# ECONOMIC AND SOCIO-DEMOGRAPHIC DETERMINANTS OF HOUSEHOLD COOKING ENERGY CHOICE IN PUBLIC HOUSING ESTATES IN MAIDUGURI, NORTH-EAST NIGERIA


## ABSTRACT

*The growing utilization of traditional energy sources particularly in developing countries has in recent times been drawing disturbing attention from researchers and policy makers in view of the environmental and health consequences associated with such fuels. Hence the need to empirically examine the economic and socio-demographic factors that drive household cooking energy choice in public housing estates in Maiduguri, North-east Nigeria. A survey questionnaire was used to elicit data from a sample of 355 household-heads using systematic sampling technique. Multinomial Logistic Regression was used to analyze the probability of households' choice of different energy types used for cooking purposes. The results revealed that higher income, higher educational level, occupation of the household head; location of residence, kitchen type and ownership of dwelling had positive effects on the probability of choosing cleaner sources of energy for cooking. Meanwhile, lower income and larger household size had positive correlation with the likelihood of choosing traditional energy sources such as fuelwood and charcoal as the primary cooking energy source among households. It is recommended that policy makers and stakeholders in the energy sector should take adequate and proactive steps that will promote access to cleaner, efficient, affordable and modern sources of energy for household cooking activities in Maiduguri, North-east Nigeria.*



**Keywords:** Household, energy, choice, cooking, traditional fuels, energy transition.


## INTRODUCTION

Access to clean, efficient, affordable and modern energy sources has been a major development challenge in Sub Saharan Africa including Nigeria where over 600 million people do not have access to electricity and about 890 million people still cook with traditional energy sources. In the absence of new policies, it is estimated that the number of people relying on traditional energy sources such as fuelwood and charcoal to meet their energy needs for cooking will increase from the present 2.5 billion to 2.7 billion globally by 2030 (IEA, 2006). Enhancing access to clean energy is therefore an important development goal given that the quality of energy consumed by households is inextricably linked to sustainable socio-economic development at the household level (Mbaka, 2018)

According to the World Bank (2005), traditional energy sources mostly in the form of biomass are consumed by over 70% of households in Asia. The situation is not much different in Nigeria where traditional energy sources account for about 72% of household energy supply. While rural households rely more on biomass fuels than those in urban areas, a substantial number of urban households in Nigeria still rely on fuelwood, charcoal and wood waste to meet their energy needs for cooking (Madukwe, 2014).

Energy sources from traditional biomass have their own implications with regards to human health and environmental degradation arising from forest resource depletion and Green House Gas (GHG) emissions. The World Health Organization (WHO, 2018) estimates that over 3.2 million people die prematurely every year as a result of illnesses attributable to indoor air pollution caused by incomplete combustion of traditional fuels used for household cooking. In fact, indoor air pollution has been described as the world's largest single environmental health risk by the World Health Organization.

The adverse effects associated with traditional fuels require urgent policy intervention that will make households accessible to modern and efficient sources of energy. There is the need to encourage households to shift from the use of less efficient energy sources to the adoption of more efficient ones. Accordingly, Lee (2013) asserted that moving towards the use of cleaner fuels is an important step to improving the standard of living for countries that rely heavily on traditional energy sources. Improving access to modern energy sources such as electricity for light and appliances and clean cooking technologies is therefore an important development goal and considered critical in enhancing the quality of life of many people particularly in developing countries (Makonese *et al.*, 2018).

Although household energy choice and its related issues have received considerable attention from scholars in recent times, the bulk of the research however tend to focus on the use of macro-level data (Ubani, 2013; Onoja & Idoko, 2012; Bhattacharyya, 2009; Urban, Benders & Moll, 2007; Davidson & Sokona, 2002). Given that the actual determinants of household energy consumption are established at the household level (Ngui, Mutua, Osiolo & Aligula, 2011; Gundimeda & Kohlin, 2008), many scholars have argued that the inability of macro-level data to capture behavioural dynamics or household diversity makes empirical results from such studies less reliable (Matsumoto, Mazobuchi & Managi, 2021; Kyeremeh, 2018; Kayode, 2016). Such aggregate data suffer from loss of information due to their inability to account for specific individual level factors, which affect household energy choice and consumption (Adom, Bekoe & Akona, 2012; Dergiades & Tsoulfidis, 2008; Richmond & Kaufmann, 2006). There is therefore limited empirical studies on household energy choice using household-level data particularly in Maiduguri, North-east Nigeria.

The few available empirical studies on household energy choice covering the study area namely by Maina, Dantama and Kyari (2017), which covered the North-east region of Nigeria based on secondary data of the National Bureau of Statistics' general household survey of 2013 was mainly descriptive. Detailed analysis of the economic and socio-demographic factors influencing households' choice and consumption behaviour of the different energy carriers was not covered by the study. Similarly, Maina, Yakubu and Kyari (2019) focused mainly on the impact of households' fuel use on the environment of Borno State. The study did not consider the influence of socio-demographic factors on households' consumption of energy sources. Hence, the economic and socio-demographic determinants of household energy choice are yet to be fully understood in the study area.

