THE EFFECT OF HOUSEHOLD INCOME ON COOKING FUEL DEMAND IN IBADAN

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Abstract

The recent escalation of cooking gas price in Nigeria raises concerns about how possible the country can achieve substantial transition to cleaner energy use by 2030 as espoused in the Sustainable Development Goals. In addition, the deteriorating economic condition of the country shrinks household income making it more difficult for many households to sustain cooking fuel demand. This study sought to examine the impact of household income on cooking gas demand in Ibadan based on the propositions of the energy ladder hypothesis and the fuel stacking theory. The study used a sample of 127 households in Ibadan and applied linear regression technique based on OLS. There was evidence of fuel stacking rather than a linear progression up the energy ladder as suggested by the energy ladder hypothesis. Moreover, the study established that cooking gas obeys the law of demand which means that it is a normal good. However, the demand for cooking gas is found to be inelastic with own price, but elastic with respect to price of alternative cooking fuels. The study recommends an improvement in Nigerian's economic wellbeing through better macroeconomic policies and solutions to rising gas prices as means of improving cooking gas affordability for Nigerian households.

Keywords: *Energy ladder; Fuel stacking; Demand; Prices.*

INTRODUCTION

The issue of cooking fuel type and household energy consumption generally, have been a front burner topic both in policy circles and in the academia. Research suggests that household energy use connotes substantial consequences that are worthy of policy intervention. For instance, the nature of cooking fuel consumed is frequently linked to household health outcomes (James et al., 2020; Liu et al., 2020; Owusu Boadi & Kuitunen, 2006; Patel et al., 2019). According to Edwards & Langpap (2012) and Epstein et al. (2013) nonclean fuel for cooking could adversely impair both adult and child health. Some studies show that indoor use of unclean cooking fuel results in breathing problems (Jagger & Shively, 2014), sight issues (Pokhrel et al., 2005), cancer of the lung (Sapkota et al., 2008), and even, blood pressure problems (Baumgartner et al., 2011; Weinhold, 2011). Other studies report negative self-reported health status among persons who commonly cook with unclean fuels (Liao et al., 2016; Liu et al., 2017). In addition to the health hazards, biomass fuels are known to have negative environmental impacts. For instance, burning biomass fuels releases the so-called “greenhouse gases” which are known to deplete the earth’s ozone layer and cause climate change problems (Foell et al., 2011; Rosenthal et al., 2018). There is also the problem of vegetation loss and deforestation occurring due to excessive dependence on unclean cooking methods like firewood, and wood coal (Ochieng et al., 2020). Moreover, using unclean cooking fuels tend to take time (Martey et al., 2021) and women and children mostly at the receiving end, due to the hardship and the time spent to harvest the unclean fuels like firewood for use (Ochieng et al., 2020). Furthermore, because women and children perform the bulk of domestic house duties, they are more exposed to the negative health impacts of biofuels among which Oluwole et al. (2013) and Pekkanen et al. (2002) mention ocular damage, cardiovascular disease, tuberculosis, and other respiratory diseases.

Given the adverse effects of non-clean or heavy cooking fuel use, policymakers and other stakeholders have become quite interested in transitioning households to cleaner fuel consumption, especially in the developing countries. Consequently, policy interventions that target uplifting households up the so-called energy ladder are becoming increasingly popular (Dickinson et al., 2019; Kar et al., 2019; Ochieng et al., 2020; Saksena et al., 2018). Despite these efforts, the dependence on unclean cooking fuels remains relatively high in many of these countries. World bank estimates that more than 3 billion people still lack access to clean cooking fuels globally (Liu et al., 2020). Patel et al. (2019) confirms that nearly half of the world population are currently lacking access to clean fuels for cooking. This means that a substantial proportion of people worldwide are still relying on unclean cooking energy such as animal dung, charcoal, crop residue, and firewood. With regards to Sub-Saharan African countries, IEA estimates that nearly 760 million persons still cook with unclean fuels, a figure that represents around 80% of the region’s population (Olopade et al., 2017). Statistics on Nigeria report that more than 60% of the population to still rely on fire wood for most of their cooking (Adamu et al., 2020). This is consistent with IEA figures according to which 122 million persons in Nigeria rely on biofuels (Olopade et al., 2017). While a greater proportion of such households reside in rural areas, Adamu et al. (2020) insist that in even in the urban areas, the demand for bio-cooking fuels is still high.

In view of these challenges, scholars opine that a transition to cleaner cooking fuels like Liquified Natural Gas or ethanol remains pertinent (Foell et al., 2011; Gould & Urpelainen, 2018; Rosenthal et al., 2018; Schlag & Zuzarte, 2008). Nevertheless, the transition to cleaner cooking fuels in the developing countries have met with minimal success so far. Some research attributes the poor LPG adoption to market barriers in the developing countries that tend to escalate LPG prices (Schlag & Zuzarte, 2008). In Nigeria for example, statistics confirm that LPG prices have risen steadily over the recent years. On year-on-year basis, the price of 5 kg of cooking gas has rose by 83.69%

from February 2021 to February 2022 while that of 12.5 kg increased by 70.68% during the same period (NBS, 2022). To worsen matters, household consumption income as mirrored by consumption expenditures has also witnessed substantial decline in the recent past. From 2019q4, household consumption expenditure growth decline in real terms by 14.46% in 2020q1, a decline that was sustained in 2020q2 of around 5.02%. Despite recording two quarters of consecutive growth, household consumption declined further by 14.13% in 2021q1 and further by 0.34% in 2021q2.

