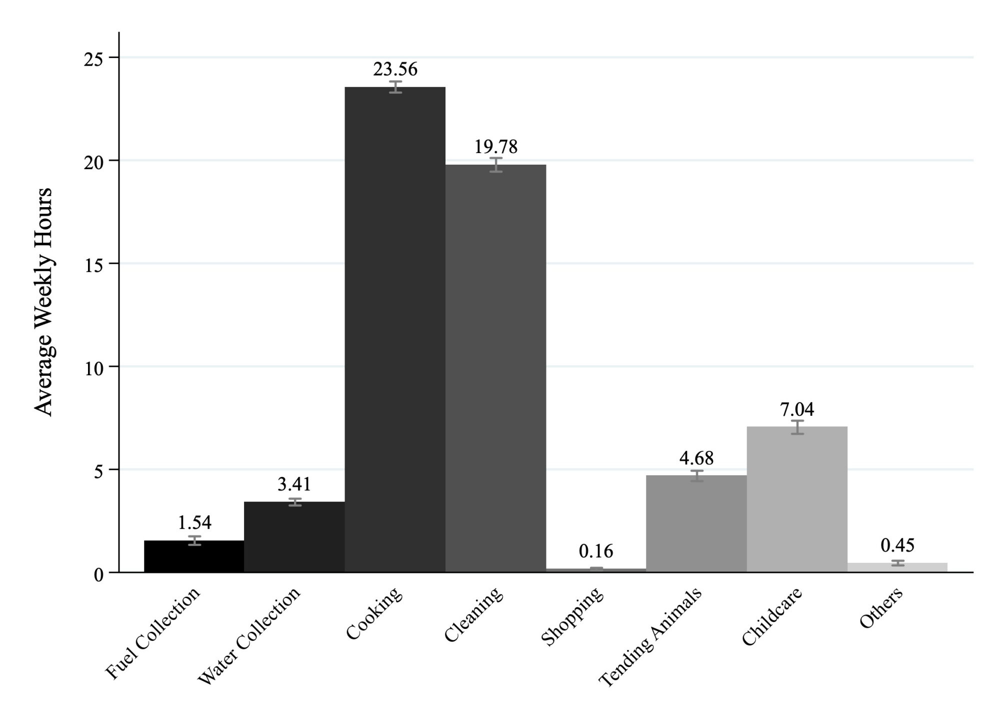
Figure 1: **Time Use of Primary Cooks (at Baseline)**



