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A breath of fresh air: Raising awareness for clean fuel adoption☆

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ABSTRACT

Air pollution is amongst the gravest public health concerns worldwide, and indoor sources are the largest contributors in many developing countries. In our study in central India, we randomly assigned villages to a campaign by rural public health workers to either raise awareness about the adverse health effects of smoke from cooking with solid fuels and measures to mitigate them, or combined health awareness with information on the universal cash-back LPG (liquid petroleum gas) subsidy program or a control group in which neither information is provided. Using LPG sales records, we find an insignificant effect of the campaign on the purchase of LPG refills when measured at annual frequency. However, there was an almost 13% rise in refill consumption per month in the combined treatment, accounting for seasonality, monthly price variation and unobserved sub-district heterogeneity. Self-reported electric stove use rose by almost 50%, over the baseline mean of 6%, and the probability that the household had an outlet for smoke or separate kitchen increased by about 5 percentage points due to the treatment. There was no decline in use of solid fuels at the extensive margin, but the intensity of usage fell on some measures. The findings highlight the salience of financial constraints and the importance of the design of public subsidy schemes in inducing regular usage of clean fuels.

1. Introduction

Air pollution levels in households that cook with solid fuels, such as firewood, are high and skyrocket during meal preparations. Fig. A.1 in Appendix. A shows the level of PM2.5 pollutants during a typical day in a rural household in northern India.[1] While the World Health Organization's guideline for 24-h average exposure to PM2.5 is 25 μg/m^3, it rises to as much as 1000 μg/m^3 during meal preparations in these households – 40 times greater than the safe limit. Not surprisingly, air pollution is one of the gravest public health concerns, not only in developing countries but across the world (Cohen et al., 2017). Household sources from the burning of fuels such as wood and cow-dung, however, are the single largest contributor to air pollution in much of the developing world (Liu et al., 2016; GBD-MAPS, 2018).

Our study builds on a novel program launched by the Government of India in 2016 to provide households with subsidized access to a clean cooking fuel – bottled liquid petroleum gas (LPG). While the program has been a huge success, with more than 72 million households gaining access by June 2019, the average annual usage of LPG by the existing and newly connected rural households remains less than half of what is thought to be needed to eliminate solid fuel use.[2] One reason for the low usage of LPG, of course, is poverty in developing countries. Although

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[1] p.m.2.5 refers to atmospheric particulate matters (PM) that have a diameter of less than 2.5 μm. Major components of PM are sulfates, nitrates, ammonia, sodium chloride, black carbon, mineral dust, and water.

[2] More information can be found at http://www.pmujjwalayojana.com/.

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LPG is subsidized in India, the cost can still be considerable for poor households. Moreover, often rural households are either unaware of the government's cash-back scheme on LPG purchases or do not understand the extent of the subsidy they receive on refills. In addition, and irrespective of income, there is low awareness of the long-term health hazards of solid fuel combustion.[3]

We conducted a cluster-randomized control trial in 150 villages in the district of Indore in Madhya Pradesh during 2018-19. It aimed to increase awareness about the health hazards of cooking with solid fuels and the universal financial subsidy scheme for LPG. The intervention had two treatment arms: one in which awareness about and measures to mitigate the adverse health effects of cooking with solid fuels was provided to household members, and a second which, in addition to health awareness, explained the existing cash-back payment deposited directly to consumers' bank accounts by the government after they purchase a refill of LPG at market price. No awareness campaign was conducted in a third group of villages - the control group.

Comparing annual LPG consumption by households in our sample, before and after the intervention and relative to the control group, we find that providing information on either the health hazards of using solid fuels or both health and the existing LPG subsidy led to an insignificant increase in annual LPG refill consumption. However, in the combined (health-plus-subsidy information) treatment arm, households with a head who had completed less than primary schooling increased annual refill consumption significantly by 10–12%, compared to those whose head was primary educated (or more). These households are more likely to be the ones that need to be informed about the health hazards of indoor air pollution and the implications of the cash-back subsidy.

When we analyze LPG consumption at monthly (rather than annual) frequency, additionally controlling for seasonality in fuel usage and internationally determined LPG refill prices, we again find insignificant impacts. However, in our preferred specification that allows for unobserved heterogeneity in campaign implementation across sub-districts, we find an 8.6% increase in refill consumption due to the overall treatment. This result is driven by a 12.5% rise in monthly refill consumption in the combined treatment. Further, the usage of electric or induction stoves for cooking increased significantly by 45–50% and 58.3–63.3% from baseline average usage of 6% in the overall and combined health and subsidy awareness treatment, respectively, suggesting substitution towards a clean fuel which is relatively cheaper than LPG.

Although health information alone did not increase consumption of LPG refills, it led to significant behavioral changes that can reduce the inhalation of indoor smoke - households were 5 percentage points (pp) more likely to have an outlet for smoke from traditional stoves (also due to treatment overall and in combined arm) and/or use a separate room as a kitchen (also overall treatment), compared to the control group that did not receive any information. The probability that households used only traditional cooking stoves to prepare the last meal decreased marginally by 5 pp in the health information-only treatment. There was an insignificant decline in firewood or dung use (extensive margin measure) in the preceding month, but the usage of clean fuels in preparing the last meal (intensive margin measure) rose in all treatment arms.

Using LPG regularly for cooking instead of freely available wood and cow dung presents significant financial challenges for poor households. The fact that our results suggest effects on LPG refill purchase and induction cooking (smaller for former) in the group that received both the health and subsidy information underlines the salience of the financial constraints that households face, since both fuels require the household to incur either fixed or recurring expenses or both – subsidy awareness loosened budget constraints. Besides, the response in the health information-only treatment suggests that households adjust on the margin of reducing smoke inhalation when they are financially constrained in shifting to a cleaner fuel.

This is the first study to measure the extent to which awareness impacts mitigating behavior in the case of air pollution. Our findings have implications for clean fuel adoption well beyond India's LPG program as several countries in South Asia and Africa expand their electricity networks, bringing the possibility of electric cooking with induction stoves to hundreds of millions of people. Our second innovation is that our awareness campaign was embedded within the rural public health system. We trained existing frontline public health workers in villages to conduct a door-to-door campaign by making up to six visits to 20 randomly sampled households in the treatment villages over a nine-month intervention period. These workers were incentivized financially in a manner and at a rate that is comparable to their existing remuneration. Our experimental intervention is, therefore, not just potentially scalable but is also replicable in other contexts.

Furthermore, self-reported outcomes could be biased by yea-saying, as may have been the case in Davis et al. (2011), but the extent of the bias is not clear. Our main outcome variables, i.e., consumption of LPG, is independent of such biases as we verify self-reports of new LPG accounts, and self-reports of cylinder refill purchases, using administrative LPG sales data from India's public oil marketing companies. Our findings can also speak to the growing literature on measuring households' willingness to pay for health and how much it depends on households' awareness (Somanathan, 2010; Kremer et al., 2011; Greenstone and Jack, 2015). Even though we do not directly measure the value of clean air to households, our study may be the first to offer some insight on the effect of health awareness about household air pollution on fuel choice and fuel expenditure in a country which had 22 of the world's 30 most air-polluted cities in 2018.[4]

Cooking with solid fuels contributed to ambient air pollution in the now developed countries in the last century, as exemplified by the infamous London fogs. The developed world cleaned up by switching to gas and electricity instead of coal and wood for cooking and heating (Freese, 2006). However, gas and electricity require considerable infrastructure as well as recurring expenditures by households. Both these requirements were thought to be too demanding for much of the developing world, especially the poorer countries of sub-Saharan Africa and South Asia. As a result, there have been many attempts to promote improved solid-fuel cookstoves starting in the 1970s and 1980s. These technologies have, by and large, failed to reduce household air pollution for a variety of reasons — they have low adoption rates (Venkataraman et al., 2010), low usage rates when adopted (Hanna et al., 2016; Sambandam et al., 2015; Venkataraman et al., 2010), and are not sufficiently effective even when used (Venkataraman et al., 2010; Sambandam et al., 2015). Our study, in contrast, emphasizes the adoption and regular

[3] WHO estimates that 3.8 million premature deaths were attributable to household air pollution in 2016, mostly in low and middle-income countries. Furthermore, according to the American Heart Association, "exposure to PM2.5 over a few hours to weeks can trigger cardiovascular disease-related mortality and nonfatal events; longer-term exposure (e.g., a few years) increases the risk of cardiovascular mortality to an even greater extent than exposures over a few days and reduces life expectancy within more highly exposed segments of the population by several months to a few years." While PM10 particles can penetrate and lodge deep inside the lungs, PM2.5, being far smaller, can enter the blood system and contribute to the risk of developing respiratory diseases, including lung cancer, besides cardiovascular diseases. Our baseline survey revealed that 87% of the sampled households were unaware of the serious long-term risks to their own or other household members' health.

[4] The 2018 ranking of world's most polluted cities by IQAir is available at https://www.airvisual.com/world-most-polluted-cities?continent=&country=&state=&page=1 &perPage = 50&cities = .

usage of a clean fuel for cooking.[5]

The literature in economics on the effects of improving awareness about the health effects of pollution on the demand for pollution mitigation began with work on water quality and has shown mixed results. The earliest studies (Madajewicz et al., 2007; Jalan and Somanathan, 2008) found substantial effects of information on mitigating behavior following the provision of personalized information to recipients. Madajewicz et al. (2007) shows that in Bangladesh, people who were unknowingly using arsenic-contaminated wells (assumed to be randomly distributed) were more likely to switch to a safer source of water if the well was marked unsafe compared to people who were using an unmarked well. Jalan and Somanathan (2008) was a cluster RCT in an Indian city that provided test results of household water quality and found that it increased within-home water purification.

Subsequent research on this issue has also mostly been in the area of water and sanitation (Guiteras et al., 2016; Bennett et al., 2018; Davis et al., 2011). Guiteras et al. (2016), however, find no impact of health information on household water chlorination and hand-washing in their RCT in slums in Bangladesh even when additional cues meant to trigger disgust and shame were added to the provision of information. Bennett et al. (2018) find effects on behavior and anthropometrics of hygiene information in an RCT in rural Pakistan only when visual details on bacteria were part of the informational package. Davis et al. (2011) in an RCT in peri-urban Tanzania show that information increased self-reports of hygiene behaviors but did not reduce the contamination of stored water.

From a policy perspective, our results indicate complementarity between improving health awareness and loosening financial constraints. Poor households may not transition to regular usage of clean fuels even if they are aware of the long-term damage caused to their health by indoor air pollution. More specifically, our findings underline the importance of public subsidy design for clean fuels, both in terms of comprehension and timing. Households that were able to comprehend the cash-back nature of the LPG subsidy internalized the information that their out-of-pocket expenditure is lower than the market price they pay upfront. Thus, intimation of subsidy deposits through text messages in local languages is relevant. More importantly, depositing the subsidy amount upfront into the accounts of beneficiary households could substantively reduce the financial burden on liquidity and credit-constrained households and increase LPG take-up further.