Clearly, the rising cooking gas prices added to the household income decline in Nigeria connotes negative implications for sustaining household transition to cleaner cooking fuels in the country. Despite the implication of prices for cooking gas consumption in Nigeria, it is surprising that research conducted on the topic have largely ignored the role of price in the adoption of cooking gas and other cleaner fuels in the country. For example, outstanding studies like those of Ajayi (2018) and Adamu et al. (2020) examined determinants of cooking fuel choice among Nigerian households, but they remained silent on the issue of price. The recent study of Shari et al. (2022) comment that high price, household income, and household size are among the impediments to adopting clean cooking fuels, but their analysis ignores the role of prices. One notable study that accommodate both income and prices is that of Arawomo (2019) which was conducted among households in Ondo State. Still, the paucity of research in that combines the influences of price and income implies that further research is needed on the subject so as to facilitate consensus.

This study therefore extends the existing literature with a specific focus on Ibadan. Ibadan remains the largest city in West Africa, and the second largest after Cairo in terms of land mass. In terms of population, Ibadan retains the third position in Nigeria after Lagos and Kano, making it one of the likely states with the most cooking fuel demand in the country. Indeed, the previous paper by Adelekan & Jerome (2006) confirm that cooking gas consumption in Ibadan has been on the increase, making it an ideal location to study the influence of household income and price on cooking gas demand. The rest of the paper is arranged as follows. Section 2 present the literature review, Section 3 covers materials and methods, while Section 4 covers analysis and discussion. The paper is concluded with policy suggestions in Section 5.

LITERATURE REVIEW

From a theoretical perspective, the decision to consume cooking gas is usually linked with theories like the energy ladder hypothesis, the fuel stacking hypothesis, and consumption theory. The energy ladder hypothesis provides strong arguments in favour of moving to cleaner fuels as the household's socioeconomic status increases (Adamu et al., 2020; van der Kroon et al., 2013). One rationale for this substitution as stated by Hanna & Oliva (2015) is that unclean fuel could have negative outcomes on the household especially in terms of health, such that there is strong incentive for a shift away from such fuels as soon as the household has the ability to do so. In propagating the energy ladder hypothesis, Masera et al. (2000) agree that as households achieve higher socioeconomic status, they tend to prefer more advanced technology such as cleaner fuels for several reasons. Most importantly, the cleaner cooking methods help increase efficiency in energy use as per the lower pollution level associated with such fuels (Hiemstra-van der Horst & Hovorka, 2008; Saatkamp et al., 2000). In addition, there is the general opinion that such advanced technologies usually confer some form of prestige on the consumer since they are generally more expensive (Meried, 2021). As such, the energy ladder theory suggests that households' energy demand reacts strongly to income changes in accordance with the need to project status (Masera et al., 2000). One weak point identified with the energy ladder hypothesis is the rigid assumption that household energy demand exhibits an upward linear movement in relation with household income. Scholars like Adamu et al. (2020) opine that observed cooking fuel choices in developing countries like Nigeria do not always conform with the suggestions of theory because households in such countries typically consume a menu of clean and unclean cooking fuels simultaneously (Mekonnen & Köhlin, 2009).

In view of the weaknesses associated with the energy ladder theory, the fuel staking theory provides an alternative explanation frequently used to analyse household cooking fuel demand in the related literature. The main argument of the fuel staking theory is that households do not necessarily abandon cooking fuels in the lower rung of the energy ladder as they rise in socioeconomic status (Adamu et al., 2020; Baiyegunhi & Hassan, 2014; Dickinson et al., 2019; Nawaz & Iqbal, 2020). Rather, they more likely accommodate different fuel types which they use as the occasion demands. Alem et al. (2016), Masera et al. (2000), and Yadav et al. (2021) provide justification for why households might exhibit fuel stacking rather than a linear progression along the energy ladder. For instance, households do not wish to over depend on the cleaner cooking fuels so that sudden price hikes do not leave then vulnerable. In addition, households that cannot afford complete reliance on cleaner fuels would continue using lower fuel types even when income rises. Kowsari & Zerriffi (2011) Muller & Yan (2018) add that occasional supply shortages of modern cooking fuels would likely force households to backslide down the energy ladder from time to time. Moreover, cultural complexities in many developing countries could compel some household to not fully transition to cleaner cooking fuels even when they are able to (Masera et al., 2000).

