



RAISING AWARENESS TO INCREASE USAGE OF LPG AND OTHER CLEAN FUELS

***SUMMARY OF FINDINGS FROM STUDY IN
INDORE (MP)***

DECEMBER 2020

Dr. Farzana Afridi, Indian Statistical Institute, Delhi

Dr. Sisir Debnath, Indian Institute of Technology, Delhi

Dr. E. Somanathan, Indian Statistical Institute, Delhi

Table of Contents

PREFACE	2
ACKNOWLEDGMENTS	3
1. EXECUTIVE SUMMARY	4
2. INTRODUCTION - CONTEXT AND RATIONALE	6
3. STUDY DESIGN	8
4. SAMPLE AND DATA DESCRIPTION	14
4.1. VILLAGE CHARACTERISTICS (CENSUS OF INDIA, 2011)	14
4.2. HOUSEHOLD CHARACTERISTICS (BASELINE SURVEY DATA, 2018).....	15
4.3. LPG RELATED CHARACTERISTICS	16
4.3.1. <i>LPG Connection & PMUY Status</i>	16
4.3.2. <i>Seasonal LPG Refill Consumption & Distance from LPG Distributor</i>	16
4.4. HOUSEHOLD FUEL CONSUMPTION	18
4.4.1. <i>Fuel Usage</i>	18
4.4.2. <i>Solid Fuel Collection</i>	<i>Error! Bookmark not defined.</i>
5. FINDINGS - IMPACT OF INFORMATION CAMPAIGN	20
5.1. LPG REFILL CONSUMPTION	20
5.1.1. <i>Annual Refill Consumption</i>	20
5.1.2. <i>Seasonal Refill Consumption</i>	21
5.1.3. <i>Monthly Refill Consumption & LPG Price</i>	21
5.2. IMPACT OF DEMAND SIDE FACTORS	22
5.2.1. <i>Household Head's Education</i>	22
5.2.2. <i>Household Wealth Index</i>	23
5.3. IMPACT OF SUPPLY SIDE FACTORS	25
5.3.1. <i>Distance from Nearest LPG Distributor</i>	25
5.4. IMPACT ON HOUSEHOLD BEHAVIOUR AND OTHER FUELS	26
5.4.1. <i>Induction Usage</i>	26
5.4.2. <i>Smoke Outlet & Separate Cooking Area</i>	27
5.5. COOKING FUEL USAGE	28
5.5.1. <i>Fuel Used in Cooking Last Meal</i>	28
5.5.2. <i>Solid Fuel Collection & No. of Fuel Collection Visits</i>	29
6. CONCLUSIONS AND POLICY RECOMMENDATIONS	31
7. REFERENCES	32

Preface

This report is based on survey and consumer level data of households in the rural areas of Indore district, Madhya Pradesh. The authors conducted a survey of 150 randomly sampled villages in the district of Indore during November-December, 2018. 3000 households in these 150 villages were randomly sampled and were surveyed regarding cooking fuel usage patterns, household characteristics, health expenditures and awareness.

Following the survey in 2018, a nine month health and subsidy information campaign was designed and implemented by the authors, with the support of the district administration, in rural Indore between January and September 2019. In 50 randomly sampled villages (of the 150) the campaign provided door-to-door information on the adverse health effects of indoor smoke by ASHA (Accredited Social Health Activist) workers to the sampled households. Additionally, in another 50 randomly sampled villages (of the 150 villages), information on the government's LPG subsidy was also given by ASHA workers to the sampled households.

The same 3000 households were re-surveyed at the end of the information campaign in October-December 2019, to assess the impact of the campaign on their LPG refill consumption, and usage of induction and other solid fuels. The LPG fuel consumption pattern of households during November 2017-December 2019 was mapped to consumer level data of all three public sector Oil Marketing Companies (OMCs) for households that had an LPG connection to assess the impact of the campaign on demand for LPG refills.

Acknowledgments

The authors are grateful to the Ministry of Petroleum and Natural Gas, particularly Mr. Ashutosh Jindal (erstwhile JS, Marketing), Mr. Binay Pradhan (erstwhile PS to Hon'ble Minister) and Mr. Manish Grover for their constant support throughout the study, the three OMCs for sharing the data with us and providing us support in the field - Ms. Rashmi Kaushal, Ms. Parvathy S, Mr. Dilip Kumar Ray, Mr. Gautam Sarkar, Mr. Yogesh Sonawane, Mr. Rajendra Kumar Patidar, Mr. Satya Vrat Dixit, Mr. Krishnendu Mukherjee.

The district administration of Indore - Mr. Nishant Warwade (erstwhile Collector, Indore) and the district nodal officers in Madhya Pradesh and Indore, especially Mr. Vikas Gupta and Mr. Ashish Pathak, The Madhya Pradesh Voluntary Health Association - Mr. Mukesh Sinha and the Chief Medical Office of Indore district.

The authors thank Pranav Mimani and Aishwarya Singh for excellent research assistance both on and off the field. The survey team at IFMR, led by Prasenjit Samanta, performed exceptionally. Financial support for this study was provided by the Initiative for What Works for Women and Girls in the Economy (IWWAGE) at IFMR (Chennai).

1. Executive Summary

- Air pollution is a grave public health concern, and indoor sources are major contributors. Cooking with solid fuels has disproportionately more adverse impact on women vis-à-vis men.
- Analysing oil marketing companies' data shows that providing information on the health hazards of indoor smoke from cooking with firewood and dung along with raising awareness of the LPG subsidy lead to a 6% increase in LPG refills purchased annually.
- In addition, raising awareness of health and LPG subsidy lead to almost 14% rise in monthly refill consumption, when we account for monthly variation in LPG price and seasonality in LPG refill consumption.
- Providing information on both health and subsidy also lead to a 51% increase in self-reported induction stove usage by the households.
- When households were provided information only on the adverse health effects of indoor smoke, there is no significant increase in refill consumption or induction stove usage, but households are more likely to have smoke outlet or separate cooking room.
- Thus, financial constraints of households are binding and a major impediment towards shifting to LPG. Improving the design of the LPG subsidy scheme could be critical to inducing LPG usage.
- The results highlight the *complementarity between health awareness and loosening financial constraints*. Poor, credit and liquidity constrained households may not be able to transition to regular usage of clean fuels even if they are made aware of the long-term damage caused to their health by indoor air pollution.
- More specifically, the findings underline the *importance of the design of public subsidy for clean fuels, both in terms of comprehension and timing*. Households that were able to better comprehend the cash-back nature of the LPG subsidy due to the awareness campaign, internalised the information that their out-of-pocket expenditure is lower than the market price they pay upfront, by increasing LPG refill purchases and electric

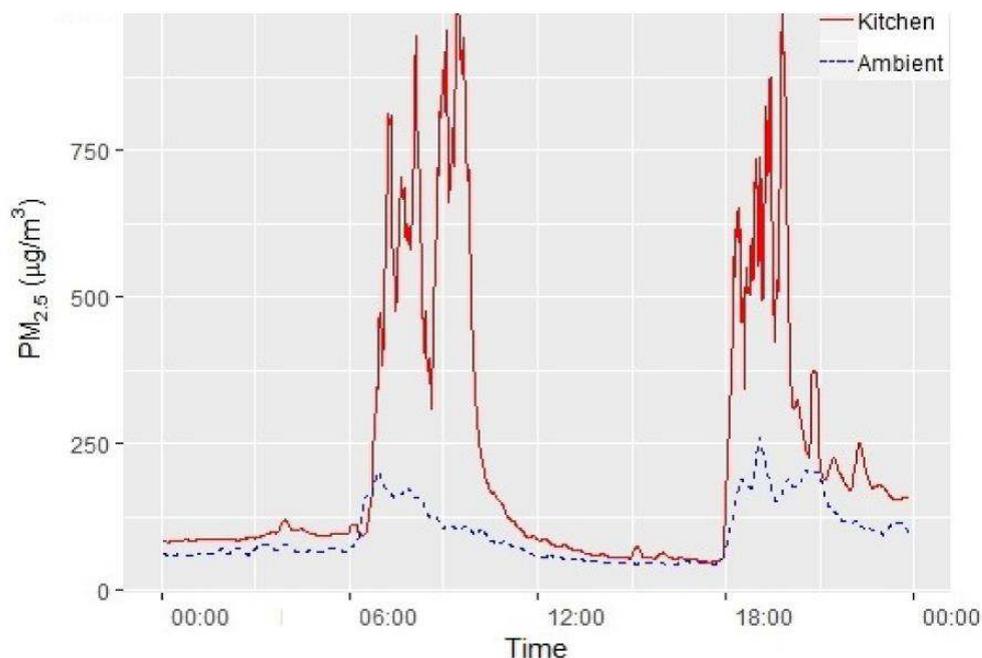
induction stoves. Thus, intimation of subsidy deposits through text messages in local languages is relevant.

- However, more importantly, since the government absorbs the variation in market price through the cash-back subsidy, *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 *Pradhan Mantri Garib Kalyan Yojana*, launched during the Covid-19 pandemic, deposits refill credit upfront to *Ujjwala* beneficiaries for three months and, according to media reports, has shown a record 13% increase in annual LPG consumption. However, this temporary and limited change in the subsidy scheme has seen only 50% success in the take-up of free cylinders. The research suggests a multipronged approach to induce households to use LPG regularly - combining measures that raise health and subsidy awareness along with a redesigned subsidy scheme.

2. Introduction - Context and Rationale

Air pollution levels in households that cook with solid fuels are high and skyrocket during meal preparations. Figure 1 below shows a high correlation between ambient and kitchen PM_{2.5}¹² levels during a typical day in a rural household in northern India. While the World Health Organization's guideline for 24-hour average exposure to this pollution is 25µg/m³, it rises with solid fuel use during meal preparations in these households – to 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, however, are the single largest contributor in much of the developing world (Liu *et al.* 2016).

Figure 1. Indoor and outdoor PM_{2.5} concentrations in a North-Indian village



Notes: The solid line plots 15-minute moving averages of PM_{2.5} concentrations over a day (10 February 2019) measured in the kitchen of a household that cooks with solid fuels in a North-Indian village. (ii) The dashed line shows data from an outdoor sensor in the same village and date. (iii) Both measures of PM_{2.5} are at one-minute resolution.

Source: Somanathan *et al.* (2019).

¹ PM_{2.5} refers to atmospheric particulate matter (PM) that have a diameter of less than 2.5 micrometers. Major components of PM are sulphate, nitrate, ammonia, sodium chloride, black carbon, mineral dust, and water. PM_{2.5} can enter the blood system and contribute to the risk of developing respiratory diseases, including lung cancer, besides cardiovascular diseases.