The remainder of the paper is organized as follows. In Section 2, we discuss the existing market for bottled LPG for cooking in India. In Section 3, we outline our sampling strategy, the experiment design and the data. We elaborate on our estimation methodology and results in Section 4. Section 5 discusses the findings and the policy implications and we conclude in Section 6.

2. Background

To buy subsidized LPG, Indian consumers must obtain a "connection" — register with one of the three state-owned oil marketing companies (OMCs) that are the only suppliers of LPG. A consumer has to pay a connection (henceforth, account) charge, a deposit for a cylinder and pressure regulator, and purchase a rubber pipe at any OMC's local distributor or "dealer". This is an upfront cost of about 3200 rupees (45 USD), which could easily be two weeks' worth of monthly household income in rural areas.[6] Since 2013 all residential LPG consumers in India, irrespective of income, receive a so-called 'direct benefit transfer' (DBT) or subsidy for up to 12 cylinder refills in a year.[7] This means that when a consumer with an LPG account buys a refill cylinder, she pays the market price to the dealer and the subsidy is credited to her bank account as cash-back within the next 2–3 days. The market price of a cylinder varied between 654 and 879 rupees during November 2017 to October 2018 in tandem with the price of imported liquefied natural gas. The government has kept the subsidized price very stable at around 500 rupees so that the corresponding subsidy delivered by DBT varied between 159 and 376 rupees during this period.[8]

To expand access to LPG, the Government of India launched the Pradhan Mantri Ujjwala Yojana (PMUY) in April 2016.[9] The PMUY is the largest program on access to clean fuel in India's history and worldwide, reaching 72 million low-income families between April 2016 and June 2019. The program mandates that a woman in a rural, socio-economically disadvantaged household, obtaining an LPG account (giving a right to buy subsidized gas) bears no upfront cost. The security deposit and administrative charges for an LPG account, in total about USD 25, are borne by the government. The woman also receives an

[5] The inconvenience and extra time needed for changes to household health technology (e.g. bed nets, improved bio-mass stoves, and hygiene practices) is one of the biggest barriers to their adoption (Thurber et al., 2013; Dupas, 2011). By contrast, LPG and induction are much more convenient than a biomass cook stove, in terms of time savings, ease of use, and reduction in eye and lung irritation. This makes switching to LPG as a preventive health technology different from those that entail adoption costs.

[6] "Connection" is the official term that refers to registration for obtaining the pressure regulator and consumer booklet along with the first cylinder. A connection entitles the consumer to the LPG subsidy. To register for an LPG account, a consumer must provide proof of identity and address and submit a security deposit equivalent to 25 USD. The security deposit is for the empty 14.2 kg capacity cylinder plus the pressure regulator. The consumer has to pay the market price separately for the gas in the cylinder (10 USD) and a stove (10 USD). While the stove can be purchased in the open market, the regulator and refill cylinders are supplied only by the OMCs through their dealers. The pressure regulator has to be returned by the consumer (along with an empty cylinder) to recover the deposit. Note that the average rural household income was approximately 7215 rupees (100 USD) per month in 2011, the latest year for which these estimates are available (Desai et al., 2011).

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

[8] All registered consumers are assigned a unique consumer number and a booklet that records, among other details, the date of opening the LPG account, LPG dealer, and purchase of every LPG refill. Consumers can purchase refills from the OMC-approved dealers serving their village. A consumer with an LPG account can obtain a cylinder refill by first booking one through a phone call to her local dealer. Typically, the local dealer delivers booked refills in exchange for empty cylinders by mini trucks within a week of booking. All OMCs sell LPG accounts and cylinder refills at similar (government regulated but internationally determined) market price. To elaborate on how the DBT functions, if the market price of an LPG cylinder is 820 rupees, the consumer pays this amount to the LPG dealer at the time of delivery. The dealer enters the refill purchase against the consumer's ID in a centralized database. The subsidy amount of 320 rupees is then directly deposited into the consumer's linked bank account within 2–3 days of purchase. Since the shift to the DBT system in 2013, corruption through leakages in the LPG subsidy or false reporting of refills is greatly reduced Barnwal (2016).

[9] This translates as Prime Minister's Brightening Program.

interest-free loan of USD 20 from the OMC to purchase the stove and the first cylinder.[10] The program has positioned itself as an initiative that empowers rural women and, therefore, does not emphasize health (or financial subsidy) awareness. While it has been successful in significantly improving rural households' access to LPG for cooking, the PMUY program is yet to ensure an increase in LPG usage.[11]

Nationwide, an estimated 79% of the households had an LPG account in 2018 (PPAC Report, 2018).[12] We focus on rural India since LPG use is much lower than in urban areas with the former having a mean annual consumption of about four cylinders and the latter about eight.[13] There are several factors, in addition to income, that are important in explaining the low demand for LPG in rural India. In forested areas, easy access to firewood reduces demand for LPG. Habit, familiarity, and custom can lead to a preference for traditional fuels even in areas that do not have freely available firewood (Gupta et al., 2020; Aklin et al., 2015) and LPG costs less than buying firewood from the market (e.g., monthly firewood purchase for a family of 4–5 members is approximately 500–800 rupees).

Furthermore, many rural households lack awareness of the subsidy on LPG because of its complex design (see Data section for details). The cash-back subsidy is deposited in a linked bank account that consumers may not monitor often. Text messages to registered phones intimating customers about the transfer to their bank account are in English and not the local language (e.g., Hindi, in north India). Physical or remote access to bank account information on fund availability is limited, particularly for women. Both features of the subsidy scheme - variation in subsidy amount and cash-back - suggest that uneducated and liquidity-constrained consumers may not be able to either comprehend or take advantage of the subsidy. Finally, lack of awareness of the health consequences may cause rural households to continue using solid fuels even if they can afford LPG.

3. Experiment design and data

3.1. Sampling

We implemented a cluster-RCT 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. Over 60% of households (rural and urban) had an LPG account in January 2018 (PPAC Report, 2018) in MP. Indore, being the commercial hub with the highest per capita income amongst all districts in MP, is less likely to be subject to supply-side constraints on households' LPG access. The location is, therefore, suitable for examining factors limiting household demand for clean fuels.

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.[14] In the sampled village, a household was deemed eligible 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. 20 eligible households were randomly sampled in each of these villages by systematic random sampling during the baseline survey.[15]

The RCT design included three arms - (1) health awareness **(H)** (2) health and financial subsidy awareness **(H + S)** (3) no awareness campaign or the control group **(C)**. The 150 villages were randomly assigned to one of the three arms 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). Throughout, we report the Average Treatment Effect on the Treated (ATT) as our main analysis with the original 50 villages assigned to the control group and the 46 villages that received the treatment in each of the two treatment arms, as per our original pre-analysis plan.[16]

Fig. 1 shows the geographical spread of the sampled villages, by treatment status, across the district of Indore. Note that the average distance between the centroids of any two nearest neighboring villages in our sample was 1.5 km.

3.2. Information campaign

Table 1 shows the timeline of the study. The baseline survey was conducted between 1st November - 22nd December 2018. Households in the sample were asked whether they currently have an LPG account or not. If they did, details of the account, including the unique consumer ID, number of refills in the past year, were recorded from their consumer booklets accompanied by photographs of the consumer details and refills in the booklet. Detailed information on household composition, fuel use, and collection, health awareness, primary cook's time use, and wellbeing were gathered for all households irrespective of whether they had an LPG account or not. Appendix B contains the English translation of the Hindi baseline questionnaire.

Following the baseline, in January 2019, the intervention to increase adoption and regular usage of LPG was initiated for nine months, until September 2019. Specifically, we designed 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 — (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

[10] Initially, this loan was to be recovered by paying cash-back refill subsidy to the OMC instead of the customer till the principal was paid back in full. But since April 2018, the government has stopped withholding the DBT to the bank accounts of the PMUY beneficiaries to encourage them to increase LPG consumption.

[11] A newspaper article covering the story can be found at https://www.downtoearth.org.in/news/energy/govt-admits-refilling-lpg-cylinders-under-ujjwala-a-challenge-plans-a-new-scheme-63835.

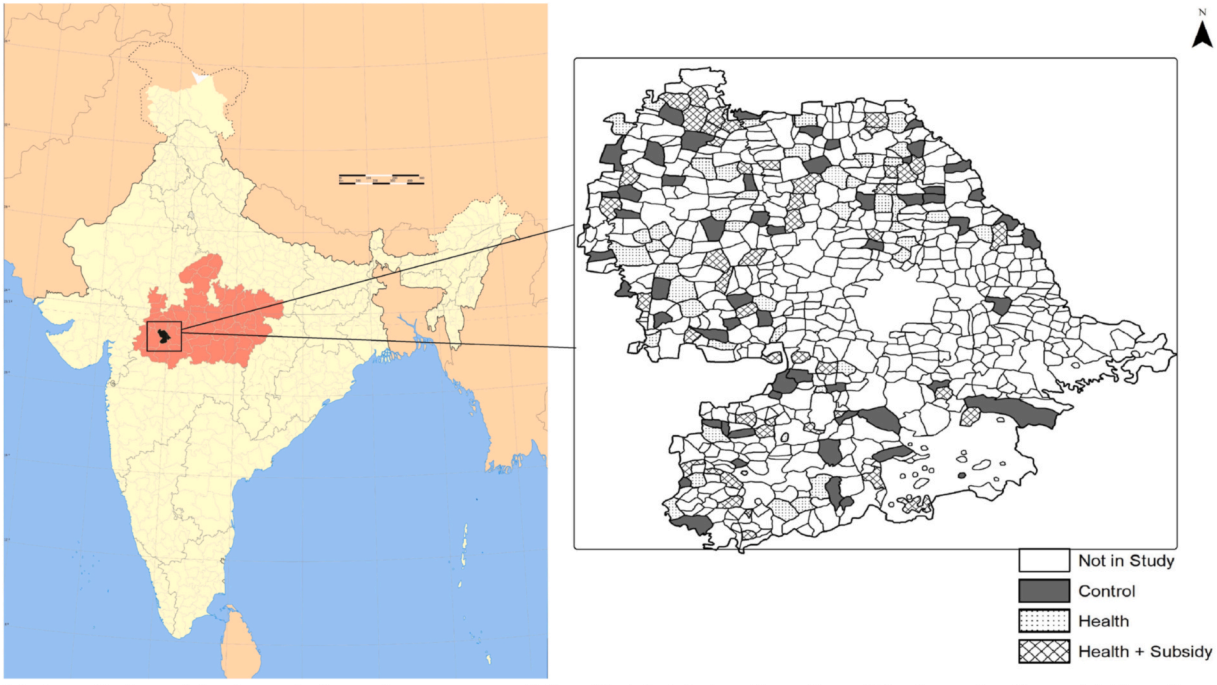
[12] Data from Census (2011b) reveals that 28.5% of households in India had access to LPG with 65% coverage in urban areas and only 11 percent coverage in rural areas. However, since the launch of PMUY in 2016, access in rural areas has gone up significantly but with large geographical variation - north India (e.g., 44% coverage in Jharkhand) continues to lag behind the south (e.g., 100% coverage in Kerala).