Other than the energy ladder and fuel stacking hypotheses, the conceptual approach to analysing cooking fuel demand in existing studies implicit draw on traditional consumption theory. For example, many studies acknowledge that in demanding for cooking fuel, households are seeking to maximize utility (Edwards & Langpap, 2005; Gupta & Köhlin, 2006; Manning & Taylor, 2014; Nlom & Karimov, 2015), a behaviour that is consistent with the theory of consumption. In this regard, some researchers (e.g., Afrane & Ntiamoah, 2011; Singh et al., 2014) opine that cooking fuel consumption and the resulting environmental impact follows a life cycle process. Moreover, the notion that households flaunt new status when they move up the energy ladder relates closely with the idea of conspicuous consumption propagated in the relative income theory of consumption (see Alvarez-Cuadrado & van Long, 2011; Brown et al., 2015; Ellison, 2002). This notion is implied in the work of Link et al. (2012) who argue that household movement towards non-wood cooking fuels are governed to some extent, by social factors. Ekholm et al. (2010) equally observe that income distributions, rather than actual income has strong implications for cooking fuel choice, thus suggesting a social character of cooking fuel demand as proposed in the relative income hypothesis.

In view the different propositions, the literature documents diverse empirical evidence either supporting or refuting the suggested household cooking fuel consumption behaviours. Within the context of Nigeria, Baiyegunhi & Hassan (2014) laments the likely health impact of unclean fuel use among rural households in Kaduna state. On the basis of their concerns, their analysis investigate transition to cleaner cooking fuels in location of interest with the aid of multinomial logit regressions. Their evidence supports energy stacking rather than smooth transitions to cleaner fuels. Households in the studied area were found to rely more on firewood, but occasionally utilized cleaner cooking fuels as well. Similar evidence was published by Cheng & Urpelainen, (2014) who worked with a national sample of Indian households. The main results confirmed fuel stacking behaviour when it comes to fuel for cooking, but not for lightening. Hanna & Oliva (2015) use the energy ladder hypothesis to investigate cooking fuel transition among Indian household, but unlike by Cheng & Urpelainen, (2014) they focus on the rural sector only. Unlike previous studies, they document evidence supporting the energy ladder for cooking fuel among the studied households.

Covering Nigeria, Bisu et al. (2016) investigate the cooking fuel choices among urban households in some Local Government Areas in Bauchi State. The study uses data on a sample of 100 households and proves that cooking fuel behaviour is more in line with the fuel stacking hypothesis than the energy ladder theory. In particular, households in the studies region typically consume a menu of cooking fuels irrespective of their income range. Yet, the consumption of cooking gas seemed to increase with affordability. Paudel et al. (2018) note a high reliance on traditional cooking fuels among Afghan households despite the suggested adverse health impacts. They draw on a national sample of Afghan households and apply the multinomial regression technique. Their findings seem to be consistent with the energy ladder theory. Wealthier households showed greater likelihood of transitioning to cooking gas relative to other fuels when compared to wealthier households. Moreover, urban residing households, households with better education, and those who had access to electricity exhibited higher likelihood of consuming cooking gas relative to other fuels. Their findings thus suggest that socioeconomic status strongly dictates the use of cleaner fuels as proposed by the energy ladder theory. Saksena et al. (2018) applies a similar procedure to cooking fuel transitions among semi-urban and rural households in Vietnam. Their result provides some justification for the energy ladder theory since more households in both rural and urban areas had improved on their cooking fuel type in response to smallholder intervention programmes.

Contrary evidence can be found in the study by Dickinson et al. (2019) which sought to evaluate the impact of the REACCTING cleaner fuel intervention program among Ghanian households. In particular, the intervention seemed to change cooking fuel patterns among the target population, but no significant decrease was recorded on the use of traditional cooking fuels in general. A similar study was conducted by Kar et al. (2019) to test the impact of an intervention programme on cooking gas usage in Indian communities. Viewing the intervention as a form of income transfer, the findings suggest support for the energy ladder hypothesis. In particular, they find an increase in LPG consumers in response to the intervention programme. Yet, there was evidence that not all households had increased clean fuel consumption, suggesting that many households might still be stacking. Also, in accordance with the energy ladder hypothesis, Adamu et al. (2020) point out poverty as a major hinderance to cleaner energy transitions among Nigerian households. Nevertheless, the authors disagree that a smooth transition would be observable for a substantial proportion of households. Nawaz & Iqbal (2020) demonstrates contrary evidences. When they analyse the impact of an unconditional cash transfer programme on the cooking fuel choices among households in rural Pakistan, they find an increase in the demand for both unclean and clean cooking fuels alike. Thus, they conclude that rural household's behaviour is more consistent with fuel stacking than linear transitions. In the qualitative study of Ochieng et al. (2020), the authors survey the opinions of rural and urban Kenyan households about cooking fuel stacking versus linear transitions as a result of a proposed intervention programme. Again, the findings demonstrate preference for stacking among households in both locations.