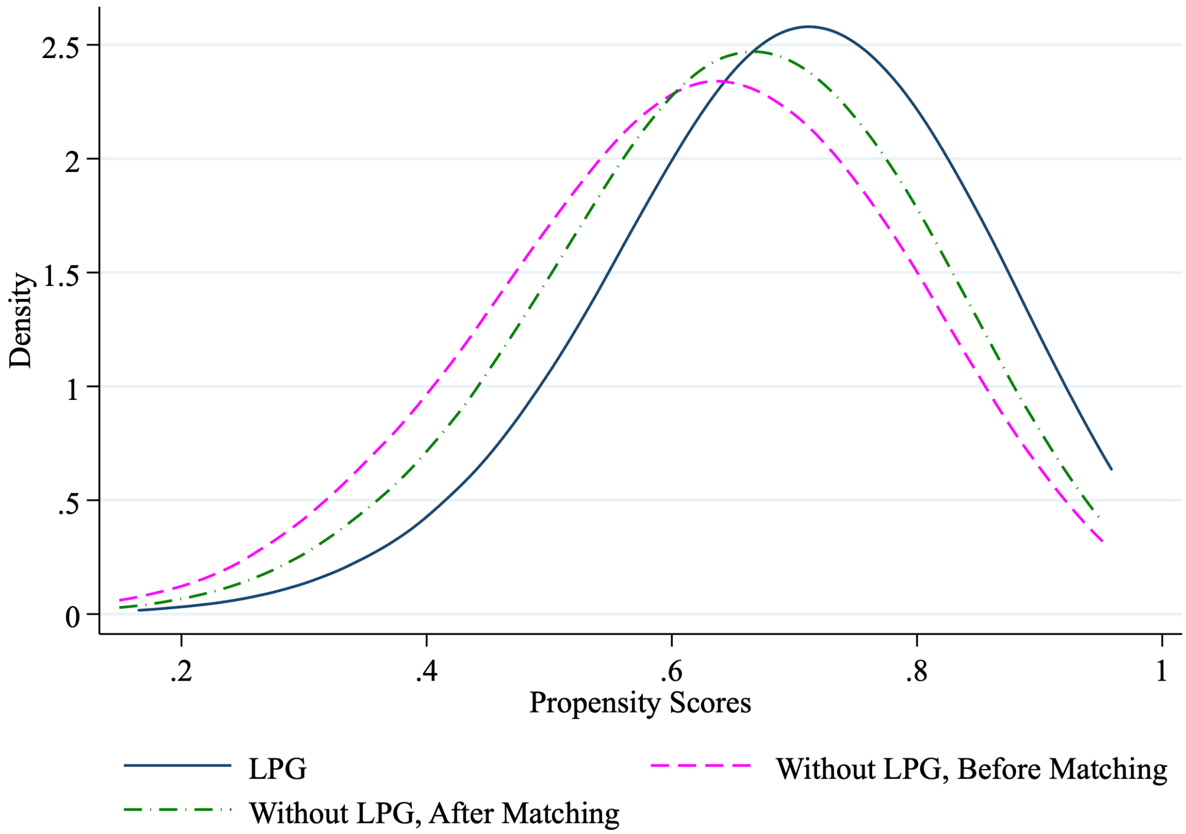
(a) Time spent on home production and other activities



(b) Time spent on home production activities

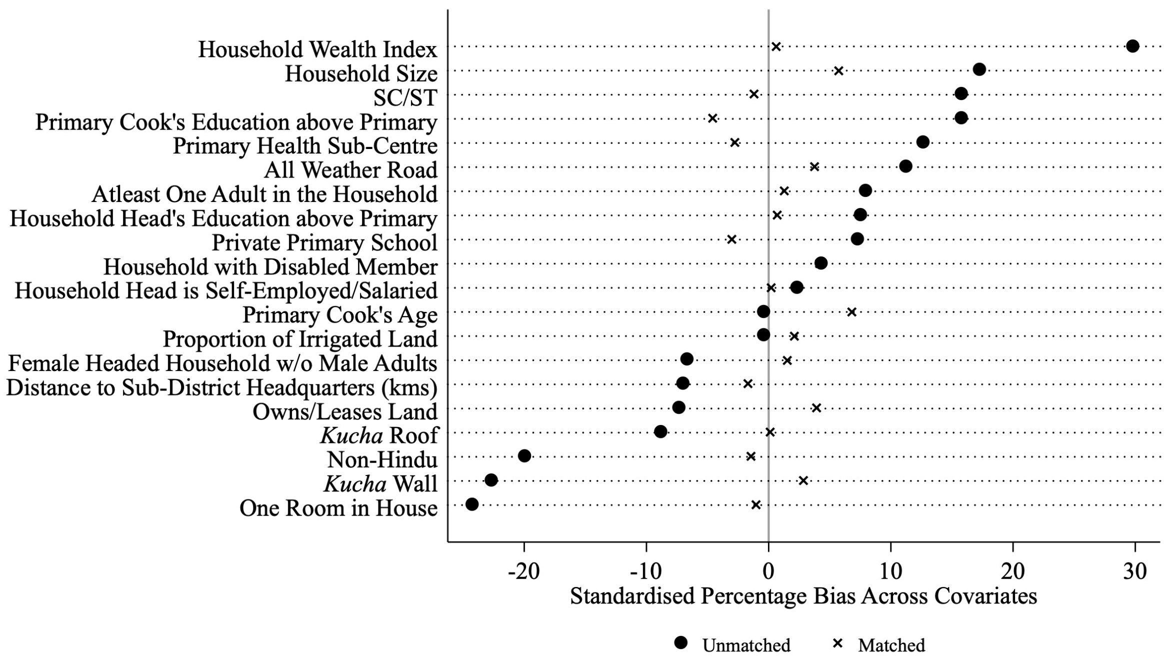
Notes: Average weekly hours spent in different activities calculated using self-reported time use survey of primary cooks at baseline in 2018. Time use reported for a regular day prior to the survey is aggregated to weekly totals. Average hours in Figure (a) sum to 168 weekly hours. The sample is restricted to 2,942 households where the total recorded time spent by the primary cook (PC) equals 24 hours or 1440 minutes.