[13] Since LPG sales data are not available publicly; these figures are based on authors' estimates from data shared by OMCs for the study area and media reports (https://www.thehindubusinessline.com/economy/ujjwala-connections-get-three-refills-annually-on-an-average/article25798623.ece).

[14] The lowest level of local government in India is the *Gram Panchayat* or village council, typically consisting of 2–3 villages. 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.

[15] Following this sampling procedure, first, an estimate of the total number of households (N) in the village was obtained by the survey team. Then, every N/20th household, starting from the center of the village and moving in a clockwise direction to come back to the starting point, was selected for the survey.

[16] Later, in Appendix A we also report Intention to Treat (ITT) estimates using the original treatment assignment.



Notes: Indore block and the urban areas of the district (viz. the city of Indore, in the middle of the district) were not part of the study. The southern part of the district has few habitations due to significant forest cover.

Fig. 1. Map of study area by treatment status of villages.

Table 1
Timeline of the study.

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

Notes: The survey covered the rural areas in the district of Indore. 54 households could not be reinterviewed at endline. Three additional households, that split at endline, are included separately.

completed at least 10th grade, were between 25 and 45 years of age, and were employed by the state government to provide public health services.[17]

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. The ASHA training manuals, translated from Hindi into English, are included in Appendix C.

During the training, ASHAs were first made aware of the adverse health impacts of solid fuels, including a list of diseases, their symptoms, and consequences. They were then provided with hand-held tablets with videos, a campaign manual, and detailed written scripts to follow for up to six household visits. The visits were scheduled for the first 15 days of January, February, March, and June, and the last 15 days of August and September. The frequency of these visits was higher during the winter season when solid fuel usage is usually high and lower during the rainy season when households may anyway use LPG more often due to the non-availability of dry wood.

The information provided in the health treatment arm (H) centered around the adverse health effects of household air pollution on all household members, emphasizing children and older adults who are more susceptible to respiratory and cardiovascular diseases. The campaign included three customized videos that depicted a typical rural household whose kitchen is in a common room in the house, making the primary cook and all household members susceptible to inhaling smoke. A licensed medical doctor then talks about long-term health impacts of indoor smoke, such as low birth weight, asthma, cardiovascular disease, and lung cancer. Each video focused on a different set of diseases, with the doctor advising them to stop using wood and other solid fuels and switch entirely to LPG. Most importantly, every video ends with the doctor advising the household to ensure an outlet for smoke from the traditional cookstove (*chulha*) and to use an induction (electric) stove for cooking if the household is unable to obtain an LPG refill. In a fourth video made of comic strips, we narrated a story in which the main characters (a new bride and her mother-in-law) had conflicting views about using LPG, again aimed primarily at emphasizing the adverse health impacts of traditional, solid fuels.[18] Each video was approximately 2 min long.

In the health and financial subsidy treatment arm (H + S), besides

[17] Usually, there is one ASHA per village. The guidelines framed by the National Rural Health Mission allow for 43 different tasks for ASHAs relating to, for example, immunization, antenatal care, institutional delivery, and family planning. There is a specific remuneration set for each task. The maximum they can earn for an activity is 5000 rupees for administering medicines to drug-resistant tuberculosis patients to just one rupee for distributing an ORS (oral rehydration solution) packet. Hence their monthly remuneration is directly dependent on their activities in that month. In our intervention, ASHAs were paid 50 rupees per visit per household.

[18] We are grateful to David Levine for sharing the material for this story with us.

the health awareness training to ASHAs, details of the cash-back design of the LPG subsidy program were also described. This included an explanation of the DBT to the beneficiary bank account on each purchase of up to 12 cylinders per year per consumer by the government and its intimation through text messages.[19] The bottom line is that households were to be made aware that their effective out-of-pocket expenditure was no more than Rs. 20 per day in a month if they consumed one 14.2 kg LPG cylinder per month (or approximately 500 rupees per month, post-subsidy), the typical requirement of a family of 4–5 members if it cooks exclusively on LPG. Thus the H + S treatment arm provided the same health information plus the LPG subsidy details.

The treatment group ASHAs were given a scripted task for each of the six household visits, including instructions on which video(s) to show during each visit and what conversations/discussions to have with the sampled households. The four videos were shown in the first three household visits, while the remaining three visits reinforce the message with no new information. ASHAs were instructed to visit the households when both the household head and the primary cook were available. The ASHAs in the control group villages were not contacted by the research team.[20]

Following the completion of the intervention, the endline survey was conducted between 24th October and 31st December 2019. Thus the households surveyed in the baseline were revisited during the same season approximately a year later. Only 54 of the 3000 households could not be re-interviewed at endline; hence attrition is negligible (1.8%).[21]

3.3. Data

Our baseline survey shows that even if households have an LPG account, they frequently use solid fuels. As high as 75% and 88% of all households reported using firewood and dung-cakes for cooking, even though 74% of the sample had also used LPG in the previous month.

To validate our premise that low awareness of the long-term adverse health effects of solid fuels is pervasive in rural India, we asked the respondents whether they thought there were any health effects of indoor smoke. Only 13% of the respondents stated that there could be long-term health effects of inhaling smoke from solid fuels. 70% of the households expected only short-term health impacts that cause temporary discomfort and have no long-term implications.[22] The low health awareness is accompanied by misinformation about the subsidy scheme. Conditional on having an LPG account, almost 33% of sampled households disagreed with the statement that the government deposits a subsidy in their bank account after they purchase an LPG cylinder and only 51% agreed that their out-of-pocket expenditure was less than the market price of an LPG refill. Over 32% of respondents believed that the refill subsidy is not universal and only PMUY customers are eligible to receive the subsidy.[23]

Table A.1 in Appendix A shows the balance at baseline between the three groups at the village and household level using data from the Census (2011a,b). The top panel reports the average village-level amenities, while the bottom panel shows the average household level amenities. We find no significant differences in educational and health facilities between groups. At the household-level, the proportion of households using firewood or LPG for cooking is comparable. There are no significant differences in ownership of other amenities such as toilets or tap water, which may reflect household health preferences. In Table 2, we show similar comparisons of household characteristics from our baseline survey data. Except for the pairwise difference in household head's education at 10% significance level, there are no differences in households' observable characteristics or perceptions regarding the effects of solid fuels and trust in ASHAs.

In Table 3 we report fuel usage of these sampled households. We do not find differences in usage and access to fuels between the three groups, except in the quantity of dung cakes purchased in the previous month at 5% significance level. Using the unique consumer ID we recorded from the LPG consumption booklet, we matched our sampled households to the OMCs' sales data and were able to verify the number of LPG refills purchased and the date of each purchase.[24] There are no significant differences in the number of LPG refills consumed by the household (approximately 3.2 cylinder refills in the previous 12 months), annually or per month across seasons, unconditional on having an LPG account. Overall, our baseline data suggest successful randomization into the three arms at the household and at the village level (Table A.1).[25]

4. Estimation methodology and results

4.1. Estimation methodology

Our first specification clubs exposure to the H (health awareness) or H + S (health + subsidy awareness) campaign into a single indicator of treatment status that takes value one if a household was exposed to either treatment and zero otherwise (control group). The OLS specification is thus:

$$Y^1_{iv} = \beta_c + \beta_T T_v + \beta_0 Y^0_{iv} + \beta'_X \mathbf{X}_{iv} + \beta'_Z \mathbf{Z}_v + \varepsilon_{iv}, \quad (1)$$

where Y^1_{iv} is the number of refills (or other outcomes) purchased by the ith household in village v at endline, i.e., between 1st February (month following the first ASHA visit in January 2019) and 31st December 2019 (approximately two months after the last ASHA visit in September 2019). Y^0_{iv} is the baseline number of refills (or other outcomes) purchased by the same household in the previous year (i.e., 1st Feb - 31st Dec 2018).[26] T_v is a dummy variable indicating whether village v is assigned to either treatment or not and $\mathbf{X}_{iv}$ are a set of baseline characteristics for household i in village v. These controls include household

[19] In the H + S arm, we also trained ASHA workers to register households' mobile phones with the OMCs, read the text messages confirming deposit of subsidies and provide information on obtaining refill LPG cylinders, if requested by the household.

[20] To prevent spillover of information to the control group, the ASHAs were given strict instructions to share the information only with the 20 sampled households in their village, and the tablets were not equipped with chips that would allow the videos to be easily shared. Moreover, since the work area of the ASHAs is restricted to their village, they are unlikely to extend their domain beyond and impinge upon another ASHA's work area.

[21] We ensured compliance with treatment through regular monitoring of the ASHA workers' performance. Monitors appointed from the MPVHA and the project Research Assistant, conducted meetings within two weeks of the end of the designated period for household visits. During the monitoring process, the ASHA workers' tablets were checked for date and time stamps on the photographs taken during the household visits and phone calls were made to the sampled households to verify their interaction with the ASHA. Payments to ASHAs for each visit were released only after the entire monitoring process was complete.

[22] We also gave the household a list of nine diseases (in random order), six of which can be caused by indoor smoke (e.g., hypertension) and three which were not (e.g., anemia) and asked whether that disease/ailment can occur due to inhaling smoke from solid fuels or not. The proportion of households with all correct responses was low at 4%.

[23] The subsidy awareness questions were asked only at the endline.

[24] Self-reported LPG refill consumption is highly correlated (over 0.77) with OMC sales records.

[25] 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), 62 were unmatched with the OMC sales data and 52 attrited, giving us a total sample of 2729 households.

[26] We use administrative data on refill consumption as our main outcome of interest throughout the analysis. Note that the period of the consumption data, either from consumer booklets or self-reported, would vary by the date of interview of the household while the administrative records provide consumption information for all households for the same period.

Table 2
Balance of household characteristics at baseline.

	Control	*Treatment*		*Difference*		
	C	**H**	**H + S**	**C–H**	**C - (H + S)**	**H - (H + S)**
	(N = 982)	(N = 907)	(N = 902)			
	(1)	(2)	(3)	(4)	(5)	(6)
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-attrition 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 *** $p < 0.01$.

size and assets, education and primary occupation of the household head, education and age of the primary cook, indicators for household religion and caste.[27] 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.[28]

The main parameter of interest is β_T, which represents the impact of the awareness campaign (either H or H + S) on the consumption of LPG. Since the treatment status was randomly assigned to the sampled villages, households' exposure to treatment was entirely exogenous. Therefore, the OLS estimation of β_T from equation (1) is the average treatment effect on the treated (ATT) of the awareness program. If information improves LPG refill consumption (or other outcomes) then β_T should be significantly positive.

Our second specification distinguishes between the two types of treatments to estimate and compare the impact of the two arms on LPG uptake and other health seeking outcomes.

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

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. If the information on long-term health impacts of solid fuels alone increases LPG refills then β_T^h should be significantly positive. If the information on LPG subsidy enhances the health awareness treatment, i.e., the two treatments complement each other, then β_T^{hs} should be positive and significantly larger in magnitude than β_T^h. Standard errors in both equations (1) and (2) are clustered at the village level.