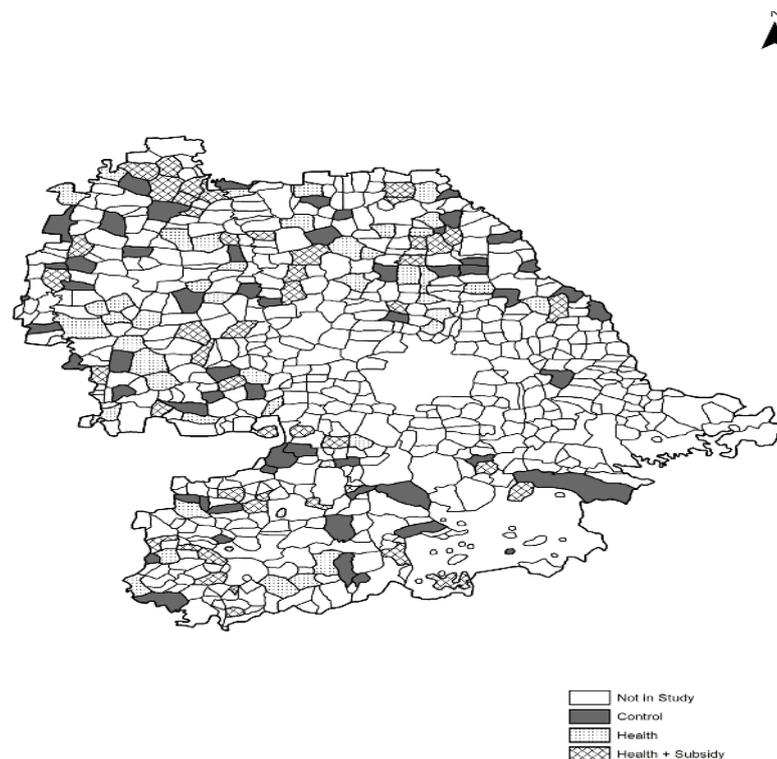
This study involves a 'cluster-RCT' (randomised controlled trial) in rural Madhya Pradesh, with the aim to induce households to switch to a clean cooking fuel, i.e. LPG. The study builds on a novel programme launched by the Government of India in 2016 - the Prime Minister's Ujjwala Yojana (PMUY) - to provide subsidised access to bottled LPG (liquid petroleum gas) to socio-economically disadvantaged households.

While the PMUY programme has been an enormous success, with more than 80 million households gaining access by September 2019, 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. One reason for this is that despite the subsidy, the cost can be considerable for poor households. Many 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. Study Design

The cluster - RCT was conducted in 150 randomly selected villages in the Indore district of Madhya Pradesh during 2018-2019. A baseline survey of these 150 villages was conducted during November-December 2018. In each village, 20 households were randomly chosen to be a part of the study, giving a total sample of 3000. These households were asked whether or not they currently have an LPG connection. If they did, details of the connection, including unique consumer ID, and number of refills in the past year were recorded from their consumer booklets. The LPG consumption data were matched with sales data from the OMCs for validation. 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 LPG connection status.

Figure 2. Map of the study area by 'treatment' status of villages



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 habitats due to significant forest cover.

Following the baseline survey an awareness campaign was conducted between January-September 2019. It aimed at increasing awareness about the health hazards of

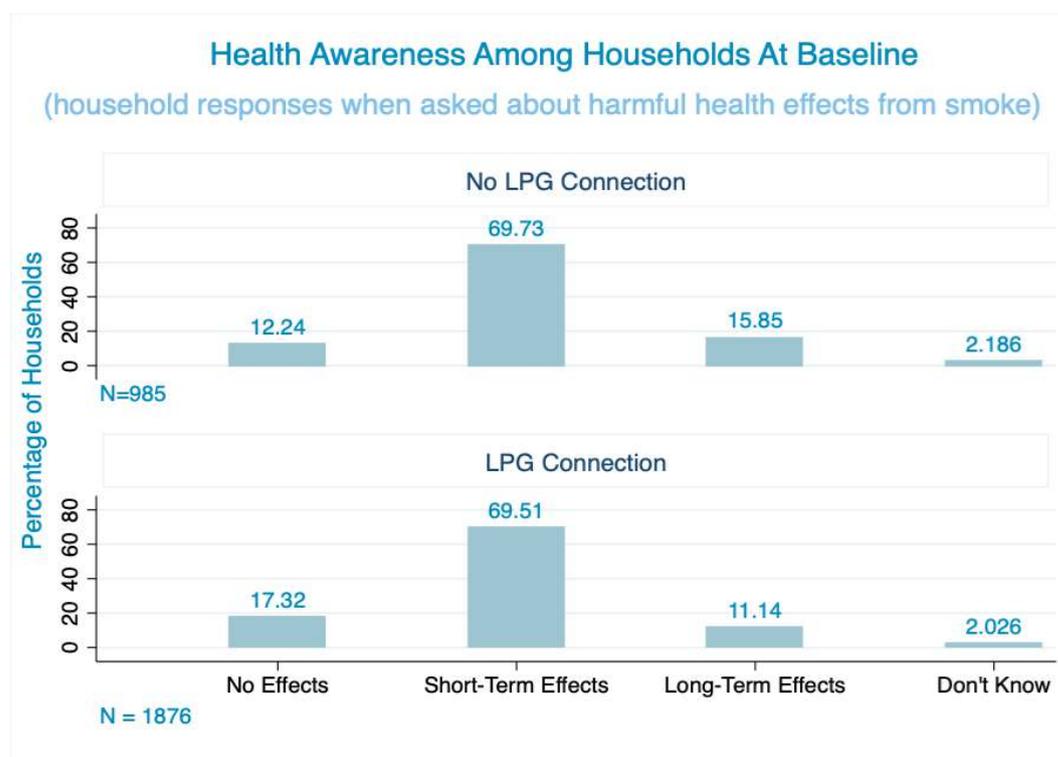
cooking with solid fuels and the universal financial subsidy scheme for LPG. The intervention had two 'treatment' arms into which 2/3rd of villages were randomized: one in which awareness about the adverse health effects of cooking with solid fuels was provided to households (50 villages), and a second which, in addition to health awareness, explained the existing cash-back payment deposited directly to consumers' bank accounts after they purchase an LPG refill at market price (50 villages). No awareness campaign was conducted in the third group of villages – the 'control' group (50 villages). The awareness campaign focused on two aspects:

A. Raising awareness of the long-term health hazards of indoor smoke

Lack of awareness of the health consequences may cause rural households to continue using solid fuels even if they can afford LPG. Understanding the impact of air-pollution is primary focus of the study. Medical research has shown that smoke is a contributing factor to respiratory diseases, cardiovascular malfunctions, cataract and can also cause low-birth weight or still births. The impact of smoke from biomass can be long-term due to sustained exposure and not merely cause short term discomfort. Households were asked about the ill effects of indoor air pollution, specifically the effects of smoke from traditional *chulha* in 2018 survey. They were provided with 4 options, viz., a) Smoke has no effects, b) Smoke has short term effects, c) Smoke has long term effects, and d) Do not know.

Figure 3 below shows that across all groups, the majority of households perceive the effects of *chulha*-smoke as having only short-term health impacts. Only 11-15% of households say that there can be long-term impacts on health. Surprisingly, a larger proportion of household within each group (12-17%), relative to those who agree that there can be long-term impacts, say that there are no harmful effects of smoke from traditional fuels such as wood and cow-dung. Thus awareness of the benefits of shifting to a clean fuel like LPG is very low and is a cause for concern.

Figure 3.



B. Simplifying the complexity of the LPG subsidy program:

To buy subsidised LPG, consumers have to 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 charge, a deposit for a cylinder (standard 14.2 kg capacity) and pressure regulator, and purchase a rubber pipe at any OMC's local distributor or 'dealer'. This is an upfront cost of about Rs. 3,200, which could easily be two weeks' worth of household income in rural areas.

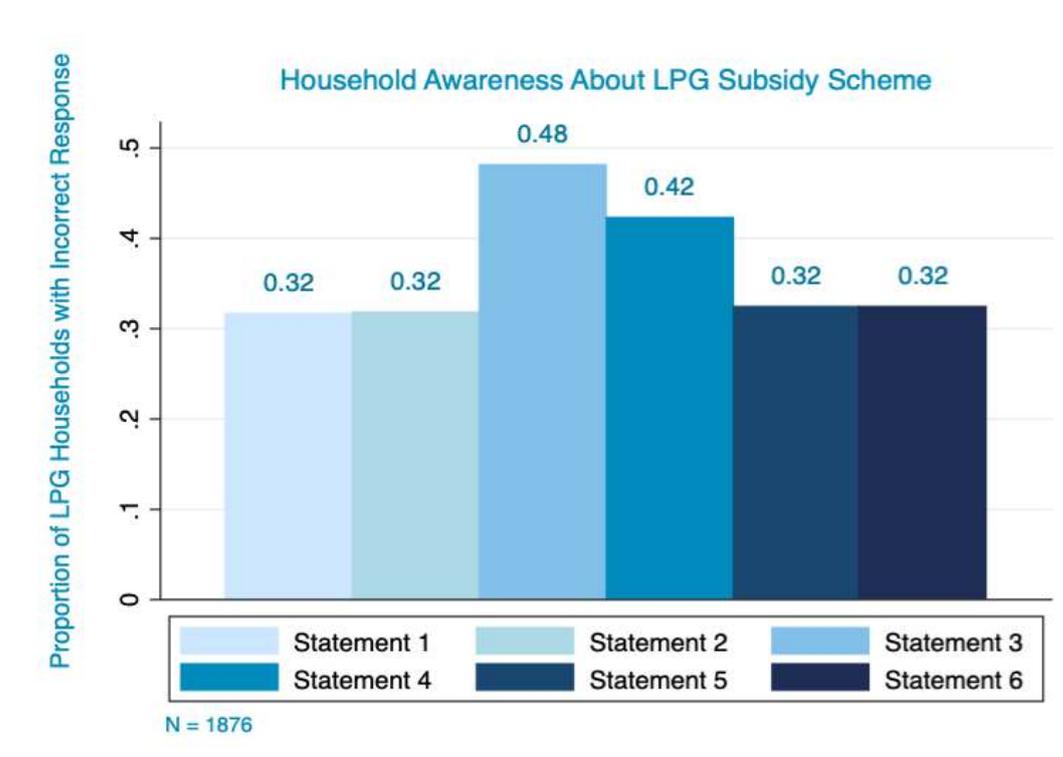
Since 2013, all residential LPG consumers in India, irrespective of income, receive a 'direct benefit transfer' (DBT) for up to 12 cylinder refills in a year. This means that when a consumer with an LPG connection buys a cylinder of LPG, s/he pays the market price to the dealer and receives a transfer to his/her bank account for the amount of the subsidy to which s/he is entitled, within the next 2-3 days. The market price of a cylinder varied between Rs. 654 and Rs. 879, during November 2017-October 2018, in tandem with the price of imported liquefied natural gas. The government has kept the subsidised price very stable at around Rs. 500 so that the corresponding subsidy delivered by DBT varied between Rs. 159 and Rs. 376 during this period.