Figure 2: **Predicted Propensity Score of LPG Connection by Actual LPG Connection Status**



Notes: The figure plots the densities of propensity scores by LPG connection of the household, before and after matching. The line-chart for LPG post-matching excludes the weights assigned to each score. The null of equal distributions between 'LPG' and 'Without LPG' distributions is rejected using the Kolmogorov-Smirnov test before matching (p-value of 0.000). Post-matching, 'LPG' and 'Without LPG' distributions are equal (p-value of 1.000). The sample is restricted to 2,942 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 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) and non-treated (without LPG) 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 2,942 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.

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

	Mean (1)	Std. Error (2)	Obs. (3)
Panel A: Fuel Access			
LPG Connection	0.672	0.009	2784
Panel B: Fuel Use			
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			
Firewood	0.704	0.010	2083
Dung Cake	0.697	0.009	2444
Crop Residue	0.726	0.025	314
Panel D: Fuel Purchase			
Firewood	0.143	0.008	2083
Dung Cake	0.291	0.009	2441
LPG Refills	0.322	0.011	1880

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 the fuels refer to firewood, crop residue (including twigs and leaves), dung cakes, LPG gas stove and electric stove, respectively. In panel C, the respondents were asked if they or anyone in their house collected firewood or crop residue (including twigs and leaves) in the last month. The question for dung cakes was 'Did they either collect or make dung cakes 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 and data on purchase of electricity was not collected (Panel D).

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

	Last Month	Last Meal
	(1)	(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

Notes: The table records mean (with standard errors) fuels usage in cooking last month and last meal 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 stove in the last month and only electric induction/heater stove in the last meal respectively, 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* in the last month and *chulha*, *sigdi*, *kande*, etc in the last meal respectively, 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. Further, less than 0.3% households consume other fuels like *gobar gas*, bio-gas, etc. and hence excluded from the table.

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

	Cooking Last Meal	**Cooking Yesterday**	**Domestic Work 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)
#Visits 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

Notes: The dependent variable is the daily time spent in the 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. The independent variables i.e. fuel use in Column 1 corresponds to last meal usage, whereas last month fuel use is taken 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. The visits for firewood collection are solely made by the PC, however, dung collection and making was recorded by all the household members and not PC individually (in a typical week in last month). Further, there are 11 missing observations for total visits 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: **Propensity Score Matched Treatment Effects: Using Baseline Data**

Fuel Collection				
Panel A: Firewood				
	Total Visits		Total Time Spent	
	Household	Primary Cook	Household	Primary Cook
	(1)	(2)	(3)	(4)
LPG Connection	-0.33**	-0.14	-10.20	-7.26
	(0.14)	(0.09)	(8.33)	(4.94)
Control Group Mean	2.58	1.61	134.11	84.08
Observations	2639	2639	2639	2639

Panel B: Dung					
	Dung Making		Dung Collecting		Col(2)+ Col(4)
	#Times	Total Time	#Times	Total Time	Total Time
	(1)	(2)	(3)	(4)	(5)
LPG Connection	-0.64***	-49.02***	-0.37***	-20.89	-69.91***
	(0.18)	(15.10)	(0.13)	(16.22)	(25.68)
Control Group Mean	3.74	290.13	1.45	143.95	434.08
Observations	2650	2650	2650	2650	2650