Twumasi et al. (2020) focus mainly on the demand for clean cooking fuels like LPG and kerosene based on a number of determinants that include income, access to credit, and education. The study utilized instrumental regression techniques and found evidence that income and education improved the use of cleaner fuels significantly, thereby supporting the energy ladder hypothesis. Zahno et al. (2020) argues that household choice to climb up the energy ladder might depend on more than just socioeconomic considerations alone. In keeping with their argument, they focus on the role of health awareness rather than on income. Using an experimental approach, they showed an increase in the likelihood of consuming LPG of 30% among households exposed to the health awareness impact of unclean fuels. The analysis by Meried (2021) centred on validating the energy ladder hypothesis using a sample of 212 households in Ethiopia. Indeed, the findings document support for the hypothesis showing that most households are likely to transit up the energy ladder. Factors identified as impacting the cooking fuel decision included education, access to credit, and income among others. The study of Yadav et al. (2021) rationalize the commonly observed behaviour of fuel stacking arguing that such cooking fuel behaviours are more prominent at certain stages of a household's socioeconomic progression. Form an analysis involving households in India's rural communities, the authors showed that fuel stacking will likely continue because it is a cultural part of such communities. Martey et al. (2021) recently approached the clean cooking fuel adoption from the angle of time poverty and consumption poverty. They argue that the use of unclean fuels consumes relatively more time whereas, the use of clean fuels consumes relatively more finances. With the aid of bivariate probit models, they show that time poverty actually supports diversion away from unclean fuels whereas, consumption poverty diverts away from clean fuel usage. Their findings demonstrate that fuel stacking would likely occur relative to linear progression since non-consumption poor persons would likely be time poor at the same time so that a variety of cooking fuels would be optimal.

The literature generally offers a robust analysis of the determinants of cooking fuel demand. However, one notable gap is that most of the notable studies reviewed have been silent on the role of price in the choice to either climb the energy ladder or hold a portfolio of cooking fuel alternatives. In other words, the implicit assumption has been that households' choice to move along the energy ladder is based strictly on their level of income. No doubt, this assumption may not be tenable because a simultaneous increase in the price of the preferred cooking fuel along with an increase in income would likely prevent an ascent along the energy ladder. Moreso, such an occurrence is likely to be consistent with fuel stacking, which might explain the overwhelming evidence in support of the fuel stacking theory. The next section outlines the research methods as well as an empirical model incorporating the role of cooking fuel price in attempt to fill the identified literature gap.

METHODOLOGY

Materials and Sample

The study relies on primary data collected with the aid of online questionnaires designed specifically for the study's purpose. In keeping with the extant literature, the questionnaires were designed with the intention of collecting information on popular variables that are suggested to influence the use of a cooking fuel over another. Consequently, the questionnaires elicited information on common demographic variables as well as measures of socioeconomic status. To capture demand for cooking gas, the households were first asked the frequency of their cooking gas purchase with available choices covering the options: “weekly”, “twice monthly”, “once monthly”, and “once in a while”. A follow up question collected quantitative information on how many kilograms of cooking fuel the household consumes per specified. This formed the main variable capturing cooking fuel demand. The main independent variable of interest is household income. This was captured with an ordinal scale question that specifies different income ranges from less than N25,000 to above N100,000.

Due to lack of knowledge on the actual population of cooking gas consumers in Ibadan, a systematic sampling technique could not be applied. Moreover, the lack of notable previous research on household cooking fuel demand within Ibadan equally constrains the use of previous samples are a benchmark in the current study. Nevertheless, experts have suggested the use of non-systematic methods in such cases which could involve techniques like snowballing or respondent-driven sampling as convenience and purposeful sampling (see Goodman, 1961; Heckathorn, 1997; Salganik & Heckathorn, 2004). The present study relies on the purposeful approach. Specifically, since the relevant inclusion criterion was for the respondent to be currently residing in Ibadan, the researcher sent the questionnaire link to social media groups that are exclusive to Ibadan residents. The whole data collection process was conducted within a week at the end of which a total of 127 responses had been recorded and these formed the sample of the study. Table 1 gives a summarized description of the variables used for analyses.

TABLE 1. SUMMARIZED DEFINITION OF VARIABLES USED FOR REGRESSION

Variable	Measurement	Definition
Cooking gas consumption	Continuous	Natural log of cooking gas kilograms consumed
Income	Ordinal	Income range of household (1 = <N25k, 2 = N25k – N50k, 3 = N51k to N100k, 4 = > N100k)
Price of cooking gas	Continuous	Natural log of price per kilogram of cooking gas
Household size	Discrete	Number of persons living in household
Sex	Nominal	Sex of household head (1 = Female, 2 = Male)
Education	Ordinal	Education level of household head (1 = Lower, 2= Secondary, 2 = Higher)
Employment	Nominal	Employment status of household head (1 = Unemployed, 2 = Self-employed, 3 = Private sector, 4 = Civil servant)
Price of alternative	Continuous	Natural log of price of alternative cooking fuel
Residential location	Nominal	Household residential sector (1 = Rural, 2 = Urban)
Accommodation	Nominal	Household accommodation type (1 = homeowner, 2 = renter)

Source: Author.