To expand access to LPG, the Government of India launched the *Pradhan Mantri Ujjwala Yojana* (PMUY) in April 2016. PMUY is the most extensive programme on access to clean fuel in the world. The programme mandates that a woman in a rural, socioeconomically disadvantaged household, obtaining an LPG connection (giving a right to buy subsidised gas) bears no upfront cost. The security deposit, along with administrative charges for a connection, are covered by the government. The beneficiary also receives an interest-free loan from the OMC for the purchase of the stove and the first LPG cylinder.

However, inspite of the PMUY program only 69% of households in our sample had an LPG connection in 2018. Moreover, the average annual consumption of LPG refills was only about 3 cylinders. Many rural households are unaware of the subsidy on LPG because it is deposited in a bank account that they 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 (for example, Hindi in North India). Physical or remote access to 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, credit and liquidity-constrained consumers may not be able to either comprehend or take advantage of the subsidy.

Figure 4 below shows the proportion of households with an official LPG connection that responded incorrectly to questions related to the LPG subsidy. As can be seen from the figure, a significant proportion of the households do not comprehend the cash-back nature of the scheme, do not receive intimation of the subsidy deposit and believe that they are not entitled to the subsidy.

Figure 4. LPG subsidy awareness



Notes: Statements mentioned in the legend of the figure above refer to as follows :-

Statement 1: When I buy an LPG cylinder, the government deposits some amount in my bank account.

Statement 2: Every time, I pay the same amount for an LPG cylinder to the dealer.

Statement 3: My out of pocket expenditure on an LPG cylinder is less than what I pay in the market.

Statement 4: If my household uses a 14.2 kg cylinder refill per month then, it costs me approx. Rs.20 per day.

Statement 5: When LPG subsidy is deposited in the bank account, I get a message on my phone number.

Statement 6: The refill subsidy is given only to PMUY/ Ujjwala connection households.

Following the baseline, in January 2019, the intervention to increase adoption and regular usage of LPG was initiated for nine months, until September 2019. The 150 villages were randomly assigned to one of three treatment arms with 50 villages each: (i) **Health** awareness (ii) **Health and Subsidy** awareness (iii) No awareness campaign (**Control** group). The intervention leveraged the existing public health system by engaging Accredited Social Health Activists (ASHA) to provide information to households in a door-to-door campaign.

ASHAs were trained by an NGO, along with the research team. ASHAs were made aware of the adverse health impacts of solid fuels, including a list of diseases, their

symptoms, and consequences. For the second treatment arm, details of the subsidy and its cash-back design were also explained. They were then provided hand-held tablets that contained videos, and a campaign manual, and detailed written scripts to follow for up to six household visits. The cost of the information campaign was low – approximately Rs. 300 per household.

The information on health (**Health** awareness) 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. A licensed medical doctor in the videos provided information about long-term health impacts like low birth weight, asthma, cardiovascular disease, and lung cancer, of indoor smoke. 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 ended with the doctor advising the household to ensure an outlet for smoke from the traditional *chulha* and to use an induction stove for cooking if the household is unable to obtain an LPG refill.

In the health and financial subsidy treatment arm (**Health and Subsidy** awareness), besides the health awareness described above, the details of the LPG subsidy and its cash-back design were also explained. This included explanation of the direct benefit transferred to the beneficiary bank account on each purchase of up to 12 cylinders per year per connection by the government and its intimation through text messages. Households were 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.

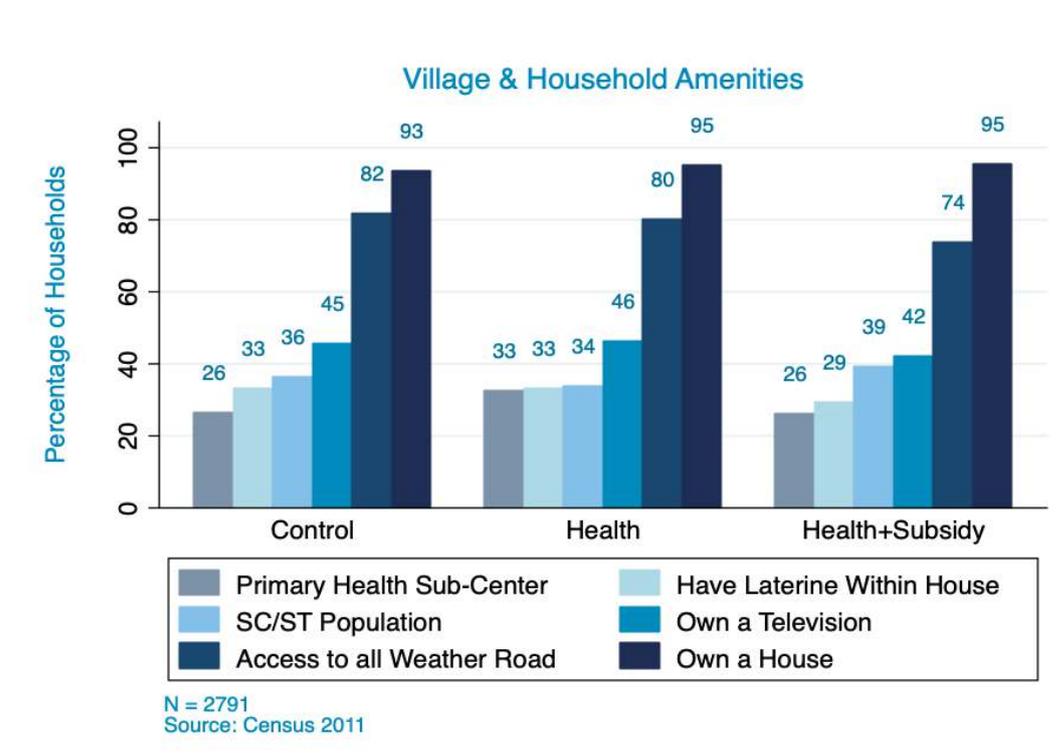
Following the completion of the intervention, the endline survey was conducted between late October and December 2019, during which the households surveyed in the baseline were revisited.

4. Sample and Data Description

4.1. Village Characteristics (Census of India, 2011)

Figure 5 below depicts the average of some of the village and household amenities across the control and treatment villages in our study sample. The figure mainly suggests that due to the randomization design, villages assigned to the control and treatment group are not significantly different from each other with respect to the developmental or socio-economic factors such as demographic composition (*proportion of SC/ST population*), infrastructure (*all weather road*), education, sanitation (*latrine within house*) or health facilities (*health sub-centers*). More importantly, we find no statistical variation in the amount of household wealth (*own a house*) and owned assets (*own television*) which can play an important role in determining the financial capacity toward LPG usage and refill consumption.

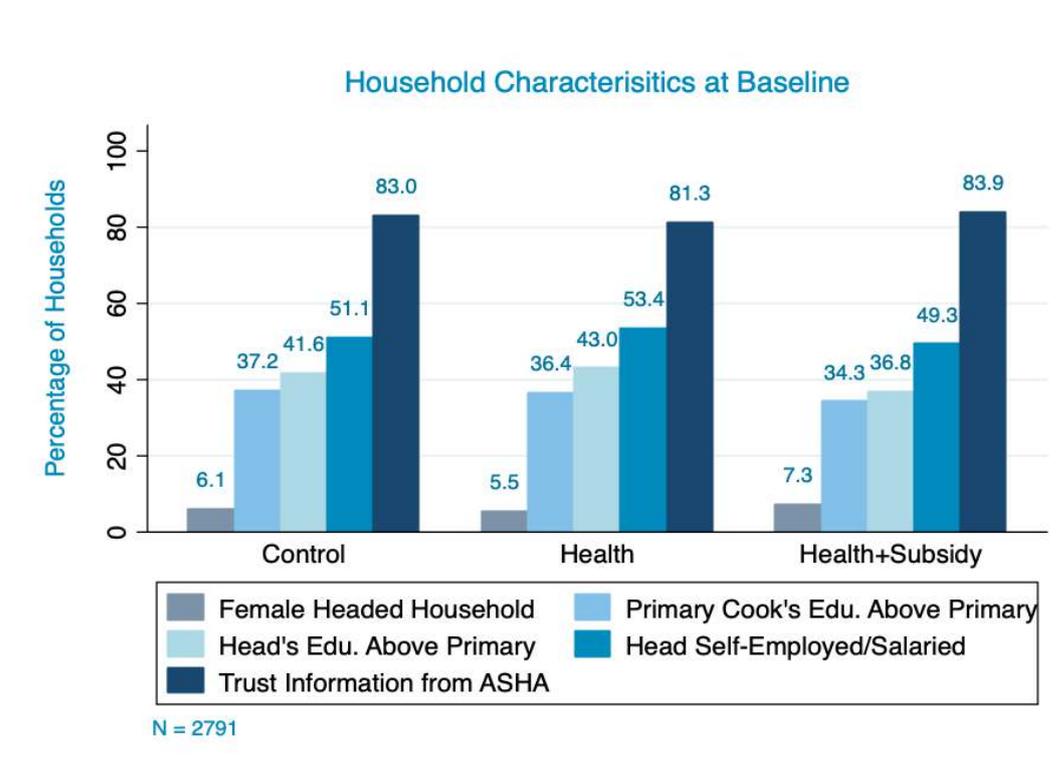
Figure 5.



4.2. Household Characteristics (Baseline Survey Data, 2018)

Figure 6 below shows similar comparisons of household characteristics but taken from our baseline survey data. Pair-wise comparisons between any two treatment groups in our sample show that households do not differ by assignment of treatment in their perceptions such as showing trust in ASHAs or observable characteristics such as head's education and occupation, primary cook's education, etc. More than 80% percent households trust information provided by the ASHAs, which strengthens the case for using these rural health workers as our channel of information dissemination. Further, more than half of our sample cover households whose head is either self-occupied or a salaried employee (as opposed to a wage labourer), suggesting that these households have relatively better financial conditions and thus, have a scope for switching to LPG and/or spending more on refill purchases.

Figure 6.