Notes: The dependent variable in **Panel A** is the total visits to collect firewood in a typical week in the last month (Columns 1 and 2) and total time spent (minutes) for collection during the last visit (Columns 3 and 4) by the household and primary cook respectively. There are 11 missing observations for total visits to collect firewood at baseline. The dependent variable in Columns 1 and 3 of **Panel B** records the number of times dung is collected and made by the household in a typical week in the last month, while the outcome variable in Column 2 and 4 is the total time taken (minutes) to make and collect dung in the last month. Finally, Column 5 in Panel B records the total time spent (in minutes) for dung collection and making. For both **Panels A and B**, the matched treatment effect of LPG is calculated using nearest neighbour matching on observations with identical propensity scores between treated (households with a LPG Connection) and control (households without a LPG Connection) groups. Control variables 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. 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. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

Table 5: **Propensity Score Matched Treatment Effects: Using Baseline Data**

	Time Use of Primary Cook			
Panel A: Overall Time Use				
	Domestic Work (1)	Market Work (2)	Personal Care (3)	Leisure (4)
LPG Connection	-19.86**	-5.58	2.14	20.72***
	(7.98)	(10.24)	(2.49)	(7.55)
Control Group Mean	154.16	579.91	522.29	183.15
Observations	2650	2650	2650	2650

Panel B: Time Spent in Domestic Work					
	Fuel Collection (1)	Cooking (2)	Cleaning (3)	Childcare (4)	Others (5)
LPG Connection	-4.66**	-6.23*	-1.74	-0.65	-6.58
	(2.18)	(3.41)	(4.12)	(3.94)	(4.13)
Control Group Mean	19.56	202.38	164.54	57.41	78.40
Observations	2650	2650	2650	2650	2650

Notes: The dependent variable both panels 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 and tending animals. For both **Panels A and B**, the propensity-score matched treatment effect is calculated using nearest neighbour matching on observations with identical propensity scores between treated (households with a LPG Connection) and control (households without a LPG Connection) group. 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. 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. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

Table 6: **Effect of 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
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

Notes: The dependent variable takes the 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 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
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

Notes: The dependent variable is the type of fuel used in cooking of 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 Treatment on Time Use of Primary Cook: Experimental Results**

Panel A: Domestic Work	(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)
p-value for $Treat_H = Treat_{H+S}$	-	0.089*
Sub-District FE	Yes	Yes
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)
p-value for $Treat_H = Treat_{H+S}$	-	0.634
Sub-District FE	Yes	Yes
Control Group Mean	165.922	165.922
R^2	0.096	0.096
N	2784	2784

Continued on next page

Table 8: **Effect of 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)
p-value for $Treat_H = Treat_{H+S}$	-	0.611
Sub-District FE	Yes	Yes
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)
p-value for $Treat_H = Treat_{H+S}$	-	0.158
Sub-District FE	Yes	Yes
Control Group Mean	606.527	606.527
R^2	0.107	0.108
N	2784	2784

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. 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 9: **Effect of Treatment on Domestic Work of Primary Cook: Experimental Results**

Panel A: 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)
p-value for $Treat_H = Treat_{H+S}$	-	0.124
Sub-District FE	Yes	Yes
Control Group Mean	197.756	197.756
R^2	0.073	0.074
N	2784	2784
Panel B: 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)
p-value for $Treat_H = Treat_{H+S}$	-	0.428
Sub-District FE	Yes	Yes
Control Group Mean	165.676	165.676
R^2	0.046	0.046
N	2784	2784

Continued on next page

Table 9: **Effect of Treatment on Domestic Work of Primary Cook: Experimental Results**

Panel C: 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)
p-value for $Treat_H = Treat_{H+S}$	-	0.272
Sub-District FE	Yes	Yes
Control Group Mean	60.984	60.984
R^2	0.184	0.185
N	2784	2784
Panel D: 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)
p-value for $Treat_H = Treat_{H+S}$	-	0.646
Sub-District FE	Yes	Yes
Control Group Mean	72.577	72.577
R^2	0.058	0.058
N	2784	2784

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. **H** denotes only health information and **H + S** refers to both health and subsidy information treatment arms, respectively. 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 *** $p<0.01$.