Model Specification

Based on the energy ladder and fuel stacking hypotheses, the existing studies focus on demographic and socioeconomic variables as key predictors of household cooking fuel choice (e.g., Meried, 2021; Paudel et al., 2018; Twumasi et al., 2020). The present study likewise draws on these propositions, specifically targeting variables like household income, education, and other similar variables as determinants of cooking fuel demand. In keeping with traditional demand theory, additional variables capturing the price of cooking gas and alternatives are also featured as determinants contrary to previous studies. Hence, the demand for cooking fuel can be expressed in the following functional form.

$$gas_i = f(y_i, p_i, size_i, sex_i, edu_i, emp_i, p_{zi}, res_i, acc_i) \quad (1)$$

Such that,

gas_i = kilogrammes of gas consumed by household i (natural logs)

y_i = income level of household i

p_i = average price paid per kilogram of gas by household i (natural logs)

$size_i$ = household size of household i

sex_i = sex of household head of household i

edu_i = education level of household head in household i

emp_i = employment status of household head in household i

p_{zi} = is the price of an alternative cooking fuel other than gas (natural logs)

res = household residential area

acc = household accommodation type

The explicit form of equation (1) can be represented in the following expression.

$$gas_i = \beta_0 + \beta_1 y_i + \beta_2 p_i + \beta_3 size_i + \beta_4 sex_i + \beta_5 edu_i + \beta_6 emp_i + \beta_7 P_{Z_i} + \beta_8 res + \beta_9 acc + \mu_i \quad (2)$$

Equation (2) is a linear model that captures the effects of household income and other determinants on gas consumption. In equation (2), β_0 to β_9 are the coefficients to be estimated whereas, μ_i represents the error term of the regression. By virtue of the linear nature of equation (2), estimation is straightforward using Ordinary Least Squares (OLS) regression. The coefficients of the variable y_i is very critical for determining if there is evidence in support of the energy ladder hypothesis or not. Given that the variable is expressed in ordinal terms, if the coefficients attached to higher categories of y_i are significantly higher than those attached to a benchmark lower category of the variable, then there is evidence of energy ladder behaviour. Otherwise, the fuel stacking hypothesis is supported. The next section presents the empirical analysis and discussion.

ANALYSIS AND DISCUSSION

Preliminary Analysis

Frequency counts and summary descriptive statistics of the variables of interest have been presented in Table 2 to show the sociodemographic characteristics of the respondents. Not surprisingly, there are more male headed households (81.1%) than female headed households (18.9%). In terms of household head's education level, there is a somewhat uniform distribution which suggests minimal bias in the data collection process. Nevertheless, the Yoruba participants are more than others (37.01%) and this is in keeping with the fact that Ibadan is a Yoruba town. Household head religion is strongly skewed in the favour of Christianity (65.35%) whereas, only few participants practice "other" religions than the ones specified (9.45%). By marital status, very few of the respondents have never been married (9.45%), most are married 71.65%), and some have been previously married (18.9%). These set of participants are either widowed, separated, or divorced. We see that most participants fall under the "other" category of employment status whereas, less are private sector employees.

TABLE 2. FREQUENCIES AND SUMMARY STATISTICS OF VARIABLES

Variable	Freq.	Percent	Mean	SD	Range
Sex					
Male	103	81.1			
Female	24	18.9			
Ethnicity of head					
Hausa	25	19.69			
Igbo	31	24.41			
Yoruba	47	37.01			
Other	24	18.9			
Religion					
Christianity	83	65.35			
Islam	32	25.2			
Other	12	9.45			
Marital					
Never married	12	9.45			
Married	91	71.65			
Previously married	24	18.9			
Employment					
Other	65	51.18			
Private sector	22	17.32			
Civil servant	40	31.5			
Education					
Lower	28	22.05			
Secondary	34	26.77			
Higher	65	51.18			
Frequency of gas demand					
Once a while	9	7.09			
Monthly	27	21.26			

Twice monthly	83	65.35			
Weekly	8	6.3			
Alternatives to cooking gas					
Kerosene	7	5.51			
Charcoal	34	26.77			
Firewood	25	19.69			
None	61	48.03			
Income					
Less than N25k	16	12.6			
N25k to N50k	28	22.05			
N51k to N100k	52	40.94			
Above N100k	31	24.41			
Residence					
Rural	82	64.57			
Urban	45	35.43			
Means of transportation					
Public transport	48	37.8			
Own car	79	62.2			
Alternative electricity					
No	33	25.98			
Yes	94	74.02			
Homeowner					
No	66	51.97			
Yes	61	48.03			
Age of head (years)			44.55	9.93	(20 - 77)
Size of household (persons)			7.98	4.33	(1 - 20)
Gas demand (kg)			17.71	9.51	(1 - 56)
Price of gas (N)			699.88	34.44	(580 - 1000)
Price of alternative (N)			422.24	145.47	(100 - 700)

Source: Author's computation from field survey.