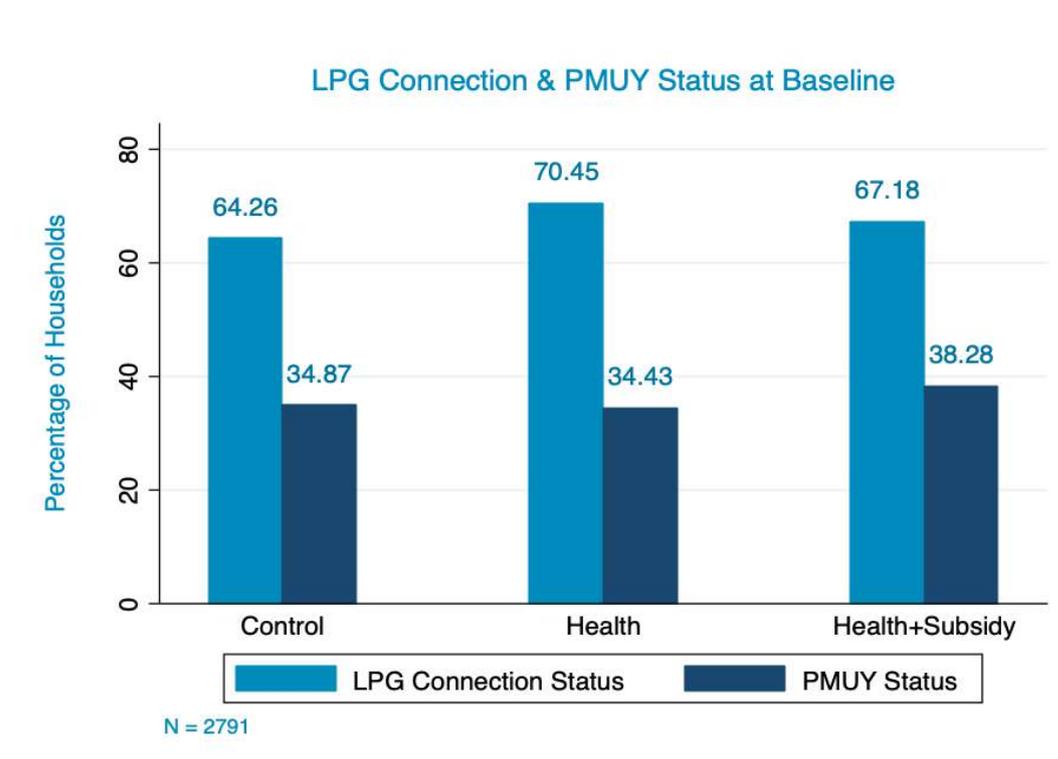
4.3. LPG Related Characteristics (Baseline Survey Data, 2018)

In our survey, we used the household's LPG consumption booklet to record its unique consumer ID which we used later to match each of our sampled household from the Oil Marketing Company's (OMC) consumer and sales records. We were able to verify the LPG connection details, no. of refill purchased, and the date of each refill purchase for 97% of our sampled LPG households.

4.3.1. LPG Connection & PMUY Status

Figure 7 below shows that at baseline, the three treatment groups were not different from each other in terms of the percentage of households with LPG connection. Further, within the LPG connection households, approximately the same proportion have an LPG connection under the PMUY status.

Figure 7.



4.3.2. Seasonal LPG Refill Consumption & Distance from LPG Distributor

Next, we used the recorded dates of each refill purchase by the LPG connection household to aggregate its refill consumption. We did this for the household's annual refill consumption as well as the seasonal consumption across summer, monsoon and winter.

Figure 8 below shows that average refill consumption *per month* doesn't vary across the control and treatment households for each of the three seasons. This approximates to a little over 3 refills consumed per household per year in our sample. Next, we use the geocodes of the households and LPG dealers to calculate the average distance between them. Figure 9 below shows that irrespective of the treatment assignment, a household with LPG in our sample is on an average *roughly* 5 km away from its nearest located LPG dealer. Overall, these figures suggest that households across the three groups are statistically similar in terms of LPG usage, consumption and any other supply side factor that may affect LPG consumption. We can therefore, say that our randomization of villages into the three arms was successful.

Figure 8.

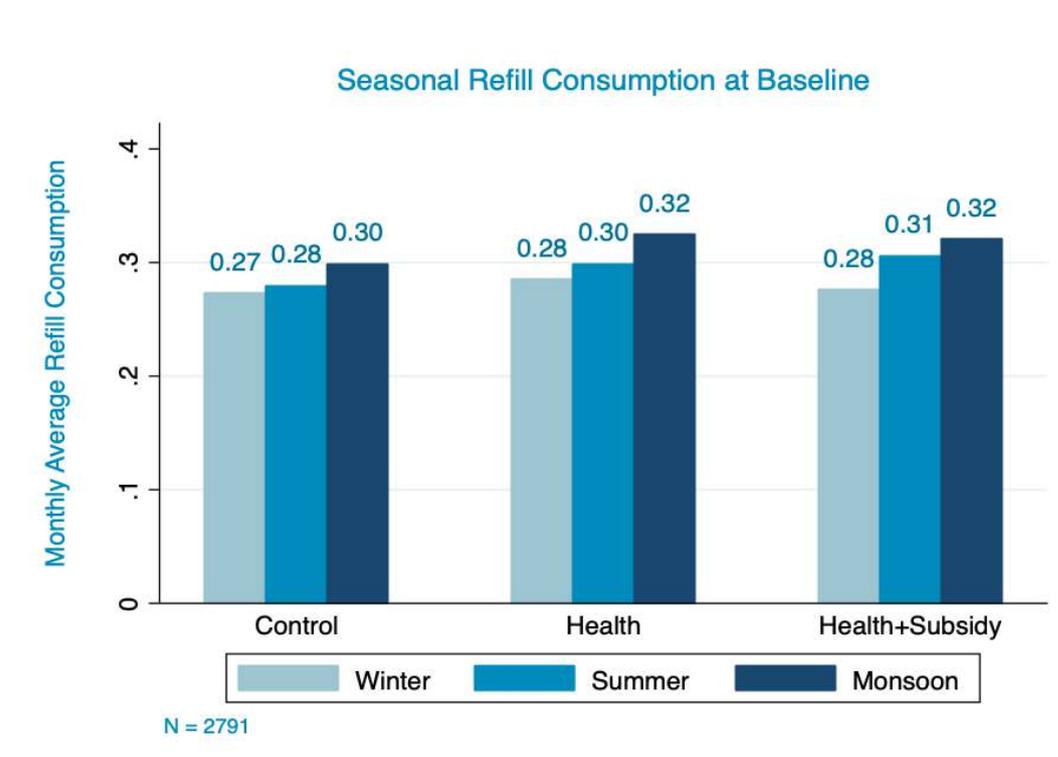
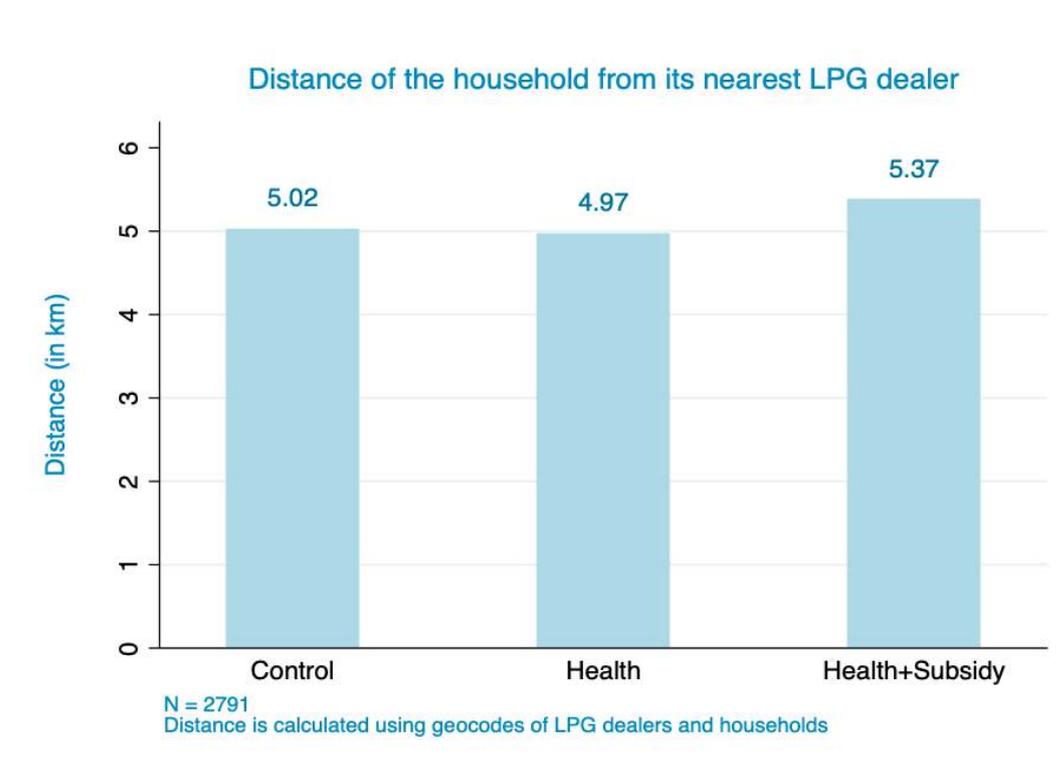


Figure 9.



4.4. Household Fuel Consumption

4.4.1. Fuel Usage

Figure 10 below shows that firewood and dung usage is very high in our study sample and does not differ across the groups. Over 70% of the households report using LPG for cooking, higher than those with an LPG connection. Induction stove usage is very low at about 5%, overall.

4.4.2. Solid Fuel Collection

On an average, households collect and make more than 30 units of dung and over 10 kgs. of firewood in the previous month (see Figure 11 below).

Figure 10.