Appendices

Supplemental Material

Appendix. A Experiment 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.[27] 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 usage of LPG was

[27]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.

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 usage 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 (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.[28] 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 (H+S). 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%).[29]

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

[28]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.

[29]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. A.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.[30] Each surveyor had to enter a table, as 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.

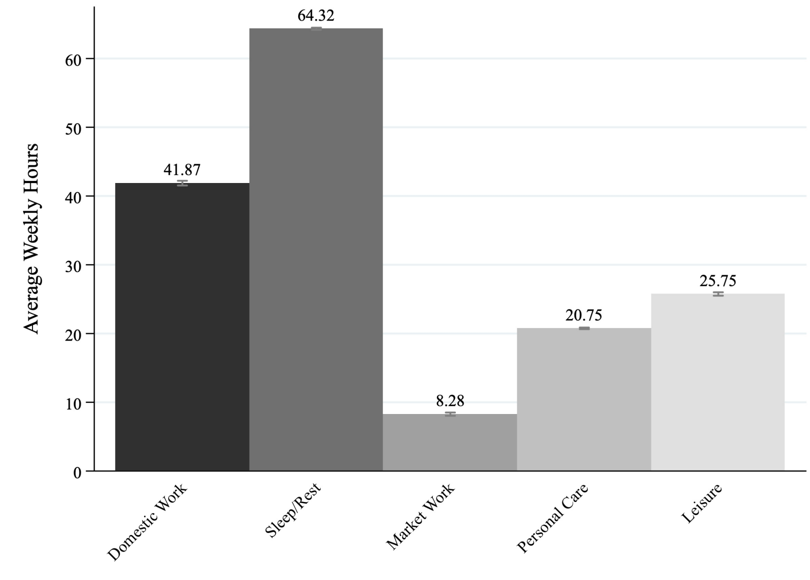
We classify the primary cook's time into five broad categories of activities (see Figure 1(a)). First, domestic work includes time spent on fuel and water collection, cooking, cleaning, shopping, tending animals and childcare as specified in Figure 1(b). Childcare further includes time spent on grooming 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.

[30]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.

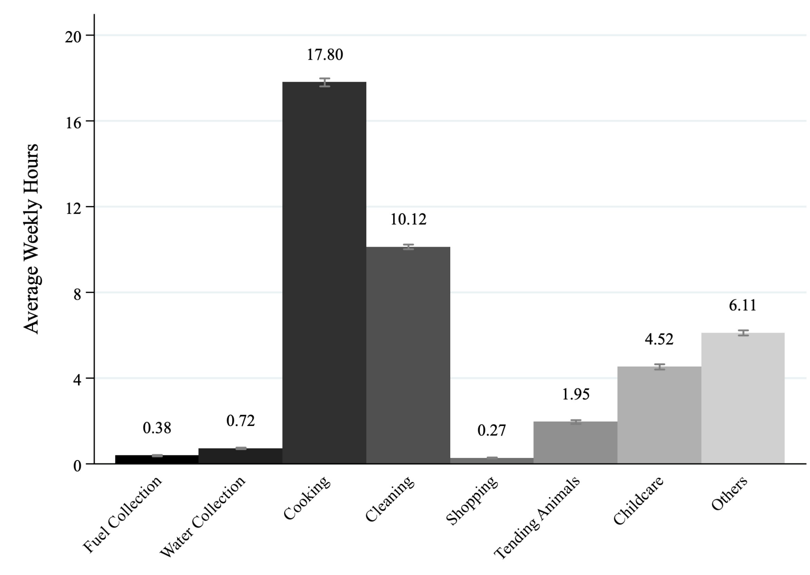
5 - 8 AM / 1 – 4 PM / 9 Pm – 12 am			8 – 11 AM / 4 – 7 PM / 12 – 3 am			11 – 1 PM / 7 – 9 PM / 3 – 5 am		
Time	**Code**	**Minutes**	**Time**	**Code**	**Minutes**	**Time**	**Code**	**Minutes**
5:00	05/04	75	8:15	02/03	90			
6:15	01/01	15						
6:30	01/03	30						
7:00	02/03	5						
7:05	01/02	10					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