Many of the participants purchase cooking gas twice monthly (65.35%). This might be a manifestation of the steadily increasing gas prices in the recent times which have probably decreased the quantity bought per period thus leading to a higher purchase frequency. It is interesting that there is strong preference towards cooking gas among the participants as most of them rely fully on gas without alternatives (48.03%). Among those who use alternative, charcoal seems to be most common (26.77) whereas, only few rely on kerosene as an alternative (5.51%). There are more households that fall under the N51k to N100k income group relative to others (40.94%). More participants reside in rural areas (64.57%), reside in as renters (51.97%), have their own cars (62.2%), and have an alternative electricity source (74.02%). Average household size, age of head, and gas demand are respectively 44.5 years, around 8 persons, and 17.71 kg. Meanwhile, the average price of cooking gas is N699.88 or approximately N700 while the average price of the alternative used is N422.24.

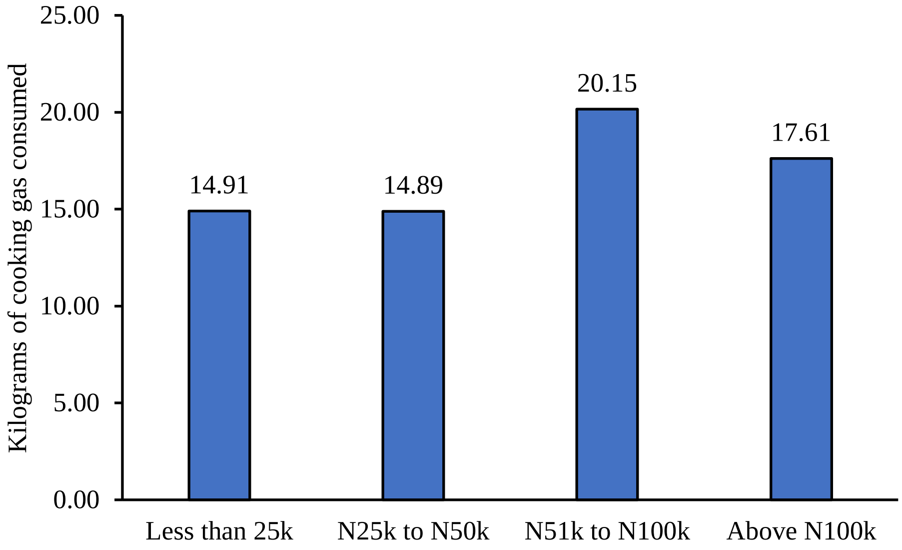

FIG 1. MEAN GAS DEMAND BY INCOME
Source: Author's design from field survey

Figure 1 shows the distribution of mean gas consumed by income. Households that fall within the N51k to N100k category have the highest mean cooking gas consumption of 20.15 kg while households within the N25k to N50k group consumed the least on average (14.89 kg). Looking at Figure 2 which shows the distribution of household residence by average cooking gas consumed, there is evidence that households in the rural areas consumed the most on average (19.07 kg).

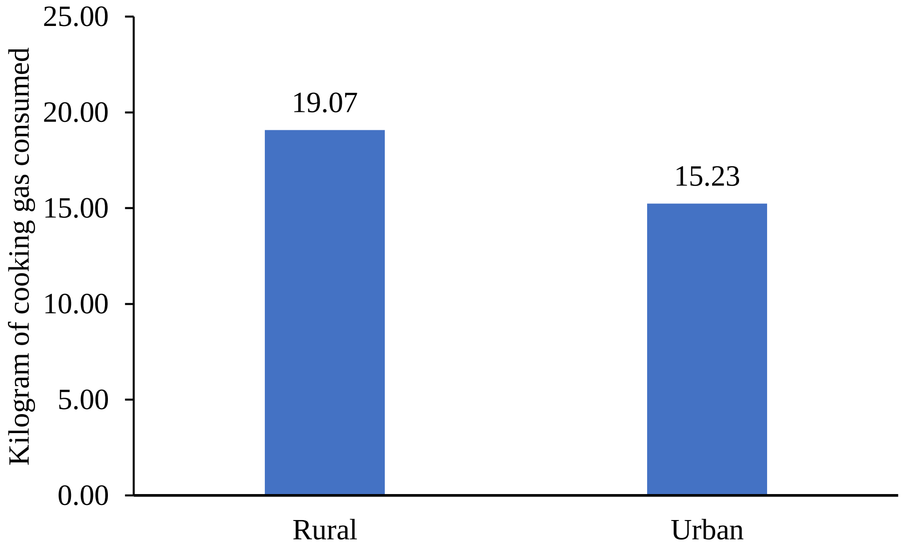

FIG 2. MEAN GAS DEMAND BY RESIDENCE
Source: Author's design from field survey.

Figure 3 equally shows that households who live in rented flats consume more cooking gas on average (19.97 kg) relative to those reside in their own houses (17.78 kg). Persons who reside in single rooms consume the least on average (15.85 kg).