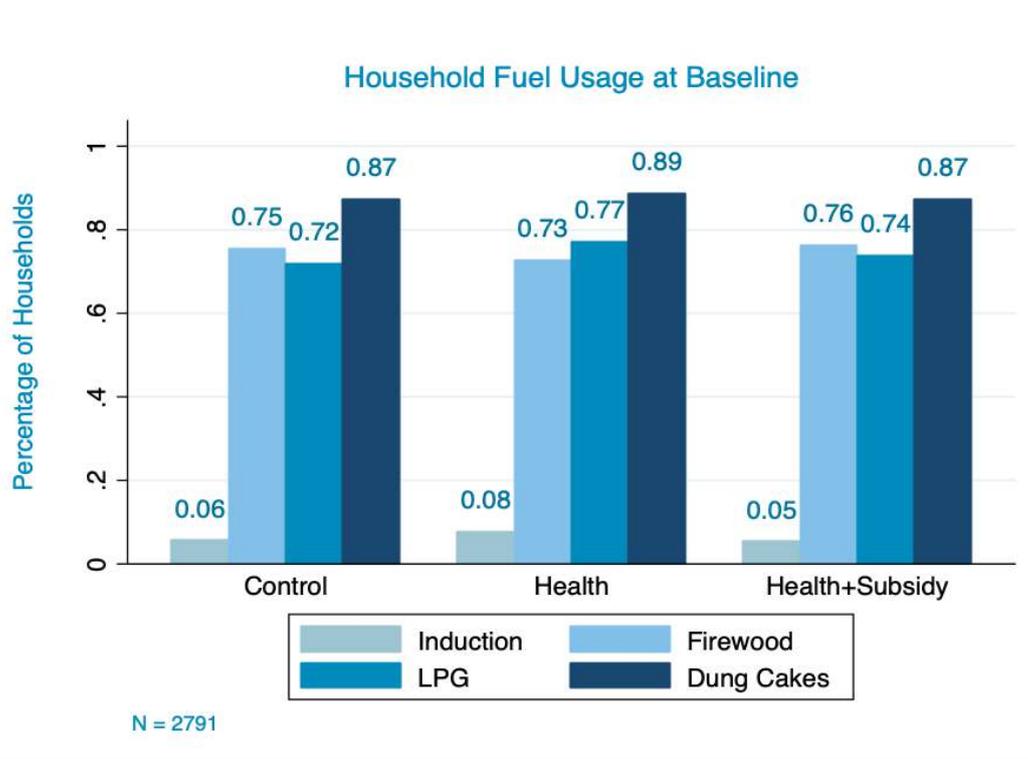
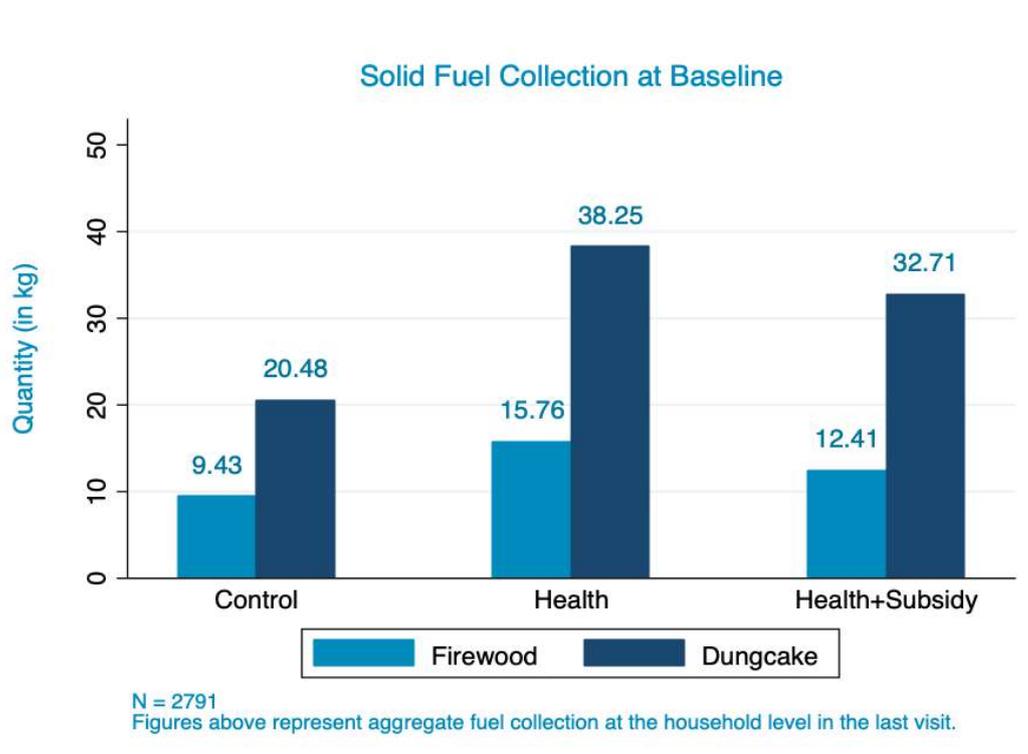


Figure 11.



5. Findings - Impact of Information Campaign

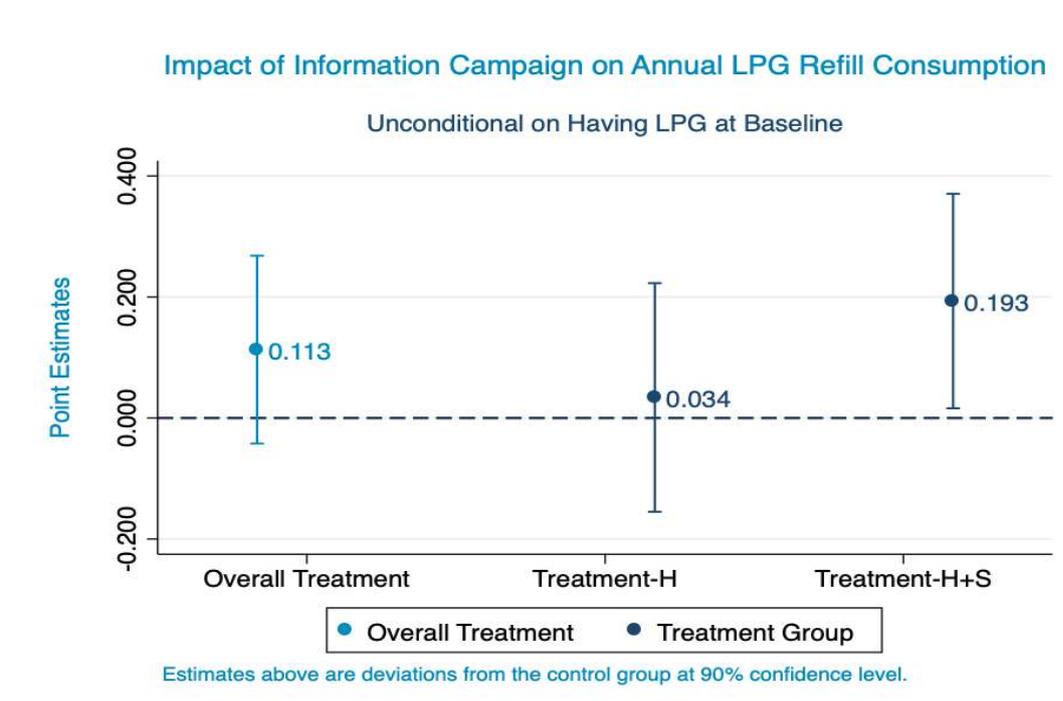
We study impacts by comparing household responses after the campaign began in 2019 and before the campaign in 2018 in treatment groups relative to the control group.

5.1. LPG Refill Consumption

5.1.1. Annual Refill Consumption

On comparing the annual LPG refill consumption by households in our study sample before (Feb-Dec, 2018) and after (Feb-Dec, 2019) the intervention and, relative to the control group (for the same periods), we found that, (see Figure 12 below) our information campaign led to a small but significant increase in the consumption of LPG by 0.193 refills annually among the H+S treatment households. This suggests that providing combined information on the LPG subsidy scheme and health hazards of using solid fuels led to a 6% (given baseline annual refill consumption of 3.12) increase in annual LPG consumption compared to the households in the control group.

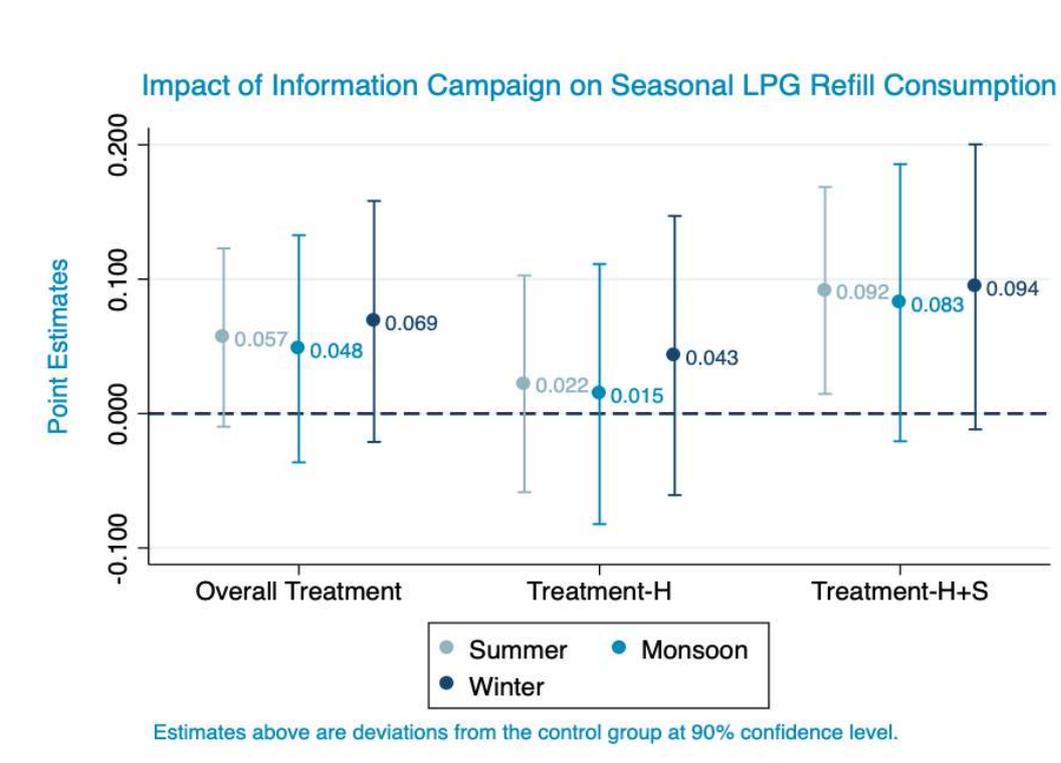
Figure 12.



5.1.2. Seasonal Refill Consumption

Figure 13 below depicts LPG refill consumption across the three main seasons witnessed in India. We find that the significant increase in the annual LPG consumption is in fact led by a significant increase of 0.092 LPG refills during the summer season, when LPG consumption is typically low due to the greater availability of solid fuels as compared to the rainy season.

Figure 13.