Appendix. B Additional Figures and Tables

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



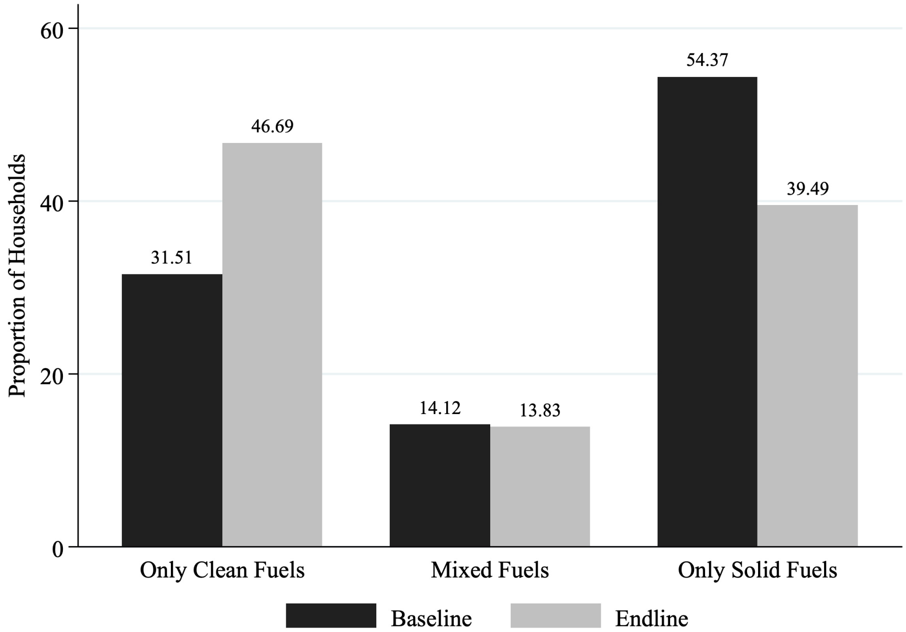
(a) Time spent on home production and other activities



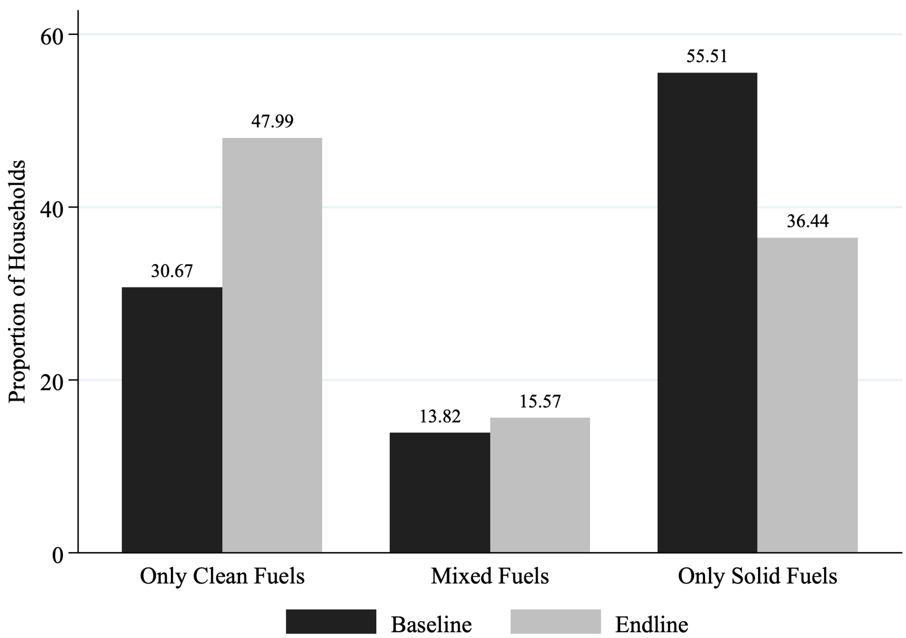
(b) Time spent on home production activities