In a deviation from the pre-analysis plan, besides these control variables discussed above, we include sub-district fixed effects (FE) to account for the variation in the administration of the local health department under whom the ASHAs function, and which may have impacted the delivery of the intervention.

4.2. Overall results

Throughout this section, we first discuss ATT results based on the pre-analysis specification followed by the pre-analysis specification with sub-district fixed effects. Our main results are unconditional on households having an LPG account at baseline.

[27] 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 above primary education and zero otherwise.

[28] 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.

Table 3
Balance of household fuel consumption at baseline.

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

Notes: Sample is restricted to non-attrition 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 *** $p < 0.01$.

4.2.1. Annual refill consumption

Pre-results specifications: Columns 1 and 2 in Table 4 report the estimated coefficients from equations (1) and (2), respectively, for annual LPG consumption with all controls described in the previous section. The results show an insignificant positive effect of the overall intervention and each treatment arm.[29] As reported in the bottom panel of the table in column 2, the impact of the H + S treatment is not significantly different from that of H.

Table 4
Impact of information campaign on annual LPG refill consumption.

	non-FE		*FE*	
	(1)	(2)	(3)	(4)
Overall Treatment	0.065		0.093	
	(0.099)		(0.096)	
Treatment - H		0.002		0.015
		(0.114)		(0.115)
Treatment - H + S		0.130		0.175
		(0.119)		(0.114)
Baseline Refill Consumption	0.802***	0.802***	0.799***	0.799***
	(0.018)	(0.018)	(0.019)	(0.019)
Joint Significance of Treatments		[0.488]		[0.274]
H = H + S		[0.308]		[0.204]
Control Group Mean	3.12	3.12	3.12	3.12
R-Square	0.594	0.594	0.595	0.596
N	2729	2729	2729	2729

Notes: The dependent variable is annual consumption of LPG refills between 1 Feb 2019–31 Dec 2019. Correspondingly, baseline refill consumption refers to annual consumption of LPG refills between 1 Feb 2018–31 Dec 2018. The sample is restricted to villages which complied with the assigned treatment. Household level controls 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 household, household caste, household wealth index. Village level controls include - dummies for presence of pvt. primary school, access to health sub-centres, all weather road, proportion of irrigated land, and distance to block headquarter. *p* values of F-tests reported in square brackets. Sub-district fixed effects (FE) included in specified columns. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Pre-results specifications with sub-district FE: Columns 3 and 4 in Table 4 include sub-district fixed effects. Qualitatively the results do not change with these additional controls, although the point estimates are larger in magnitude.

These results also hold in the sample of households with an LPG account at baseline (see Table A.3, Appendix A). We report ITT estimates (following our original treatment assignment for all 150 villages irrespective of compliance) in Table A.4, which suggests 0.196 or 6.28% additional refills ($p < 0.10$) consumed annually in the H + S treatment, as shown in column 4, Table A.4.[30] We do not find any variation in impacts across seasons, as shown in Table A.6.[31]

4.2.2. Monthly refill consumption

Next, we analyze LPG refill consumption at monthly frequency for the same period since households make refill purchase decisions every month, and report the results in Table 5. This allows us to take into

[29] The mean difference-in-differences between the control and each treatment group is positive for H + S and negative for H, but insignificant, as shown in Table A.2, Appendix A.

[30] Using specifications (1) and (2), we estimated the impact of our intervention on (a) household having an LPG account and (b) a household using LPG for cooking at the endline, both unconditional on having an LPG account. We find insignificant impact of the treatments as shown in Table A.5, Appendix A.

[31] Using the past eight years of temperature and rainfall data for Indore from the Indian Meteorological Department, we define the period between 16th October to 15th March as cold, 16th March to 15th June as summer, and 16th June to 15th October as wet.

Table 5
Impact of information campaign on monthly LPG refill consumption.

	non-FE						*FE*					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Overall Treatment	0.016		0.016		−0.062		0.023*		0.024*		−0.052	
	(0.015)		(0.015)		(0.082)		(0.014)		(0.014)		(0.081)	
Treatment - H		0.007		0.007		−0.058		0.013		0.013		−0.051
		(0.017)		(0.017)		(0.097)		(0.017)		(0.017)		(0.096)
Treatment - H + S		0.025		0.026		−0.062		0.034**		0.035**		−0.047
		(0.018)		(0.018)		(0.101)		(0.017)		(0.017)		(0.100)
Market Price (in 2019)			−0.035***	−0.035***	−0.042***	−0.043***			−0.036***	−0.036***	−0.043***	−0.043***
			(0.006)	(0.006)	(0.008)	(0.008)			(0.006)	(0.006)	(0.008)	(0.008)
Market Price × Overall Treatment					0.011						0.011	
					(0.011)						(0.011)	
Market Price × H						0.009						0.009
						(0.014)						(0.013)
Market Price × H + S						0.013						0.012
						(0.014)						(0.014)
Baseline Refill Consumption	0.268***	0.268***	0.267***	0.267***	0.267***	0.267***	0.264***	0.264***	0.263***	0.263***	0.263***	0.263***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Joint Significance of Treatments		[0.376]		[0.352]		[0.768]		[0.131]		[0.115]		[0.831]
H = H + S		[0.341]		[0.316]		[0.966]		[0.260]		[0.230]		[0.970]
Control Group Mean	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
R-Square	0.080	0.080	0.081	0.081	0.081	0.081	0.083	0.083	0.084	0.084	0.084	0.084
N	30019	30019	30019	30019	30019	30019	30019	30019	30019	30019	30019	30019

Notes: The dependent variable is monthly consumption of LPG refills between 1 Feb 2019 and 31 Dec 2019. Baseline refill consumption refers to monthly consumption of LPG refills between 1 Feb 2018 till 31 Dec 2018. All controls included as mentioned in Table 4. The market price is of 14.2 kg LPG cylinder in hundreds of rupees in each month in 2019. p values of F-tests reported in square brackets. Standard errors, clustered at the village level, reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

account the observed variation in the market price of LPG refill across months, (which is determined by the international prices and hence exogenous to our sampled households) and the larger seasonal (vis-à-vis annual) variation in households refill consumption.

Pre-results specifications: We do not find any significant effect of treatment without price controls, with price controls or in the interaction model in columns 1–6. Note that the coefficient on the monthly price is significantly negative across all specifications, suggesting that higher prices dampen refill consumption despite the cash-back subsidy keeping the out-of-pocket expenditure more or less constant at 500 rupees per refill. This reinforces our claim that households may not be comprehending the subsidy scheme fully or are liquidity constrained or both.

Pre-results specifications with sub-district FE: When we additionally include sub-district fixed effects (columns 7–12), we find a significant increase of 0.023 ($p < 0.10$) refills per month due to the overall treatment and 0.034 ($p < 0.05$) refills per month due to the H + S treatment in columns 7 and 8, respectively. When we control for the market price of LPG in columns 9 and 10, our estimates are unchanged and signify an 8.6% and 12.5% increase in monthly LPG refill consumption due to the overall and H + S treatment, respectively. We do not find a significant effect of the treatments when interacted with the LPG price in columns 11–12.[32]

To summarize, we find insignificant or imprecise effects of the information campaign on LPG refill purchases when measured at an annual frequency of consumption in either treatment arm. However, the estimated impact of the overall treatment and the H + S treatment is significantly positive when refill consumption is measured at a monthly frequency in our preferred specification (with sub-district fixed effects). These results indicate the binding financial and liquidity constraints faced by low-income families in rural areas. They also suggest complementarity between health and financial information - health awareness alone may not be sufficient for raising clean fuel take-up significantly.

4.3. Heterogeneity

The above findings could vary with both demand-side factors, e.g., the economic status of households, education of the household head and decision-making abilities of the primary cook, as well as supply-side factors such as distance to the LPG dealer. We use specifications (1) and (2) to analyze heterogeneity in the impact of the treatment effects on annual LPG consumption in more detail in Tables 6 and 7.

4.3.1. Demand-side factors

A. Education

Pre-results specifications: The effect of exposure to the treatment might vary by the level of education of the head (and/or primary cook) of the household – less educated households are more likely to be unaware of both the health impacts and the design of the LPG subsidy. We, thus, interact the treatment indicator(s) in equations (1) and (2) with a dummy that equals one if the education level of the household head was above primary schooling at baseline and zero otherwise. Table 6, column 1, suggests that the more educated households purchased 0.306 ($p < 0.10$) fewer refills due to the treatment, as indicated by the interaction term. In column 2, the coefficient on H + S treatment is significantly positive at 0.309 ($p < 0.05$) but negative (−0.462, $p < 0.05$) when interacted with the household head's education. We find a similar, significantly negative coefficient on the interaction of the treatment dummy (both H and H + S) with the primary cook's education. These findings suggest that there was a significant improvement in the LPG take-up by less educated households, who are likely to have lower awareness, due to the combined treatment but none in more educated households. Indeed, we find that households whose heads had less than primary schooling were significantly less likely to respond correctly to our questions on awareness of the financial subsidy on LPG, relative to those whose heads had above primary education ($p < 0.01$).[33]

Pre-results specifications with sub-district FE: These results are held up in our preferred specification in columns 3–4, indicating a 10–12% increase in annual refill consumption in less educated households in the H + S treatment arm.

B. Wealth and primary cook's bargaining power

As discussed previously, the consumption of LPG refills is subsidized in India. Consumers pay the market price, and the subsidy is directly credited to their bank accounts. As a result, the market price is higher than the out-of-pocket price. This difference can be substantial for economically disadvantaged and liquidity-constrained consumers. The awareness campaign on the LPG subsidy can have more impact on them. To measure this heterogeneity in treatment effects by household wealth, we interact the treatment indicator(s) in equations (1) and (2) with the asset index of the household at baseline.

Pre-results specifications: Table 6, columns 5–6 show a negative, although insignificant, coefficient on the interaction terms, suggesting that treatment effects did not vary by household wealth. In columns 9–10, we also interact the treatment indicators with an index of the primary cook's (PC) decision-making power.[34] The coefficient on the interaction term is insignificant throughout.

Pre-results specifications with sub-district FE: The results are consistent in our preferred specification with sub-district fixed effects in columns 7–8 and 11–12 for household wealth and the primary cook's decision-making power, respectively.

4.3.2. Supply-side factors

Next, we assess how supply-side factors, particularly accessibility, may impact LPG consumption in Table 7. Depending on current LPG usage, we measure a household's distance from the local LPG dealer in a couple of ways. In columns 1–4, for households with LPG accounts, we use the distance to their actual dealer; and the nearest dealer for those without LPG accounts. Since a household's preferred LPG dealer is endogenous, in columns 5–8, we use the distance to the nearest dealer for all households irrespective of their LPG usage, and consider this as a more reliable measure of any impact of distance on LPG consumption.[35]

Pre-results specifications: The impact of treatment is significantly (insignificantly) positive for H + S (H) households, accounting for imputed distance to LPG dealer, as indicated in column 6. The negative,

[32] Algebraically, the impact of the treatment on annual LPG refills should be equivalent to the monthly estimate multiplied by 11 (months). Table A.7, Appendix A confirms this when we do not control for the baseline refill consumption. Thus the non-equivalence between the two sets of estimates (Table 4 vs. Table 5) is arising due to the time-varying regressors and higher variance in monthly refill consumption vis-a-vis annual consumption, as indicated by the lower correlation (coefficients on the baseline refill consumption) between the baseline and endline monthly refills.