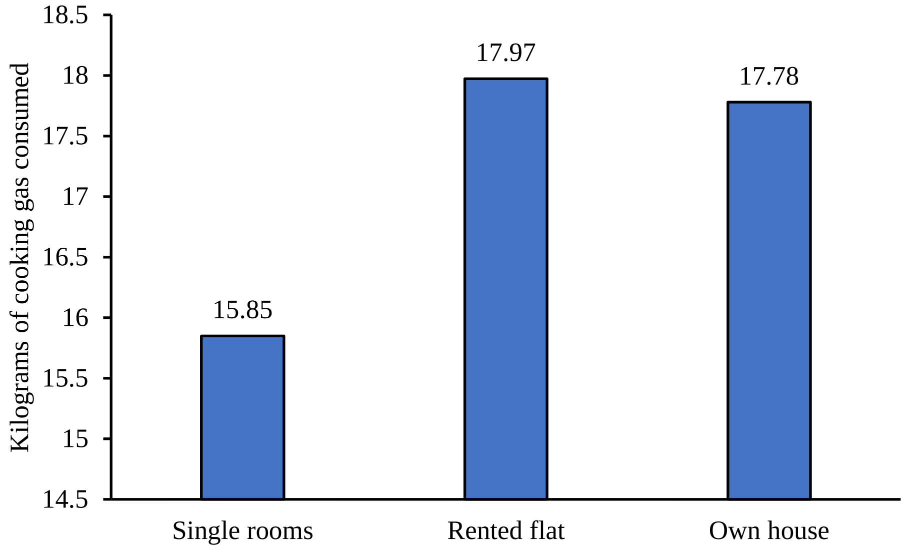

FIG 3. MEAN GAS DEMAND BY ACCOMMODATION
Source: Author's design from field survey.

Finally, in Figure 4, the mean consumption of cooking gas by education of household head is reported. Households who have secondary education as their highest education level have the highest cooking gas consumption on average (2.44 kg). Meanwhile, households in which the head has attained higher education consume 17.22 kg of cooking gas on average. Households with heads having just primary education consumed the least (14.30 kg).

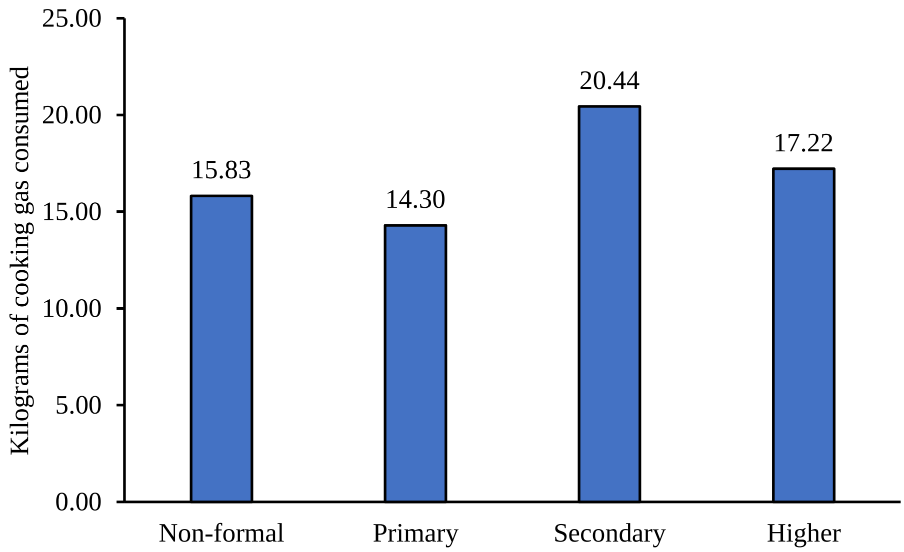

FIG 4. MEAN GAS DEMAND BY HEAD'S EDUCATION
Source: Author's design from field survey.

Main Results

In order to analyse the specific objective of the study which is to examine how income and the other specified determinants influence household cooking fuel demand, a linear regression was estimated using OLS, and the result has been summarized in Table 3. One striking feature of the result is the lack of significance of the income variable. The result specifically suggest that higher income households consume less cooking gas on average relative to lower income households. The insignificance of the income variable seems to suggest support in favour of fuel staking rather than a smooth transition up the energy ladder. This result is consistent with diverse other studies (e.g., Bisu et al., 2016; Cheng & Urpelainen, 2014; Nawaz & Iqbal, 2020; Ochieng et al., 2020; Paudel et al., 2018; Yadav et al., 2021) that showed that households in the developing countries actually stack different cooking fuels rather than transition to higher ones as suggested by the energy ladder.