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 sample is restricted to 31,291 females are 12-86 years old, live in the rural areas and the reported month of the survey is October-December (same as our sample survey). 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 B.2: **Fuel Use by Time of Cooking Last Meal: Experimental Sample**



(a) Morning (before 1 PM)



(b) Evening (at and after 1 PM)

Notes: Both figures record fuel usage in cooking for the 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). Out of all 2942 households, at baseline, 1,244 cook for the last meal in the morning and remaining 1,698 households cook in the evening. 'Only Clean Fuels', 'Mixed Fuels' and 'Only Solid Fuels' are defined in Table 2.

Table B.1: Average Weekly Hours for Time Use (at Baseline)

	Mean	Std. Error	Obs.
Total Weekly Hours			
Domestic Work	60.624	19.032	2942
Personal Care	17.958	5.929	2942
Market Work	19.343	23.455	2942
Leisure	9.875	11.656	2942
Sleep	59.950	14.066	2942
Other	0.251	3.376	2942
Share of Total Weekly Hours			
Domestic Work	0.361	0.113	2942
Personal Care	0.107	0.035	2942
Market Work	0.115	0.140	2942
Leisure	0.059	0.069	2942
Sleep	0.357	0.084	2942
Other	0.001	0.020	2942

Notes: The table displays average weekly hours spent by the primary cooks (PC) in different activities at baseline. The sample is restricted to households where total time spent by the PC equals 24 hours. 'Domestic work' includes time spent on childcare. 'Others' includes time spent on attending school or college and self-study or homework. The shares in panel B is calculated as a proportion of total 168 hours in a week.

Table B.2: Average Weekly Hours of Domestic Work (at Baseline)

	Mean	Std. Error	Obs.
Total Weekly Hours	60.624	19.032	2942
Cooking	23.556	7.463	2942
Cleaning	19.779	9.171	2942
Fuel Collection	1.544	5.714	2942
Childcare	7.043	8.849	2942
Water Collection	3.412	4.556	2942
Shopping	0.156	1.818	2942
Tending Animals	4.682	6.961	2942
Others	0.452	3.145	2942
Share of Total Domestic Weekly Hours			
Cooking	0.411	0.137	2942
Cleaning	0.329	0.123	2942
Fuel Collection	0.021	0.072	2942
Childcare	0.103	0.121	2942
Water Collection	0.057	0.076	2942
Shopping	0.002	0.024	2942
Tending Animals	0.071	0.102	2942
Others	0.006	0.037	2942

Notes: The table shows average weekly hours spent by the primary cooks (PC) on domestic work at baseline. The sample is restricted to households where total time spent by the PC equals 24 hours. The shares in Panel B are calculated as a proportion of time spent in domestic work.