[33] We do not find a significant difference in health awareness of households by the education level of their household head.

[34] Following standard survey instruments, we collected information on the primary cook's say in decision-making on: (a) what to cook daily, (b) whether to buy an expensive item, (c) what to do if she falls sick, and (d) what to do if her child falls sick. We create a single index using a principal component analysis over the four measures where the responses are categorized as: (1) respondent is not involved in the decision-making, (2) respondent decides along with someone in the household, or (3) respondent is sole decision-maker.

[35] We measure distance using the geocoded locations of the sampled households and the universe of LPG dealerships in the Indore district. The average distance of a sampled household to its local dealer is approximately eight km.

Table 6
Impact of demand side characteristics on annual LPG refill consumption.

	Head's Education				Household Wealth				PC's Bargaining Power			
	non-FE		*FE*		*non-FE*		*FE*		*non-FE*		*FE*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Overall Treatment	0.193		0.227*		0.207		0.233		0.063		0.092	
	(0.127)		(0.128)		(0.223)		(0.223)		(0.101)		(0.098)	
Treatment - H		0.068		0.082		0.188		0.198		−0.006		0.005
		(0.140)		(0.144)		(0.260)		(0.264)		(0.118)		(0.118)
Treatment - H + S		0.309**		0.363**		0.214		0.249		0.139		0.188
		(0.155)		(0.152)		(0.245)		(0.243)		(0.120)		(0.116)
Characteristic	0.194	0.192	0.175	0.172	0.164	0.164	0.166	0.164	−0.049	−0.049	−0.059	−0.057
	(0.127)	(0.127)	(0.128)	(0.128)	(0.114)	(0.114)	(0.114)	(0.114)	(0.057)	(0.057)	(0.057)	(0.057)
Characteristic × Overall Treatment	−0.306*		−0.318*		−0.091		−0.090		−0.026		−0.021	
	(0.169)		(0.170)		(0.128)		(0.127)		(0.072)		(0.072)	
Characteristic × H		−0.141		−0.143		−0.117		−0.115		0.059		0.068
		(0.193)		(0.195)		(0.144)		(0.144)		(0.085)		(0.086)
Characteristic × H + S		−0.462**		−0.482**		−0.054		−0.048		−0.099		−0.099
		(0.206)		(0.206)		(0.144)		(0.143)		(0.082)		(0.081)
Baseline Refill Consumption	0.805***	0.805***	0.802***	0.802***	0.802***	0.801***	0.799***	0.798***	0.801***	0.800***	0.798***	0.796***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Control Group Mean	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12
R-Square	0.594	0.595	0.595	0.596	0.594	0.594	0.595	0.596	0.592	0.593	0.593	0.594
N	2729	2729	2729	2729	2729	2729	2729	2729	2638	2638	2638	2638

Notes: The dependent variable is annual consumption of LPG refills between 1 Feb 2019–31 Dec 2019. Correspondingly, baseline refill consumption refers to annual consumption of LPG refills between 1 Feb 2018–31 Dec 2018. Head's education is a dummy that take value one if above primary level and zero otherwise. Household wealth is an index of all durable and non-durable goods owned by the household using principal component analysis. Primary cook's (PC) bargaining power is an empowerment index of decision making ability on four dimensions. To ensure uniformity of response we drop PCs who did not have children and hence were not asked about decision-making if own child falls sick in columns (9)–(12) (91 observations). All controls included as mentioned in Table 4. Standard errors, clustered at the village level, reported in parentheses.*$p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table 7
Impact of supply side characteristics on annual LPG refill consumption.

Distance of Household from LPG Distributor at Baseline								
	Actual & Imputed Distance				Imputed Distance			
	non-FE		*FE*		*non-FE*		*FE*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall Treatment	0.115		0.140		0.326		0.355	
	(0.204)		(0.200)		(0.249)		(0.247)	
Treatment - H		0.200		0.230		0.173		0.194
		(0.262)		(0.256)		(0.305)		(0.305)
Treatment - H + S		−0.068		−0.059		0.505**		0.538**
		(0.214)		(0.213)		(0.244)		(0.247)
Characteristic	0.028	0.027	0.034	0.033	−0.011	−0.012	−0.002	−0.003
	(0.022)	(0.022)	(0.022)	(0.022)	(0.044)	(0.044)	(0.042)	(0.043)
Characteristic × Overall Treatment	−0.008		−0.007		−0.050		−0.052	
	(0.027)		(0.027)		(0.049)		(0.049)	
Characteristic × H		−0.026		−0.028		−0.034		−0.036
		(0.031)		(0.031)		(0.056)		(0.057)
Characteristic × H + S		0.026		0.031		−0.070		−0.070
		(0.029)		(0.030)		(0.052)		(0.052)
Baseline Refill Consumption	0.796***	0.797***	0.791***	0.791***	0.799***	0.798***	0.798***	0.797***
	(0.018)	(0.018)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Control Group Mean	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12
R-Square	0.595	0.596	0.597	0.598	0.595	0.595	0.596	0.596
N	2729	2729	2729	2729	2729	2729	2729	2729

Notes: The dependent variable is annual consumption of LPG refills between 1 Feb 2019–31 Dec 2019. Correspondingly, baseline refill consumption refers to annual consumption of LPG refills between 1 Feb 2018–31 Dec 2018. For households with an LPG account, we compute the distance from their actual/own LPG dealer, and for households without an LPG account, we measure distance from the nearest LPG dealer using geodetic distances in columns (1)–(4). In columns (5)–(8) we measure the distance to nearest LPG dealer for all households. All controls included as mentioned in Table 4. Standard errors, clustered at the village level, reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

but insignificant coefficient on the interaction of distance with H and H + S treatment, when we account for the notional or nearest dealer location in column 6, suggests that the treatment may have had a larger effect when the nearest dealer was located closer to the household.

Pre-results specifications with sub-district FE: We reach similar conclusions in columns 7–8 of Table 7.

4.4. Behavioral impacts and other fuel usage

4.4.1. Induction cooking and behavioral changes

Recall that mixed fuel usage for cooking is the norm in rural India, as we discussed earlier. In our information campaign, the health practitioner at the end of each video emphasized measures that households

could undertake to reduce smoke inhalation - ensuring an outlet for smoke and using induction cooking if an LPG refill could not be obtained. In our survey, we gathered information on households' smoke inhalation mitigating behavior. Hence we explore whether exposure to treatment increased the likelihood of households having a separate room as the kitchen, an outlet for smoke in the kitchen, and the adoption of electric induction stoves as additional outcome variables (all binary dependent variables) in Table 8.

Pre-results specifications: Due to the treatment, overall induction use increased by 3 percentage points (pp) ($p < 0.01$) - a 50% increase from baseline (column 1). This was driven primarily by the H + S treatment in which induction stove usage went up by almost 63.3% (column 2). We observe behavioral changes in the H treatment, even though we do not observe any impacts on LPG refill consumption (see Table 5). Households were 5.2 pp more likely to have an outlet for smoke or chimney due to the treatment (as observed by the surveyor) - 4.9 pp due to H and 5.6 pp due to H + S treatment (columns 5–6). There was also a 4.8 pp increase in households separating the kitchen area due to the H treatment (column 10).

Pre-results specifications with sub-district FE: In our preferred specification, with sub-district FE, the estimated increase in induction use is 45% for the overall treatment (column 3) and 58.3% for the H + S treatment (column 4). The results for the likelihood of having a smoke outlet and a separate kitchen reported in columns 7–8 and 11–12 are consistent with results without the sub-district fixed effects reported above.

4.4.2. Fuels for cooking last meal

Pre-results specifications: We see similar impacts on usage of induction stove overall and in H + S treatment, as well as reduced usage of solid fuels (only *chulha* and only LPG) in the primary cook's responses to fuels used in the last meal that she had cooked in Table 9, possibly reflecting intensity of usage. The overall treatment increases the probability of using an induction stove for cooking the last meal by 0.9 pp (column 1) and by 1.4 pp in the H + S treatment (column 2). Usage of only LPG for cooking the last meal rose marginally by 4.8 pp in the H treatment (column 4) and also in H + S treatment, albeit insignificantly. Consequently, the probability that households used *only* solid fuels for cooking the last meal fell marginally by 4.7 pp in H treatment (column 6). Our intervention videos carried one consistent message - reduce smoke inhalation, and if for any reason the household is unable to purchase an LPG refill, ensure an outlet for smoke and use an induction stove for cooking. These messages resulted in the H group changing behavior to mitigate the adverse impact of smoke inhalation on health within their budget constraints. Our results are very strong when we account for multiple hypothesis testing for correlated outcomes using the methodology proposed by Kling et al. (2007) and analyze an index of clean fuel usage in columns 7–8. There is an estimated 12.1% of a std. dev. increase in clean fuel usage in the overall treatment (column 7), 9.4% in H only, and 14.9% of a std. dev. rise in the H + S treatment (column 8).

Pre-results specifications with sub-district FE: These results are consistent with those reported for our preferred specification with sub-district FE in Table 10.

4.4.3. Solid fuel usage and collection

Pre-results specifications: We find systematically negative coefficients on treatment, although insignificant, for households' use and collection of solid fuels - firewood and dung - in the previous month, as shown in Table 11. In columns 1–6, we analyze treatment effects on whether the household used (extensive margin usage measure), collected and the number of trips made to collect firewood (intensive margin usage measure), while columns 7–12 analyze the same outcomes for dung. While there are insignificant impacts on usage (columns 1–2), we find a 5.2 pp marginal decline in the probability that the household collected firewood in the previous month due to the combined treatment in column 4.

Pre-results specifications with sub-district FE: The above results are stronger when we include sub-district FE in Table 12. Firewood collection in the previous month in H + S fell by 5.9 pp ($p < 0.05$). The overall treatment impact appears stronger for dung making/collection - 5.7 pp (column 9) and 0.824 or 17.5% (column 11) fewer trips. The latter effect is driven by 0.865 fewer trips in the H + S arm (column 12).

4.4.4. Other outcomes

Since our health information campaign included videos that focused on specific diseases caused by indoor smoke inhalation, we estimate the impact of the treatment on awareness of these diseases individually and the number of correct responses out of all nine diseases we quizzed the households on. We find an increase in awareness of pneumonia (Table A.8), although the number of correct answers did not improve significantly either for the six diseases caused by indoor smoke or the three diseases that are not attributable to smoke inhalation (Table A.9). Note the very low correlation between baseline and endline score (as indicated by the coefficient on baseline score), suggesting that households may have been responding to our question on whether the disease is caused due to indoor smoke randomly. We infer that our measure of

Table 8
Behavioral impact of information campaign.