TABLE 3. REGRESSION RESULTS

Variable	Coef.	St. Err.	t-val.	p-val.	95% CI	Sig.
Income						
Less than N25k (ref)						
N25k to N50k	-0.189	0.162	-1.170	0.245	-0.509 – 0.131	
N51k to N100k	-0.048	0.160	-0.300	0.766	-0.365 – 0.269	
Above N100k	-0.049	0.167	-0.29	0.769	-0.380 – 0.282	
Sex of head						
Male (ref)						
Female	0.255	0.124	2.07	0.041	0.011 – 0.500	**
Education of head						
Lower (ref)						
Secondary	0.267	0.159	1.69	0.095	-0.047 – 0.581	*
Higher	0.21	0.125	1.69	0.094	-0.037 – 0.457	*
Employment of head						
Other (ref)						
Private sector	-0.287	0.139	-2.07	0.041	-0.562 – -0.012	**
Civil servant	0.126	0.122	1.04	0.301	-0.115 – 0.367	
Residential sector						
Rural (ref)						
Urban	-0.173	0.095	-1.82	0.071	-0.361 – 0.015	*
Homeownership status						
Non-homeowner (ref)						
Homeowner	-0.008	0.098	-0.08	0.934	-0.202 – 0.185	
Gas of price	-0.037	0.017	-2.18	0.031	-0.071 – -0.003	**
Price of alternative	2.471	1.016	2.43	0.017	0.459 – 4.483	**
Household size	-0.287	0.139	-2.07	0.041	-0.562 – -0.012	**
Constant	-14.092	6.65	-2.12	0.036	-27.267 – -0.917	**
R-squared	0.373	Obs.	127			
F-test	5.18	Prob > F	0.000			

Ref implies reference category
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's estimation using Stata 16.

There is evidence of a statistically significant impact of household head sex on the demand for cooking among Ibadan residents. The result suggests that female headed households purchase on average, 22.5% of cooking gas compared to male headed households. This result is, indeed, unexpected since the conventional assumption is that female headed households are less well-off economically compared to male headed households. Nevertheless, the result could be consistent with the findings about income which shows an insignificant effect. In fact, Paudel et al. (2018) had previously documented contradictory evidence working on Afghanistan. The influence of household head's education is more in keeping with expectations. Households where the heads have secondary education or higher are shown to consume around 26.7% and 21% less more cooking fuel relative to households where the heads have lower education. The evidence provides support for the previous analysis of Bisu et al. (2016) where it was seen that demand for dirtier fuels decrease relative to that of clean fuels owing to higher household head education.

According to the result, households in the urban sector consume less cooking gas than household in the rural sector, although the effect of residence is only marginally significant (at 10%). In addition, a homeowning household should consume less cooking gas than non-homeowning households, but the result is not statistically significant. Nevertheless, homeowners may have the freedom to switch easily to unclean cooking fuels compared to non-homeowners since they live alone and do not need to be concerned of the adverse effects of unclean fuel use on neighbours. Conversely, non-homeowners live with neighbours. As such, they are mindful of the influence of their cooking choices on their neighbours. Hence, they may use coking gas more relative to owners. In fact, the result of Martey et al. (2021) support these arguments when they showed that renters are less likely to consume biomass fuels than homeowners.

Other interesting can be found with respect to the effects of prices and household size on cooking gas demand. The result confirms that a 1% increase in gas prices results in around 0.37% decrease in the demand for cooking gas. This finding is in accordance with the expectation that higher cooking gas prices would cause consumers to decrease consumption. Moreover, the result is consistent with the observed steady increase in the price of cooking gas in Nigeria and how this has impacted its consumption. The result confirms that cooking gas is indeed, a normal good. This paper's finding with respect to price matches that of Arawomo (2019) who confirmed a decrease in gas demand when price increased working with a sample of Ondo State households. Looking at the price of alternatives, we find a positive effect which is consistent with substitution. Hence, households tend to substitute to alternative cooking fuels when the price of cooking gas increases and vice versa. When one compares the own price elasticity (-0.037) with the cross-price elasticity (2.47), we notice that cooking fuel has an inelastic demand, meaning that households respond marginally to increase in cooking gas price. Conversely, the cross-price elasticity is elastic (higher than 1) implying that households do not hesitate to switch to cooking gas when they find it affordable relative to other fuels. This finding is consistent with that of Bisu et al. (2016) which reported a that affordability improves cooking gas demand. Finally, the findings report that an additional household member decreases the demand for cooking gas by around 28.7%. This means that households with more members usually lack the financial capability to demand for gas. Diverse other findings like that of Paudel et al. (2018) had demonstrated similar results.

CONCLUSION AND RECOMMENDATION

This study sought to examine the impact of household income on cooking gas demand in Ibadan based on the propositions of the energy ladder hypothesis and the fuel stacking theory. The study used a sample of 127 households in Ibadan and applied linear regression technique based on OLS. There was evidence of fuel stacking rather than a linear progression up the energy ladder as suggested by the energy ladder hypothesis. Moreover, the study established that cooking gas obeys the law of demand which means that it is a normal good. However, the demand for cooking gas is found to be inelastic with own price, but elastic with respect to price of alternative cooking fuels. Larger households are shown to on average, demand less cooking gas than smaller ones.

The findings have several implications for policy actions in the direction of household cooking fuel demand. Government and relevant policymakers ought to seriously consider the effects of rising cooking fuel price on household cooking fuel demand in Nigeria. Hence, there is need for government to brace up and initiate policies such as subsidization to ameliorate the effect of rising cooking gas prices on households' purse. The dwindling economic wellbeing of Nigerians owing to the country's low economic performance has no doubt, constituted a drag on cooking gas consumption. There is therefore need for government to work sincerely towards improving the economy which would help boost household economic wellbeing and raise their ability to transition to cleaner cooking fuel like gas.

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