Table B.3: Covariate Balance Pre-matching

	(1) LPG	(2) Non-LPG	(3) Diff.
Household Size	6.290	5.896	0.394***
	(0.065)	(0.083)	
Household Head Education above Primary	0.417	0.380	0.037*
	(0.014)	(0.018)	
Household Head is Self-Employed/Salaried	0.516	0.505	0.012
	(0.014)	(0.019)	
Primary Cook's Education above Primary	0.383	0.308	0.075***
	(0.014)	(0.018)	
Primary Cook's Age	33.863	33.904	-0.041
	(0.308)	(0.443)	
Non-Hindu	0.060	0.116	-0.056***
	(0.014)	(0.025)	
SC/ST	0.431	0.354	0.077***
	(0.020)	(0.026)	
Household Wealth Index	1.645	1.420	0.226***
	(0.025)	(0.034)	
Private Primary School	0.329	0.295	0.034
	(0.040)	(0.040)	
Proportion of Irrigated Land	0.587	0.587	-0.001
	(0.021)	(0.023)	
All Weather Road	0.800	0.753	0.047**
	(0.033)	(0.040)	
Primary Health Sub-Centre	0.292	0.236	0.056**
	(0.039)	(0.036)	
Distance to Sub-District Headquaters (km)	19.462	20.070	-0.608
	(0.734)	(0.800)	
One Room in the House	0.110	0.196	-0.087***
	(0.009)	(0.016)	
Own or Lease Land	0.538	0.574	-0.036
	(0.017)	(0.023)	
Household with Disabled Member	0.308	0.289	0.020
	(0.012)	(0.017)	
Atleast One Adult in the Household	0.997	0.991	0.006*
	(0.001)	(0.003)	
Female Headed w/o Male Adults	0.006	0.012	-0.006
	(0.002)	(0.003)	
Kucha Roof	0.115	0.145	-0.029*
	(0.013)	(0.019)	
Kucha Wall	0.173	0.266	-0.093***
	(0.013)	(0.021)	
Observations	1,975	967	2,942

Notes: The table shows the mean of covariates before propensity score matching. Column 3 records the difference between columns 1 and 2. Standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

Table B.4: Covariate Balance Post-matching

	(1) LPG	(2) Non-LPG	(3) Diff.
Household Size	6.290	6.159	0.130
	(0.065)	(0.112)	
Household Head Education above Primary	0.417	0.413	0.004
	(0.014)	(0.028)	
Household Head is Self-Employed/Salaried	0.516	0.515	0.001
	(0.014)	(0.029)	
Primary Cook's Education above Primary	0.383	0.405	-0.022
	(0.014)	(0.027)	
Primary Cook's Age	33.863	33.076	0.786
	(0.308)	(0.618)	
Non-Hindu	0.060	0.064	-0.004
	(0.014)	(0.016)	
SC/ST	0.431	0.436	-0.006
	(0.020)	(0.030)	
Household Wealth Index	1.645	1.640	0.005
	(0.025)	(0.044)	
Private Primary School	0.329	0.342	-0.014
	(0.040)	(0.046)	
Proportion of Irrigated Land	0.587	0.581	0.005
	(0.021)	(0.025)	
All Weather Road	0.800	0.784	0.016
	(0.033)	(0.039)	
Primary Health Sub-Centre	0.292	0.304	-0.012
	(0.039)	(0.045)	
Distance to Sub-District Headquaters (km)	19.462	19.606	-0.144
	(0.734)	(0.856)	
One Room in the House	0.110	0.113	-0.004
	(0.009)	(0.016)	
Own or Lease Land	0.538	0.518	0.020
	(0.017)	(0.034)	
Household with Disabled Member	0.308	0.289	0.019
	(0.012)	(0.023)	
Atleast One Adult in the Household	0.997	0.996	0.001
	(0.001)	(0.002)	
Female Headed w/o Male Adults	0.006	0.005	0.002
	(0.002)	(0.002)	
Kucha Roof	0.115	0.115	0.001
	(0.013)	(0.019)	
Kucha Wall	0.173	0.161	0.012
	(0.013)	(0.018)	
Observations	1,975	675	2,650

Notes: The table shows mean of covariates after propensity score matching by LPG connection at baseline. Column 3 is the difference between columns 1 and 2. The sample excludes unmatched households after propensity score matching. Standard errors, clustered at the village level, are reported in parentheses. * $p<0.10$, ** $p<0.05$ and *** $p<0.01$.

Table B.5: 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 B.6: 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 B.7: Balance of Household Fuel Consumption 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)
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 B.8: 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 *** $p<0.01$.