	Induction Use				Chimney/Smoke Outlet				Separate Cooking Room			
	non-FE		*FE*		*non-FE*		*FE*		*non-FE*		*FE*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Overall Treatment	0.030***		0.027***		0.052***		0.053***		0.042*		0.040*	
	(0.010)		(0.010)		(0.019)		(0.019)		(0.022)		(0.021)	
Treatment - H		0.023*		0.019		0.049**		0.055**		0.048**		0.053**
		(0.012)		(0.013)		(0.022)		(0.022)		(0.024)		(0.024)
Treatment - H + S		0.038***		0.035***		0.056***		0.050**		0.036		0.027
		(0.014)		(0.013)		(0.021)		(0.020)		(0.026)		(0.026)
Baseline Outcome	0.191***	0.191***	0.193***	0.193***	0.072***	0.072***	0.073***	0.073***	0.069***	0.069***	0.070***	0.070***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.017)	(0.017)	(0.017)	(0.017)	(0.019)	(0.019)	(0.019)	(0.019)
Joint Significance of Treatments		[0.010]		[0.021]		[0.021]		[0.027]		[0.125]		[0.092]
H = H + S		[0.370]		[0.359]		[0.680]		[0.800]		[0.593]		[0.291]
Control Group Mean	0.06	0.06	0.06	0.06	0.73	0.73	0.73	0.73	0.65	0.65	0.65	0.65
R-Square	0.070	0.070	0.075	0.076	0.035	0.035	0.039	0.039	0.071	0.072	0.075	0.076
N	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791

Notes: 'Induction use' equals one if the household reports using inducation stove for cooking; 'Chimney or a smoke outlet' takes a value one if the surveyor observes an outlet in household's cooking area; 'Separate cooking room' equals one if surveyor observes a separate kitchen from living areas. All controls included as mentioned in Table 4. *p* values of F-tests reported in square brackets. Standard errors, clustered at the village level, reported in parentheses.*$p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table 9
Impact of information campaign on choice of cooking fuel.

Outcomes Related to Fuel Used in Cooking Last Meal								
	Only Induction		Only LPG		Only Chulha		Last Meal's Clean Fuel Use Index	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall Treatment	0.009***		0.034		−0.038		0.121***	
	(0.003)		(0.026)		(0.023)		(0.042)	
Treatment - H		0.004		0.048*		−0.047*		0.094**
		(0.003)		(0.029)		(0.026)		(0.044)
Treatment - H + S		0.014**		0.019		−0.028		0.149**
		(0.006)		(0.030)		(0.028)		(0.062)
Baseline Fuel Used	0.087	0.086	0.351***	0.352***	0.306***	0.307***	0.299***	0.298***
	(0.061)	(0.061)	(0.023)	(0.023)	(0.019)	(0.019)	(0.038)	(0.038)
Joint Significance of Treatments		[0.030]		[0.229]		[0.192]		[0.019]
H = H + S		[0.113]		[0.294]		[0.476]		[0.411]
Control Group Mean	0.01	0.01	0.30	0.30	0.53	0.53	0.00	0.00
Sub-district FE	No	No	No	No	No	No	No	No
R-Square	0.018	0.020	0.160	0.160	0.168	0.169	0.099	0.100
N	2791	2791	2791	2791	2791	2791	2791	2791

Notes: Outcome variables are sources of fuel used by the household for cooking the last meal prior to the survey - whether the primary cook prepared the last meal using only induction (=1 and 0 otherwise); using only LPG (=1 and 0 otherwise); using only *chulha* (=1 and 0 otherwise). "Only" implies that the household didn't mix fuels while preparing the last meal. The index combines all outcomes reported in col (1)–(6). The dependent variable in col (5)–(6) is recoded as 1 = 'no *chulha*' and 0 otherwise for computing the index. All controls included as mentioned in Table 4. *p* values of F-tests reported in square brackets. Standard errors, clustered at the village level, reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table 10
Impact of Information Campaign on Choice of Cooking Fuel (with sub-district fixed effects).

Outcomes Related to Fuel Used in Cooking Last Meal								
	Only Induction		Only LPG		Only Chulha		Last Meal's Clean Fuel Use Index	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall Treatment	0.008**		0.040		−0.039*		0.120***	
	(0.003)		(0.026)		(0.023)		(0.041)	
Treatment - H		0.002		0.050*		−0.045*		0.081*
		(0.003)		(0.029)		(0.026)		(0.045)
Treatment - H + S		0.015**		0.030		−0.032		0.162**
		(0.006)		(0.030)		(0.028)		(0.063)
Baseline Fuel Used	0.088	0.087	0.342***	0.343***	0.305***	0.305***	0.299***	0.297***
	(0.061)	(0.061)	(0.023)	(0.023)	(0.019)	(0.019)	(0.038)	(0.038)
Joint Significance of Treatments		[0.030]		[0.215]		[0.211]		[0.016]
H = H + S		[0.076]		[0.476]		[0.633]		[0.252]
Control Group Mean	0.01	0.01	0.30	0.30	0.53	0.53	0.00	0.00
Sub-district FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Square	0.020	0.023	0.166	0.166	0.169	0.170	0.101	0.102
N	2791	2791	2791	2791	2791	2791	2791	2791

Notes: Outcome variables are sources of fuel used by the household for cooking the last meal prior to the survey - whether the primary cook prepared the last meal using only induction (=1 and 0 otherwise); using only LPG (=1 and 0 otherwise); using only *chulha* (=1 and 0 otherwise). "Only" implies that the household didn't mix fuels while preparing the last meal. The index combines all outcomes reported in col (1)–(6). The dependent variable in col (5)–(6) is recoded as 1 = 'no *chulha*' and 0 otherwise for computing the index. All controls included as mentioned in Table 4 with sub-district fixed effects. *p* values of F-tests reported in square brackets. Standard errors, clustered at the village level, reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

health awareness is possibly invalid. It suggests that the survey questions needed better framing to elicit true perceptions or awareness of health effects of solid fuels.

On the other hand, we find an increase in self-reported major or long-term morbidity overall and due to the H treatment, as shown in columns 3 and 4 of Table A.10 in Appendix A. We interpret this as an increase in reporting, possibly due to improved awareness of long-term health hazards, rather than a rise in the actual incidence of morbidity. Since awareness of the minor or short-term health impacts was high at the baseline, we do not find a significant effect of the intervention on households' self-reported short-term health morbidity due to indoor smoke (columns 1–2). We run a 2SLS analysis of the effect of the number of refills the household purchased between 1st Jan - 31st Oct 2019, instrumenting it with H and H + S treatment status, on monthly health expenditures (for both short- and long-term morbidity) in Table A.11 in Appendix A to find no impacts.[36]

5. Discussion

Our results indicate that financial constraints impede clean fuel take-up. When we provide households with information on mitigating adverse health effects of solid fuels along with the LPG subsidy program, there is a significant increase in consumption or usage of clean fuels - both LPG and induction, but small for the former. Once households

[36] Throughout we report findings for the pre-results specifications in this section, but they do not differ from those with sub-district FE.

Table 11
Impact of information campaign on solid fuel usage and collection.

	Firewood						Dung					
	Use		Collection		Collection Trips		Use		Make/Collect		Make/Collection Trips	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Overall Treatment	−0.014		−0.031		−0.087		0.000		−0.041		−0.621	
	(0.024)		(0.026)		(0.102)		(0.018)		(0.032)		(0.426)	
Treatment - H		−0.023		−0.012		−0.035		−0.014		−0.058		−0.710
		(0.026)		(0.029)		(0.115)		(0.021)		(0.037)		(0.486)
Treatment - H + S		−0.005		−0.052*		−0.144		0.015		−0.022		−0.527
		(0.027)		(0.030)		(0.116)		(0.020)		(0.037)		(0.474)
Baseline Outcome	0.237***	0.238***	0.214***	0.214***	0.137***	0.137***	0.189***	0.189***	0.265***	0.265***	0.343***	0.343***
	(0.023)	(0.023)	(0.020)	(0.020)	(0.019)	(0.019)	(0.030)	(0.030)	(0.020)	(0.020)	(0.030)	(0.030)
Joint Significance of Treatments		[0.607]		[0.177]		[0.419]		[0.294]		[0.281]		[0.328]
H = H + S		[0.428]		[0.142]		[0.317]		[0.119]		[0.329]		[0.680]
Control Group Mean	0.75	0.75	0.54	0.54	1.82	1.82	0.87	0.87	0.64	0.64	4.72	4.72
Sub-district FE	No	No	No	No	No	No	No	No	No	No	No	No
R-Square	0.114	0.115	0.094	0.095	0.059	0.059	0.057	0.059	0.101	0.101	0.102	0.102
N	2791	2791	2552	2552	2542	2542	2791	2791	2791	2791	2791	2791

Notes: For each solid fuel, 'Use' is a dummy for whether household reports using the solid fuel for cooking in the previous month; 'Collect' or 'Make/Collect' is a dummy for whether the household collected/made the solid fuel in the previous month; 'Collection trips' or 'Make/Collection trips' is the number of times household member (s) either made trips to the forest to collect or make (for dung) the solid fuel in a typical week in the previous month. 239 observations with missing data on firewood 'collection' - 11 with missing data at baseline and 228 with missing data at endline. All controls included as mentioned in Table 4. *p* values of F-tests reported in square brackets. Standard errors, clustered at the village level, reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table 12
Impact of Information Campaign on Solid Fuel Usage and Collection (with sub-district fixed effects).

	Firewood						Dung					
	Use		Collection		Collection Trips		Use		Make/Collect		Make/Collection Trips	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Overall Treatment	−0.024		−0.037		−0.129		−0.005		−0.057**		−0.824**	
	(0.021)		(0.025)		(0.091)		(0.017)		(0.027)		(0.341)	
Treatment - H		−0.031		−0.017		−0.085		−0.017		−0.064*		−0.786*
		(0.024)		(0.027)		(0.102)		(0.020)		(0.034)		(0.420)
Treatment - H + S		−0.017		−0.059**		−0.176*		0.008		−0.050		−0.865**
		(0.024)		(0.029)		(0.105)		(0.019)		(0.030)		(0.370)
Baseline Outcome	0.226***	0.226***	0.208***	0.208***	0.127***	0.127***	0.183***	0.183***	0.247***	0.247***	0.314***	0.314***
	(0.023)	(0.023)	(0.020)	(0.020)	(0.020)	(0.019)	(0.029)	(0.029)	(0.020)	(0.020)	(0.028)	(0.028)
Joint Significance of Treatments		[0.438]		[0.107]		[0.249]		[0.415]		[0.113]		[0.049]
H = H + S		[0.553]		[0.122]		[0.371]		[0.190]		[0.676]		[0.844]
Control Group Mean	0.75	0.75	0.54	0.54	1.82	1.82	0.87	0.87	0.64	0.64	4.72	4.72
Sub-district FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Square	0.128	0.128	0.100	0.101	0.074	0.075	0.063	0.064	0.132	0.132	0.150	0.150
N	2791	2791	2552	2552	2542	2542	2791	2791	2791	2791	2791	2791

Notes: For each solid fuel, 'Use' is a dummy for whether household reports using the solid fuel for cooking in the previous month; 'Collect' or 'Make/Collect' is a dummy for whether the household collected/made the solid fuel in the previous month; 'Collection trips' or 'Make/Collection trips' is the number of times household member (s) either made trips to the forest to collect or make (for dung) the solid fuel in a typical week in the previous month. 239 observations with missing data on firewood 'collection' - 11 with missing data at baseline and 228 with missing data at endline. All controls included as mentioned in Table 4 with sub-district FE. *p* values of F-tests reported in square brackets. Standard errors, clustered at the village level, reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

realize that their out-of-pocket expenditure is lower than they thought due to the cash-back scheme, their LPG refill purchase increased. Moreover, since the (fixed) cost of an induction stove and accompanying cooking vessels is significant (approximately 2100–4500 rupees or 29–62% of monthly household income, depending on the quality of the utensils and stove) for these households, awareness of the LPG subsidy had a spillover effect. It loosened the perceived budget constraint of households in the H + S group and induced them to incur one-time expenditure towards a relatively cheaper clean fuel vis-à-vis LPG - induction cooking - to mitigate smoke inhalation.[37] However, we do observe strong behavioral responses to mitigate smoke inhalation, that did not require additional expense, in the H group.