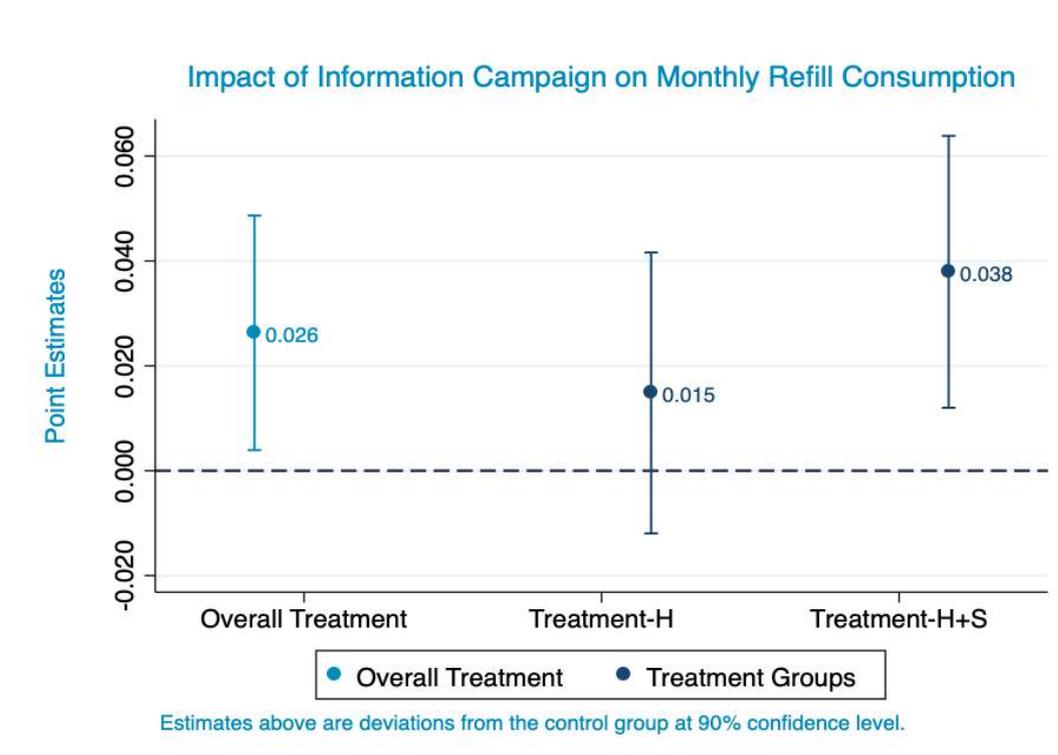


5.1.3. Monthly Refill Consumption & LPG Price

Running the analysis monthly allows us to take into consideration any observed variation in the LPG prices, which mostly updates in the market on the 1st of every month and also monthly decisions regarding LPG refill purchases. Further, LPG prices are determined by the prices internationally, and thus, serve as an exogenous factor in determining LPG consumption by our sampled households. In the overall treatment, we find a significant increase of 0.026 refills per month (see Figure 14) which corresponds to a 9.3% increase in the monthly refill consumption. This result is driven

by a monthly increase of 0.038 refills in our H+S treatment group corresponding to a 13.6% rise.

Figure 14.



5.2. Impact of Demand Side Factors

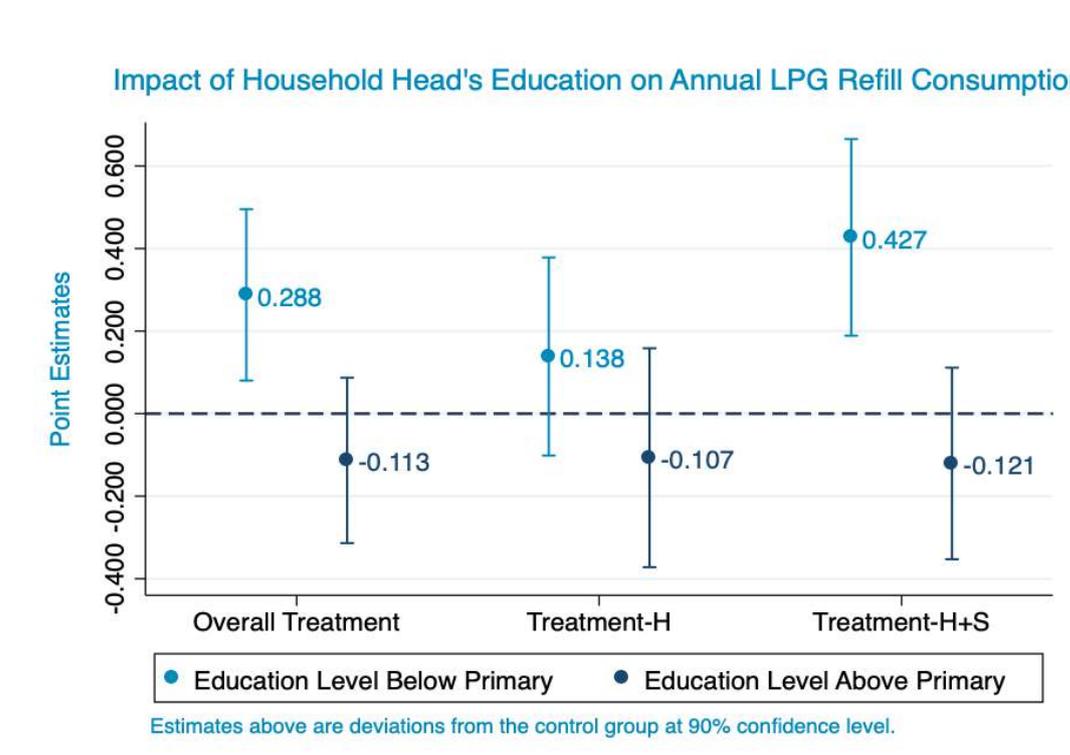
The impact of our intervention on the annual refill consumption as discussed above could vary with various demand side factors such as household's socio-economic status, household heads' educational/occupational qualifications or say, primary cook's decision making power, social well-being etc. In this section, we ascertain the role of two such crucial factors namely, *household head's education* and *household wealth index* which have shown to be significantly affecting annual LPG refill consumption when interacted with the treatment status of a household.

5.2.1. Household Head's Education

Less educated households are more likely to be less aware of the adverse health impacts from smoke, the benefits that accrue to beneficiaries under the ongoing PMUY scheme or even the current structure of direct transfers of subsidy to the bank account.

Figure 15 below shows that households with head educated below primary school level responded more to the assigned treatment than households with a head educated at primary level or above. There is a significant increase in annual LPG consumption by 0.288 and 0.427 refills due to the overall treatment and H+S treatment respectively, among households whose head has completed less than primary education. Further, households whose head has attained more than primary level of schooling didn't show any significant change/increase in the refill consumption. Overall, these results suggest that the effects on LPG refill consumption are more concentrated among the less educated households – precisely the type of households that ought to be more informed about the health hazards of indoor air pollution and financial implications of subsidy, and therefore, benefits of switching to cleaner fuels such as LPG.

Figure 15.

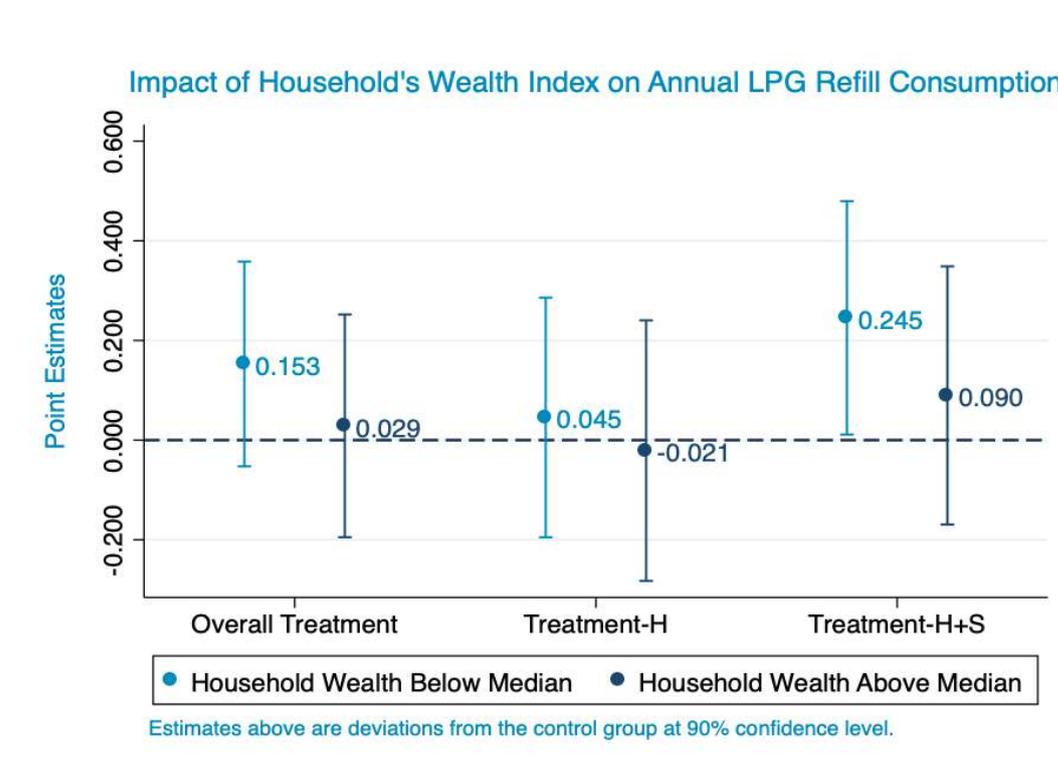


5.2.2. Household Wealth Index

In India, LPG customers get subsidy on each LPG refill bottle purchased, which then gets credited back into their bank accounts. As a result, the effective price per LPG refill bottle after deducting the subsidy is much lower than the actual price paid by the customer to the LPG dealer. This difference between the prices (also called as subsidy) can be very financially relieving for poorer households who are often faced with financial/liquidity constraints. We therefore, expect to see a relatively higher impact among the lower income households, especially, among those assigned to the H+S treatment group.

To study this impact we divide our sample into households below and above the median wealth of households in our study sample. In line with our expectation, we see that a significant increase of 0.245 LPG refills (*see Figure 16*) among the below median wealth households due to the H+S treatment. This result suggests that, relatively poorer households were more likely to respond to the combined information awareness campaign.

Figure 16.