Our intervention was cost-effective. Each ASHA received 50 rupees per household per visit which equals 300 rupees for six visits per household. Fixed costs were incurred on creating the videos (800,000 rupees) and ASHA training (500 rupees per ASHA + incidentals). The

[37] The fact that newly elected state government in December 2018 rolled out a program of free electricity to households up to some limit per month implies that households bore low or no recurring costs of using induction.

variable costs, therefore, were very low at approximately USD 5 per household, and if scaled up, the fixed costs would be negligible. We can value the benefits in terms of the opportunity cost of time spent collecting/making solid fuels by the household. At baseline, only 29% of households reported using LPG exclusively in preparing the last meal. 14% (29%) of households reported purchasing firewood (dung cakes) worth 790 (698) rupees in the previous month, which is more than the out-of-pocket expenditure on one LPG refill (500 rupees). 70% (70%) of households spent 44 h (40 h) in the previous month, on average, collecting firewood (making dung cakes). Given the minimum daily wage for unskilled labor at 280 rupees in Madhya Pradesh, this amounts to these households losing income from up to 5 days of work or 1400 rupees in a month. Thus the opportunity cost of using solid fuels can be substantial, given that the average monthly income of a rural household in the state of Madhya Pradesh was 5672 rupees in 2011 (Desai et al., 2011).[38]

A possible confounding factor in establishing information as the only mechanism that impacts households' uptake of LPG is that the number of ASHA visits to the treated households was likely to have been higher than for the control group. Our experiment design did not include placebo visits by ASHAs in the control group, given that at the baseline only 13% of households were aware of long-term health effects from indoor smoke. However, at the endline, we gathered information on the frequency of ASHA visits to our sampled households in each village since January 2019 through an ASHA survey. Thus, we have data on the number of times the ASHA visited both the treatment and control households between January and October 2019. The coefficient on the interaction of the treatment dummy in equations (1) and (2) with the number of ASHA visits during this period is insignificant, suggesting that the number of ASHA visits did not affect treatment efficacy.

Another related concern is whether the nature of the campaign, rather than information per se, impacted behavior. To elaborate, our awareness campaign was conducted by existing public health workers who were also residents of the same village. If the campaign were to be conducted through impersonal text messages or unfamiliar informants, would effect sizes be the same? To answer this question, we measure the heterogeneity of response to treatment on LPG refill consumption by households' trust in ASHAs from our baseline survey (see Table 2). We do not find a significant coefficient on the interaction of household 'trust' with treatment indicator.[39]

6. Conclusion

In this study, we conducted a cluster randomized control trial to investigate whether creating awareness of the health hazards of indoor smoke from solid fuels and measures that households can adopt to mitigate them can induce households to adopt and use non-polluting fuels more regularly in rural India. We varied our door-to-door campaign by bundling health awareness with financial information on the existing cash-back LPG subsidy provided by the government in another treatment arm. We then analyzed the take-up and usage of LPG, induction and other health seeking behavior by households in villages in the health, and health plus subsidy awareness treatments vis-à-vis the control group of villages which received no information.

While we find no impacts of the intervention on the extensive margin, our results suggest a small increase in the regular usage of LPG (when measured at monthly frequency in our preferred specification) and some take-up of induction cooking (a relatively cheaper clean fuel than LPG) when health and financial awareness were bundled together. In the health awareness only arm we observe behavioral changes to reduce smoke inhalation which did not entail additional expenditure by households. Although the estimated impacts of the two treatments on LPG consumption are insignificantly different, our findings suggest complementarity between health awareness and financial constraints. They indicate that loosening financial constraints is a key policy tool that could be adopted under the existing public health system to reduce air pollution in the most polluted, and often, poorest countries in the world. This entails redesigning existing public subsidy programs to address poor households' liquidity and credit constraints. Thus lowering the perceived cost of clean fuels through an optimally timed subsidy (upfront rather than cash-back), and improving comprehension and intimation of existing subsidy programs, may be crucial.

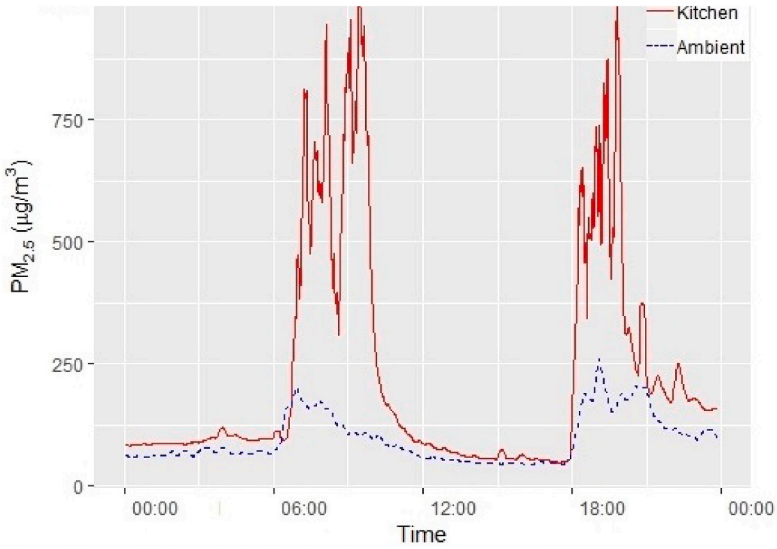
7. Disclaimer & administrative information

This paper was accepted as Pre-results, Stage 1 article at the Journal of Development Economics. The authors are grateful to the editor and two anonymous referees, Kapil Goel, David Levine and Vital Strategies for advising and generously sharing materials for the intervention, MPVHA for their assistance in the implementation of the intervention and the district administration of Indore for its cooperation in the conduct of the study. The paper has benefited from comments by seminar participants at CASI (UPenn) and UT-Austin. We acknowledge the support of the Ministry of Petroleum and Natural Gas (Government of India), and the Oil Marketing Companies, especially Manish Grover, in the conduct of this study. Pranav Mimani and Aishwarya Singh provided exceptional research assistance. Afridi acknowledges financial support from the Initiative for What Works to Advance Women and Girls in the Economy (IWWAGE), housed at IFMR. Ethics approval for the research was obtained from the IRBs of the ISI and IFMR.

Appendix. A. Additional Analysis

[38] Valuing the health benefits, on the other hand, requires an assumption about the reduction in air pollution associated with an additional LPG cylinder and the resulting monetary value of any positive health effects of this reduction, e.g., improvement in lung capacity. However, data on such health measures and related improvements in labor productivity are unavailable, making it difficult to calculate these benefits.

[39] There may have been spillover effects from treated to untreated households within our treatment villages. Unfortunately, the LPG sales data do not provide us with reliable household location information. We are, thus, unable to measure impacts at the aggregate village level to account for spillover effects.



Notes: The solid line plots 15-minute moving averages of PM2.5 concentrations over a day (10 February 2019) measured in the kitchen of a household that cooks with solid fuels in a north Indian village. The dashed line shows data from an outdoor sensor in the same village and date. Both measures of PM2.5 are at one-minute resolution.

Fig. A.1. Indoor and Outdoor PM2.5 Concentrations in a North-Indian Village.
Source: Somanathan et al. (2019).

Table A.1
Balance of Village and Household Amenities (Census 2011).

	Control	***Treatment***		***Difference***		
	C	**H**	**H + S**	**C–H**	**C - (H + S)**	**H - (H + S)**
	(N = 50)	(N = 46)	(N = 46)			
	(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. **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 A.2
Mean Differences in Annual LPG Refill Consumption.

Treatment Group	**Treatment - Control**		**Difference**
	Baseline	Endline	Endline - Baseline
	(1)	(2)	(2)–(1)
Health	0.208	0.179	−0.029
	(0.293)	(0.284)	(0.115)
Health + Subsidy	0.178	0.247	0.069
	(0.296)	(0.280)	(0.116)

Notes: N = 957 for the control group; N = 882 for H and N = 890 for H + S. We exclude non-compliance villages. Standard errors, clustered at the village level, in parentheses.

Table A.3
Impact of Information Campaign on Annual LPG Refill Consumption (conditional on having an LPG account at baseline).

	non-FE		*FE*	
	(1)	(2)	(3)	(4)
Overall Treatment	0.101		0.139	
	(0.140)		(0.136)	
Treatment - H		0.034		0.045
		(0.166)		(0.164)
Treatment - H + S		0.172		0.240
		(0.166)		(0.161)
Baseline Refill Consumption	0.670***	0.669***	0.664***	0.663***
	(0.025)	(0.025)	(0.025)	(0.025)
Control Group Mean	4.70	4.70	4.70	4.70
R-Square	0.426	0.426	0.429	0.429
N	1819	1819	1819	1819

Notes: The dependent variable is annual consumption of LPG refills between 1 Feb 2019–31 Dec 2019. Correspondingly, baseline refill consumption refers to annual consumption of LPG refills between 1 Feb 2018–31 Dec 2018. The sample is restricted to villages which complied with the assigned treatment and households that had an LPG account at baseline. Household level controls 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 household, household caste, household wealth index. Village level controls include - dummies for presence of pvt. primary school, access to health sub-centres, all weather road, proportion of irrigated land, and distance to block headquarter. Sub-district fixed effects (FE) included in specified columns. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table A.4
ITT Effects of Information Campaign on Annual LPG Refill Consumption (unconditional on having an LPG account at baseline).

	non-FE		*FE*	
	(1)	(2)	(3)	(4)
Overall Treatment	0.082		0.121	
	(0.097)		(0.096)	
Treatment - H		0.022		0.048
		(0.111)		(0.115)
Treatment - H + S		0.144		0.196*
		(0.117)		(0.113)
Baseline Refill Consumption	0.805***	0.805***	0.802***	0.802***
	(0.018)	(0.018)	(0.018)	(0.018)
Control Group Mean	3.12	3.12	3.12	3.12
R-Square	0.597	0.597	0.598	0.599
N	2882	2882	2882	2882

Notes: The dependent variable is annual consumption of LPG refills between 1 Feb 2019–31 Dec 2019. Correspondingly, baseline refill consumption refers to annual consumption of LPG refills between 1 Feb 2018–31 Dec 2018. The sample includes all 150 villages as per the original assignment of treatment. Controls as elucidated in Table A.3. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table A.5
Impact of Information Campaign on LPG Usage at Extensive Margin.

	LPG Account		LPG Use	
	(1)	(2)	(3)	(4)
Overall Treatment	−0.015		−0.005	
	(0.013)		(0.017)	
Treatment - H		−0.018		−0.018
		(0.014)		(0.019)
Treatment - H + S		−0.013		0.008
		(0.015)		(0.021)
Baseline LPG Outcome	0.800***	0.800***	0.542***	0.542***
	(0.018)	(0.018)	(0.024)	(0.024)
Control Group Mean	0.65	0.65	0.72	0.72
Sub-district FE	No	No	No	No
R-Square	0.726	0.726	0.368	0.369
N	2791	2791	2791	2791

Notes: The dependent variable is a dummy variable that equals 1 if the household has an LPG account (col 1–2) and if it reports using LPG for cooking (col 3–4). The sample is restricted to villages which complied with the assigned treatment. Controls as elucidated in Table A.3. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table A.6
Impact of Information Campaign on Seasonal LPG Refill Consumption.

	Summer		Monsoon		Winter	
	(1)	(2)	(3)	(4)	(5)	(6)
Overall Treatment	0.042		0.019		0.042	
	(0.040)		(0.057)		(0.056)	
Treatment - H		0.020		−0.021		0.027
		(0.050)		(0.061)		(0.064)
Treatment - H + S		0.065		0.061		0.058
		(0.049)		(0.070)		(0.067)
Baseline Refill Consumption	0.514***	0.514***	0.670***	0.670***	0.643***	0.643***
	(0.028)	(0.028)	(0.024)	(0.024)	(0.025)	(0.025)
Control Group Mean	0.84	0.84	1.20	1.20	1.09	1.09
Sub-district FE	No	No	No	No	No	No
R-Square	0.279	0.279	0.410	0.410	0.372	0.372
N	2729	2729	2729	2729	2729	2729

Notes: Outcome variable here is the seasonal consumption of LPG refills by the household. Summer refills are calculated from 16th March - 15th June for a given year, monsoon refills are calculated from 16th June - 15th October and winter refills are calculated from 16 October - 31 December and then from 1 March - 15 March in a given year. The sample is restricted to villages which complied with the assigned treatment. Controls as elucidated in Table A.3. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table A.7
Impact of Information Campaign on LPG Refill Consumption (Annual vs. Monthly).

	Annual Refills		Monthly Refills	
	(1)	(2)	(3)	(4)
Overall Treatment	0.21322		0.01938	
	(0.247)		(0.022)	
Treatment - H		0.17919		0.01629
		(0.284)		(0.026)
Treatment - H + S		0.24694		0.02245
		(0.279)		(0.025)
Constant	3.53396***	3.53396***	0.32127***	0.32127***
	(0.206)	(0.206)	(0.019)	(0.019)
Sub-district FE	No	No	No	No
R-Square	0.001	0.001	0.000	0.000
N	2729	2729	30019	30019

Notes: The dependent variable in columns (1) and (2) is the annual consumption of LPG refills between 1 Feb 2019–31 Dec 2019. In columns (3) and (4), the dependent variable is the monthly consumption of LPG refills between the same period. Apart from the treatment dummies and the constant, no other controls are included in the specification. The sample is restricted to villages which complied with the assigned treatment. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table A.8
Impact of Information Campaign on the Awareness of Diseases Caused by Smoke.

	LBW		Pneumonia		TB		Heart Disease		Cataract		Lung Cancer	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Overall Treatment	0.020		0.055**		0.010		0.019		−0.012		−0.010	
	(0.025)		(0.024)		(0.027)		(0.026)		(0.024)		(0.025)	
Treatment - H		0.015		0.052*		−0.007		−0.008		−0.025		−0.044
		(0.028)		(0.028)		(0.031)		(0.029)		(0.026)		(0.031)
Treatment - H + S		0.025		0.057*		0.027		0.048		0.001		0.025
		(0.029)		(0.029)		(0.030)		(0.031)		(0.027)		(0.028)
Baseline Awareness	0.058***	0.058***	0.058***	0.058***	0.034*	0.035*	0.038*	0.039*	0.033*	0.034*	0.039*	0.040**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)	(0.021)	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)
Control Group Mean	0.34	0.34	0.30	0.30	0.52	0.52	0.32	0.32	0.67	0.67	0.57	0.57
Sub-district FE	No	No	No	No	No	No	No	No	No	No	No	No
R-Square	0.016	0.016	0.015	0.015	0.011	0.012	0.011	0.013	0.016	0.017	0.014	0.016
N	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791

Notes: Outcome variable equals 1 if the household says 'yes the disease is caused by indoor smoke'. The sample is restricted to villages which complied with the assigned treatment. Controls as elucidated in Table A.3. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table A.9
Impact of Information Campaign on Health Awareness Score.

	Score out of 9		Score out of 6	
	(1)	(2)	(3)	(4)
Overall Treatment	0.003		0.078	
	(0.146)		(0.121)	
Treatment - H		−0.110		−0.022
		(0.171)		(0.138)
Treatment - H + S		0.121		0.184
		(0.165)		(0.139)
Baseline Score	0.037	0.037	0.081***	0.082***
	(0.025)	(0.025)	(0.021)	(0.021)
Control Group Mean	4.53	4.53	2.73	2.73
Sub-district FE	No	No	No	No
R-Square	0.016	0.017	0.020	0.021
N	2791	2791	2791	2791

Notes: Outcome variables here are the health awareness scores which are derived from responses to the questions "Do you think that the AILMENT can occur due to inhaling smoke from use of solid fuels?" (0) No (1) Yes (2) Don't know. We asked for respondent's awareness on a total of 9 AILMENTS, among which 6 (low birth weight, pneumonia, tuberculosis, heart disease, cataract, and lung cancer) are caused by smoke from solid fuels while 3 (polio, diabetes, and anemia) are not, in random order. These diseases were listed in a random order. The health awareness score counts the number of correct responses to all 9 (col 1–2) or 6 (col 3-2) diseases caused by smoke. The sample is restricted to villages which complied with the assigned treatment. Controls as elucidated in Table A.3. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table A.10
Impact of Information Campaign on Health Morbidity.

	Household Member(s) had any Morbidity (Yes/No)					
	Minor Morbidity		Major Morbidity		Morbidity Index	
	(1)	(2)	(3)	(4)	(5)	(6)
Overall Treatment	−0.011		0.015**		0.038	
	(0.023)		(0.008)		(0.032)	
Treatment - H		−0.022		0.022**		0.048
		(0.028)		(0.010)		(0.039)
Treatment - H + S		0.001		0.008		0.027
		(0.029)		(0.009)		(0.041)
Baseline Health Outcome	0.119***	0.119***	0.132***	0.132***	0.191***	0.191***
	(0.021)	(0.021)	(0.029)	(0.029)	(0.029)	(0.029)
Control Group Mean	0.53	0.53	0.05	0.05	0.00	0.00
Sub-district FE	No	No	No	No	No	No
R-Square	0.021	0.021	0.038	0.038	0.042	0.042
N	2772	2772	2775	2775	2758	2758

Notes: Minor/major morbidity equals 1 if the household responds 'yes' to the question "In the last month, did any one in the household suffer from cough, chest pain, eye irritation or breathing issues?"/"In the last year, has anybody in the household been diagnosed with a long-term respiratory/lung diseases like asthma, lung cancer, tuberculosis or COPD?" In col 5–6 the index is an equally weighted average of z-scores of minor and major morbidity. The sample is restricted to villages which complied with the assigned treatment. Missing response to minor (major) morbidity for 19 households - 7 at baseline and 12 at endline (16 households - 12 at baseline

and 4 at endline). Missing responses in the health index for 33 households - 18 at baseline and 13 at endline. Controls as elucidated in Table A.3. Standard errors, clustered at the village level, are reported in parentheses.*$p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Table A.11
Impact of Information Campaign on Health Expenditure.

	Total Expenditure on Morbidity (in Rs.)			
	Minor Morbidity		Major Morbidity	
	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
LPG Refill Consumption	27.609	−1551.731	683.515	17212.509
	(29.805)	(1893.808)	(604.302)	(21163.458)
Baseline Health Outcome	0.031***	0.025*	0.086	0.093
	(0.004)	(0.014)	(0.094)	(0.096)
Control Group Mean	1466.94	1466.94	6205.50	6205.50
Sub-district FE	No	No	No	No
R-Square	0.012	.	0.012	.
N	2697	2697	2713	2713

Notes: The dependent variable is the monthly expenditure by the household when one or more members is faced with minor (in previous month) or major morbidity (in previous year/12).The sample is restricted to villages which complied with the assigned treatment. 32 observations are missing for minor health expenditure and 16 for major expenditure. Controls as elucidated in Table A.3. Standard errors, clustered at the village level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jdeveco.2021.102674.

Disclosure statement

Farzana Afridi:

1. This research was funded by the Bill and Melinda Gate Foundation's Initiative for What Works for Women and Girls in the Economy (IWWAGE).
2. I have not received any financial support from any other organization for this study.
3. I have not held any paid or unpaid position as officer, director or board member of any "relevant" non-profit or profit making organization.
4. No relative or partner of mine has held any paid or unpaid position as officer, director or board member of any "relevant" non-profit or profit making organization.
5. No organization had the right to review this paper before it was circulated.
6. There is no conflict of interest with any other published work.
7. IRB approval was obtained for this study at the Indian Statistical Institute and the Institute for Financial Management and Research.
8. I concur with the AEA suggestion that its members and other economists should apply the above principles in other publications: scholarly journals, op-ed pieces, newspaper and magazine columns, radio and television commentaries, as well as in testimony before federal and state legislative committees and other agencies.

Sisir Debnath:

1. This research was funded by the Bill and Melinda Gate Foundation's Initiative for What Works for Women and Girls in the Economy (IWWAGE).
2. I have not received any financial support from any other organization for this study.
3. I have not held any paid or unpaid position as officer, director or board member of any "relevant" non-profit or profit making organization.
4. No relative or partner of mine has held any paid or unpaid position as officer, director or board member of any "relevant" non-profit or profit making organization.
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8. I concur with the AEA suggestion that its members and other economists should apply the above principles in other publications: scholarly journals, op-ed pieces, newspaper and magazine columns, radio and television commentaries, as well as in testimony before federal and state legislative committees and other agencies.

E. Somanthan

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8. I concur with the AEA suggestion that its members and other economists should apply the above principles in other publications: scholarly journals, op-ed pieces, newspaper and magazine columns, radio and television commentaries, as well as in testimony before federal and state legislative committees and other agencies.

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