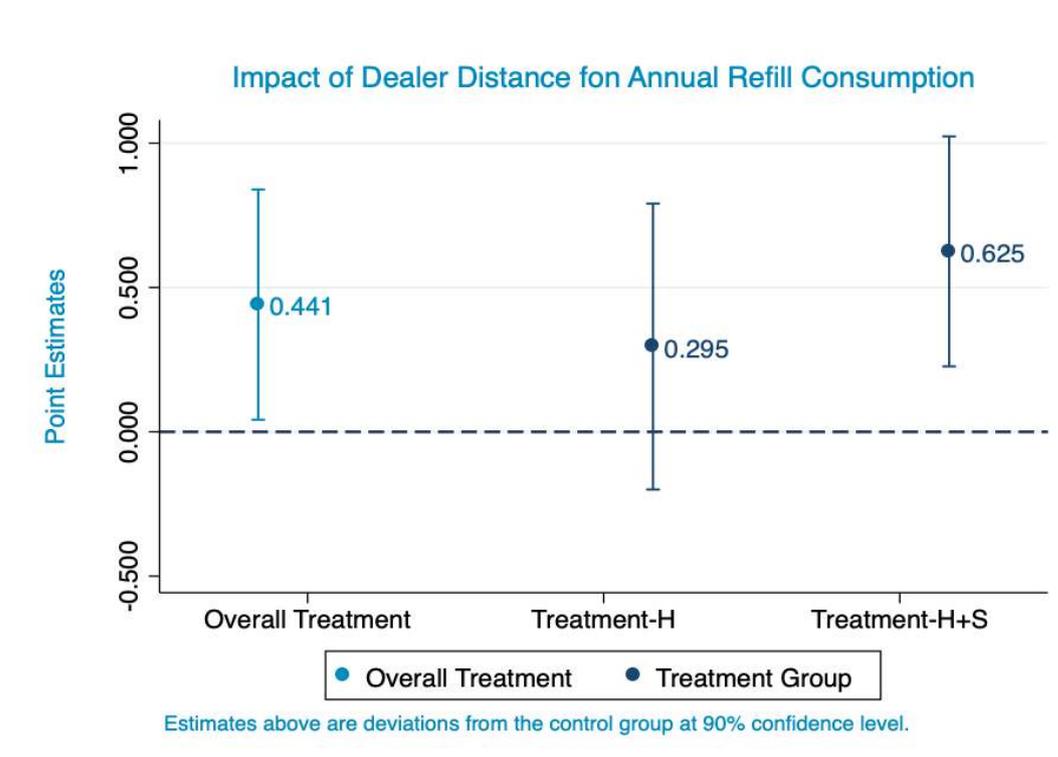
Impact of Supply Side Factors

Accessibility/timely delivery of LPG cylinders is one of the supply side constraints that can affect both LPG usage and its consumption level among households. In this section, we discuss distance of a household from its nearest LPG distributor as one of the supply side factors that affects cost of delivering LPG and hence, access of LPG

5.2.3. Distance from Nearest LPG Distributor

The cost of transporting LPG cylinders home is relatively higher if the LPG dealer is located far off from a household. The cost can be even higher in case of rural areas, where villages are farther away from the LPG market which is most likely stationed in an urban/semi-urban area. Households located far away from their dealer can get discouraged in their usage and consumption of LPG due to higher transportation costs of delivering LPG cylinders the burden of which falls on the household. Therefore, reducing supply-side constraints particularly, distance from the LPG dealer can have a significant effect on the take-up of cleaner fuels. We estimate this effect by calculating distance between each household in our sample and its nearest serving LPG dealer using geodetic distances based on their geolocations. Annual consumption of refills significantly go up by 0.441 and 0.625 in the overall treatment and H+S treatment groups, respectively, conditional on distance to dealer (*see Figure 17*). We find a negative but marginally insignificant effect when we include an interaction term of treatment H+S and distance to the nearest LPG dealer. The negative sign suggests that intervention programmes such as our information campaign have the potential to raise LPG consumption if the household is assigned the nearest located LPG distributor.

Figure 17.



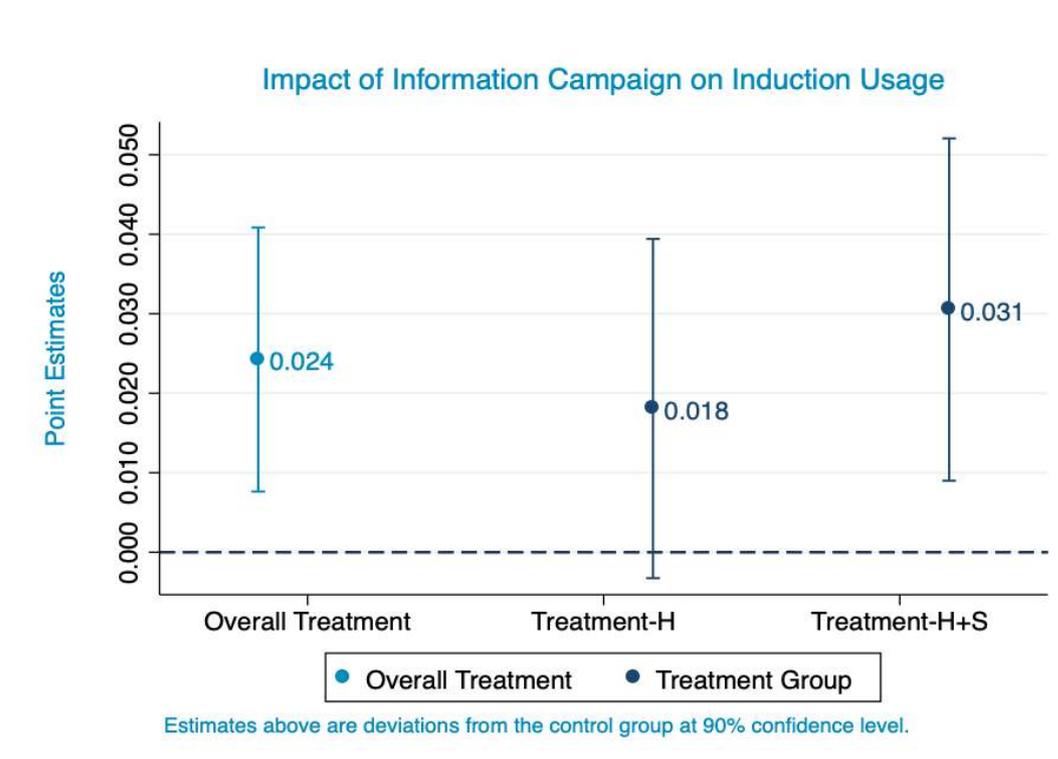
5.3. Impact on Household Behaviour and Other Fuels

Next, we discuss some of the alternate behavioural measures that can be very effective in reducing a household's exposure to smoke from use of traditional cooking fuels. We explore this further in this section through household's usage of electric stove / induction, access to a separate cooking area and access to a smoke outlet or chimney in 2019 (after information campaign) relative to 2018 (before campaign) vis-à-vis the control group.

5.3.1. Induction Usage

We find a dramatic increase in usage of induction stoves by 2.4 percentage points (*see Figure 18*) which corresponds to a 40 percent increase from baseline. This increase in the overall treatment is fuelled by a more than 51 percent increase in adoption of electric stoves among the households that were assigned to the H+S treatment.

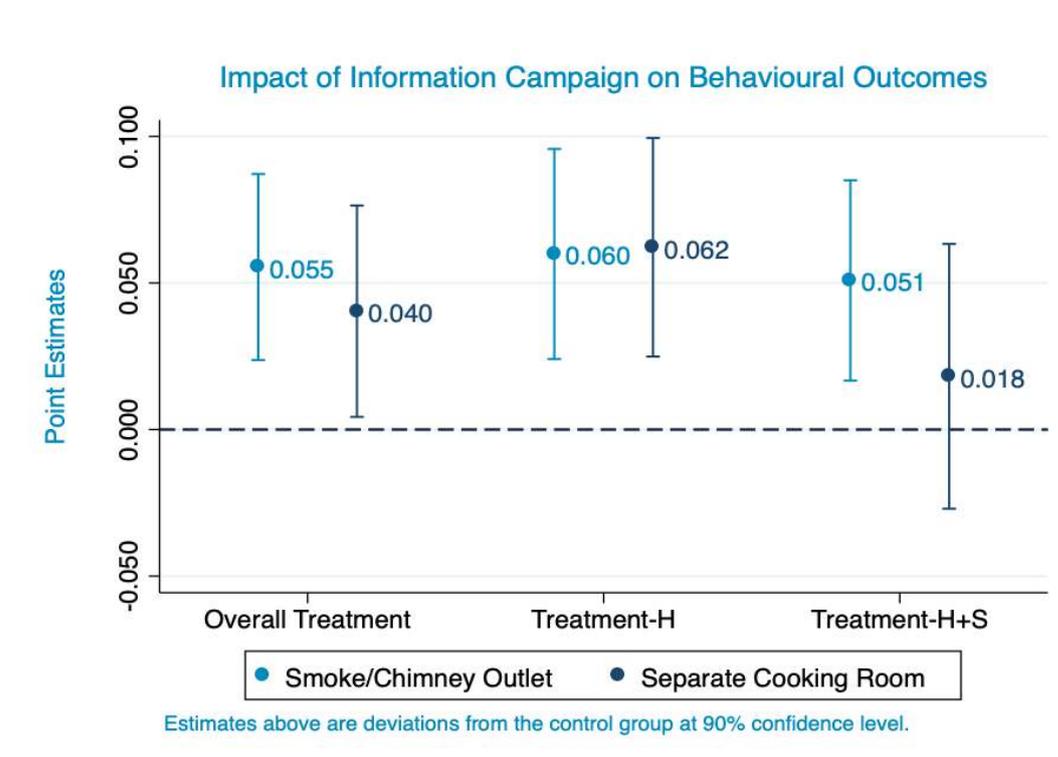
Figure 18.



5.4.2. Smoke Outlet & Separate Cooking Area

Although the health intervention alone did not increase LPG refill consumption, it led to significant behavioural changes which can be very effective in mitigating the inhalation of indoor smoke from cooking on solid fuels. Households in the health intervention (*refer to Figure 19*) alone experienced a 6 percentage point increase in the likelihood of having an outlet for smoke and use of a separate room as kitchen, as compared to the households in the control group which did not receive any information from the rural health workers.

Figure 19.

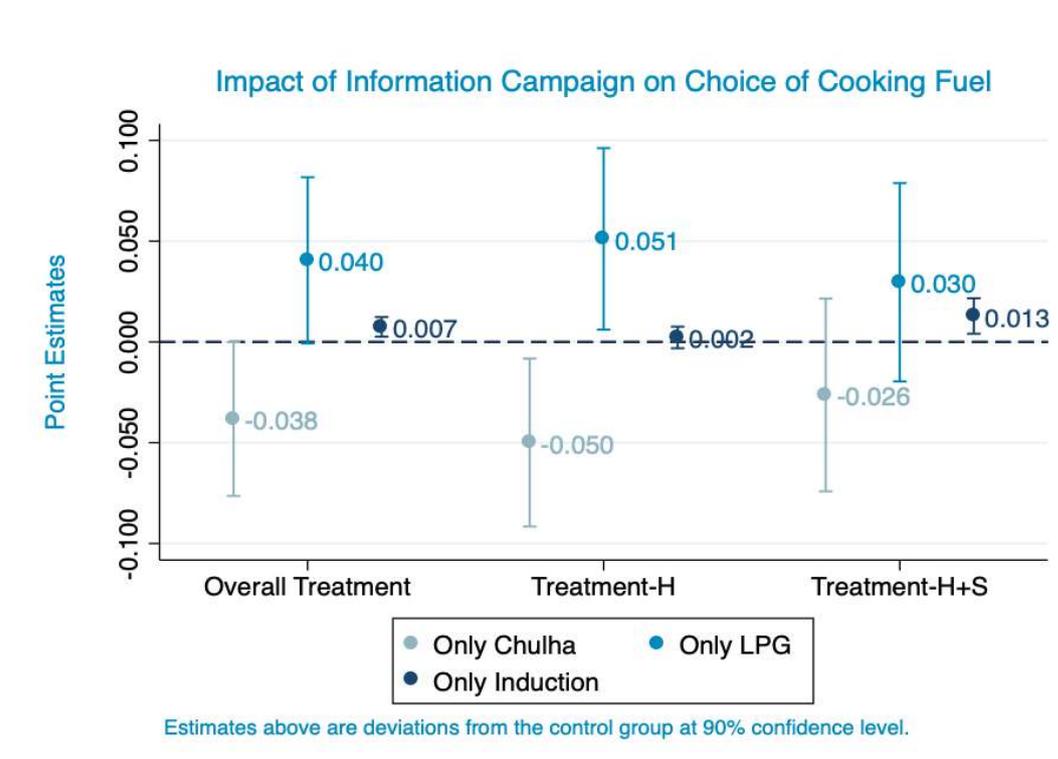


5.4. Cooking Fuel Usage

5.4.1. Fuel Used in Cooking Last Meal

We asked the primary cook of each household which cooking fuel they used to prepare the last meal before the survey. *Figure 20* below shows a 5 percentage point decline in the likelihood of households using the traditional *chulha* to cook their last meal in the *health only* treatment group. Similarly, households were 5.1 percentage point more likely to adopt cleaner cooking fuels such as LPG when assigned to the *health only* treatment. We observe similar trends of increased probability of induction usage by 0.7 and 1.3 percentage points due to the overall and H+S treatment respectively. This increased induction use correspond to massive effect sizes of 70 percent and 130 percent respectively.

Figure 20.



5.4.2. Solid Fuel Collection & No. of Fuel Collection Visits

Corresponding to a decline in the use of the traditional *chulha*, we find a decline in the collection and usage of solid fuels that are used for cooking meals on the *chulha* – namely *firwood* and *dungcakes*. We find a 4.1 percentage point decline (see Figure 21) in the probability of a household collecting firewood in the previous month due to overall treatment and a 6.3 percentage point decline due to the H+S treatment. Further, the number of trips made by the household to collect firewood in a typical week in the previous month declined by 0.188 trips due to the H+S treatment (see Figure 22).

We find a larger and more significant effect on dung collection and dung making/collection trips. The probability that the household either makes or collects dung (or does both) declined by 6.1 percentage point due to the overall treatment and by 5.6 percentage points due to H+S treatment (see Figure 21). Significant impacts of

both health only and H+S treatment were found in reducing the no. of visits made for making or collecting dung (see Figure 22).

Figure 21.

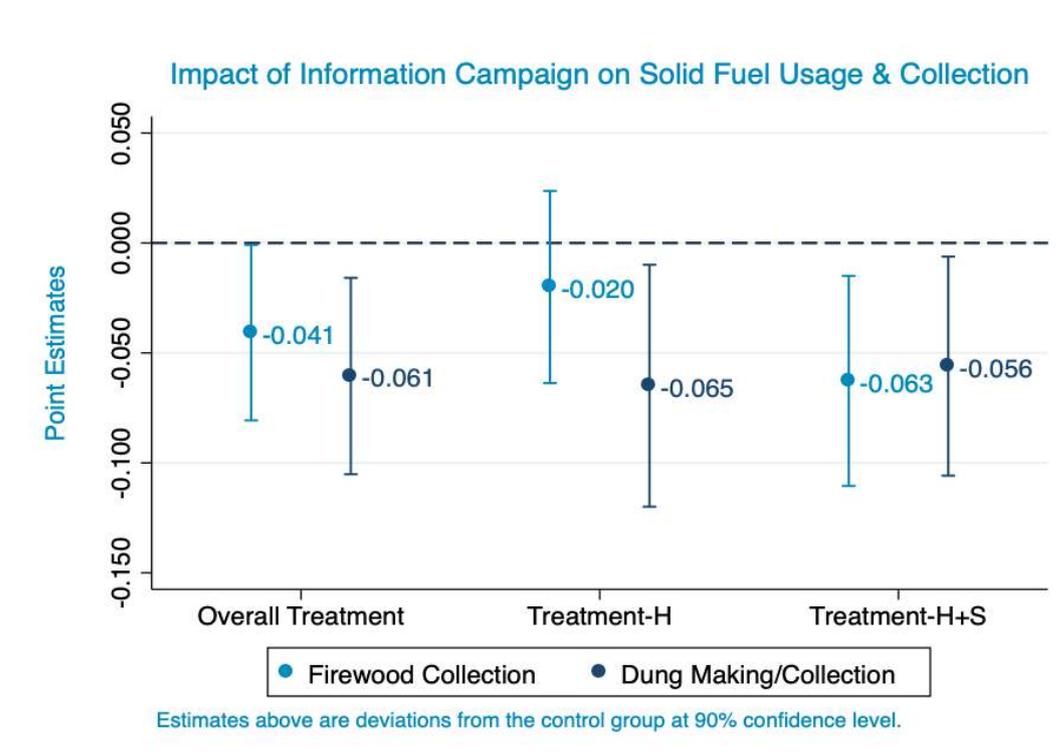
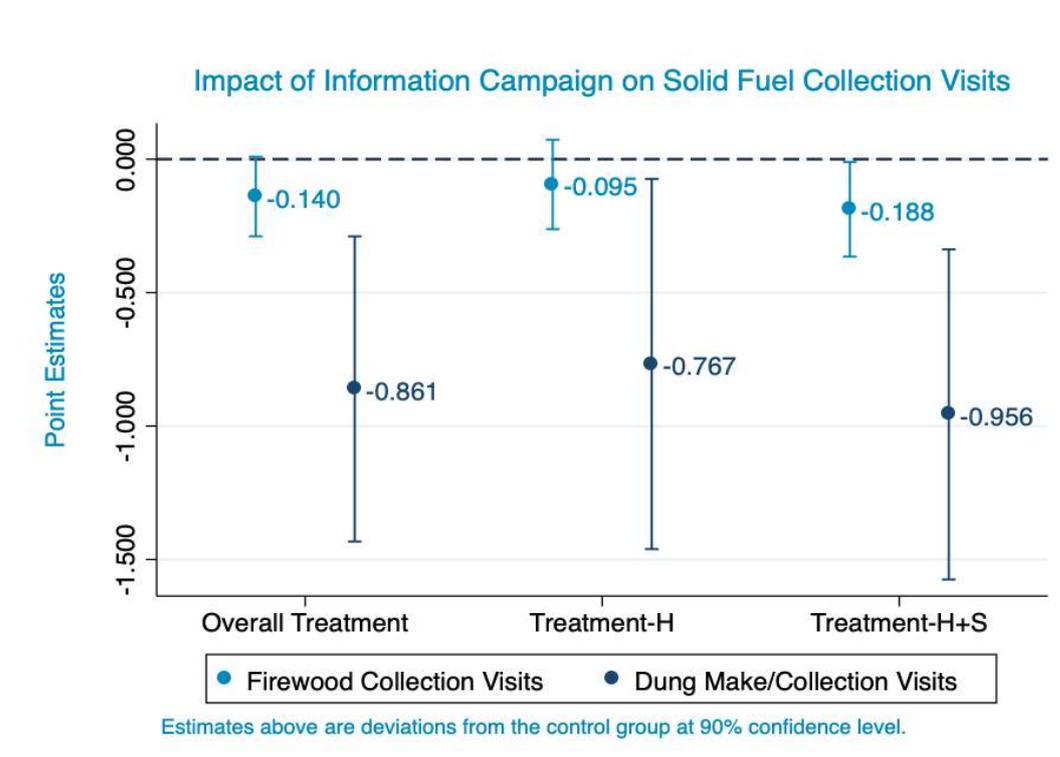


Figure 22.



6. Conclusions and Policy Recommendations

- Poor households may not be able to transition to regular usage of clean fuels even when they are made aware of the long-term damage caused to their health by indoor air pollution due to financial constraints – lack of liquidity and absence of credit access.
- The findings underline the *importance of the design of public subsidy for clean fuels, both in terms of timing and comprehension*. Households that were provided information on the cash-back feature of the LPG subsidy along with health awareness (H+S), internalised the information that their out-of-pocket expenditure is lower than the market price they pay upfront and responded by marginally increasing their LPG refill purchases and usage of electric induction stoves - both of which incur significant out-of-pocket costs. Thus, improving the comprehension of the LPG subsidy scheme and intimation of subsidy deposits through text messages in local languages can be helpful in increasing usage of clean fuels.
- More importantly, since the government absorbs the variation in market price through the cash-back subsidy, *depositing the subsidy amount upfront into the accounts of beneficiary households* could substantively reduce the financial burden on households that are liquidity or credit constrained, and can further increase their LPG take-up. Thus, the timing of the subsidy transfer should be rethought by the government.
- The *Pradhan Mantri Garib Kalyan Yojana*, launched during the Covid-19 pandemic, deposits refill credit upfront to *Ujjwala* beneficiaries for three months and, according to media reports, has shown a record 13% increase in annual LPG consumption. However, this temporary and limited change in the subsidy scheme has seen only 50% success in the take-up of free cylinders. *This research suggests a multipronged approach to induce households to use LPG regularly – combining measures that raise health and subsidy awareness along with a redesigned subsidy scheme.*

7. References

Afridi, F., Debnath, S. and Somanathan, E., 2020. *A Breath of Fresh Air: Raising Awareness for Clean Fuel Adoption*. Working paper, Indian Statistical Institute, Delhi.

Cohen, A.J., Brauer, M., Burnett, R., Anderson, H.R., Frostad, J., Estep, K., Balakrishnan, K., Brunekreef, B., Dandona, L., Dandona, R. and Feigin, V., 2017. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *The Lancet*, 389(10082), pp.1907-1918.

Liu, J., Mauzerall, D.L., Chen, Q., Zhang, Q., Song, Y., Peng, W., Klimont, Z., Qiu, X., Zhang, S., Hu, M. and Lin, W., 2016. Air pollutant emissions from Chinese households: A major and underappreciated ambient pollution source. *Proceedings of the National Academy of Sciences*, 113(28), pp.7756-7761.