Empirical findings have also revealed that the determinants of household energy choice and consumption are location-specific and tend to differ in magnitude and impact from one geographical region to the other due to differences in socio-economic, environmental and cultural factors (Bisu, *et al.*, 2016). For instance, while studies by Rao and Reddy (2007), Khandker, Barnes and Samad (2012), Rahut, *et al*. (2016) found that energy sources used by households changes as income level increases, Huang (2015), Masera, *et al*. (2000) and Nansaior *et al*. (2015) reported that a rise in income do not always lead to households switching to cleaner energy sources. Differences in such findings prevent generalizations to be made to other geographical areas.

Consequently, the economic and socio-demographic determinants of households' cooking energy choice remain largely unclear thus underscoring the need for further empirical investigation. This present study is limited in spatial extent to public housing estates in Maiduguri, North-east Nigeria comprising of people with a whole range of economic and socio-demographic characteristics which allowed for rigorous analysis of the influence of those characteristics on their choice of cooking energy types. The outcome of this study will guide policy initiatives and strategy towards sustainable energy use and planning in Nigeria.

## STUDY AREA AND METHODOLOGY

### *Study Area*

The study was conducted in Maiduguri, which is the capital city of Borno State, North-east Nigeria. Geographically, it lies at latitude $11^{0}50'$ north of the Equator and longitude $13^{0}09'$ east of the Greenwich Meridian. Maiduguri is situated at an elevation of 320 metres above sea level and occupies an area of 50,778 square kilometers. The climate of Maiduguri is characterized by hot and dry climate for the greatest part of the year. March, April and partially May are the hottest months with temperature ranging from $29.4^{0}C$ to $44^{0}C$ (Waziri, 2009). According to the 2006 population census, Maiduguri has a population of 521,492 people with an annual growth rate of 2.8%. Households in Maiduguri vary in terms of income levels due to its cosmopolitan nature. Maiduguri is linked to the national grid and has good road networks and other infrastructural facilities. The city is accessible by road, rail and air, which serve north-eastern Nigeria and parts of Niger, Cameroon and Chad.

## METHODOLOGY

### *Population and Sample*

The target population of the study consisted of all household heads in the 3,192 public housing estates directly under the control and management of the Borno State Housing Corporation (BSHC). Households' heads were chosen since they were essentially the ones responsible for making decisions on energy use in their respective households. The sample size was determined using Yamane's (1967) formula for sample size determination as follows:

$$n = N/_{1 + N(e)^2}$$

Where: n = sample size, N= population size, e= level of precision.

At 95% level of significance

$n = 3192/\{1+3192(0.05)^2\}$ Therefore, n = 355 Households

Having calculated the sample size of 355 households, the figure was then divided proportionately among the seven public housing estates so as to determine the actual number of questionnaires to be distributed in each of the estate (Table 1). This was achieved by multiplying the total housing units in each estate by the sample size of 355 and then dividing the product with the total number of housing units (3,192) in the entire estates.

**Table 1: Distribution of questionnaire across public housing estates in Maiduguri**

| S/No | Name of Housing Estate | Location | Number of Housing Units | Sample Size | Percentage (%) |
|---|---|---|---|---|---|
| 1 | 202 Housing Estate | Bama Road | 202 | 22 | 6.2 |
| 2 | 303 Housing Estate | Bama Road | 316 | 35 | 9.9 |
| 3 | 505 Housing Estate (Abbagana Terab Estate) | Gamboru-Ngala Road | 500 | 56 | 15.8 |
| 4 | 777 Housing Estate | Kano Road | 756 | 84 | 23.7 |
| 5 | 1000 Housing Estate | Kano Road | 1004 | 112 | 31.5 |
| 6 | Legacy Estate (Zannah Umar Mustapha Housing Estate) | Kano Road | 288 | 32 | 9.0 |
| 7 | CBN Quarters | Damboa Road | 126 | 14 | 3.9 |
| | **TOTAL** | | **3,192** | **355** | **100** |

Source: Author's compilation (2022)

***Sampling technique***

Systematic random sampling technique was adopted in selecting the actual respondents for the study. The width interval for each estate was first determined by dividing the total population of housing units in a given estate by the sample frame as stated by Kumar (2011). According to Kothari (2004), an element of randomness is introduced when using systematic sampling technique. Thus, the first house was randomly selected and subsequently, every ninth house was chosen as the width interval/sampling digit for all the housing units with the exception of CBN Quarters where every tenth housing unit was chosen as the width interval/sampling digit. Informed consent was sought and obtained by the researcher before administering the research instrument on each of the household head selected for the study.

***Data analysis***

Multinomial logistic regression (MNLR) was used to determine the influence of economic and socio-demographic variables of households on energy choice for cooking purposes. Multinomial logistic regression model is used when a dependent variable is unordered and where it is comprised of more than two categories (Ozcan, *et al.,* 2013). An individual may choose one alternative from the group of the categories and the labelling of these categories is arbitrary.

***Model specification***

Drawing from Greene (2003) and Ogwumike *et al*. (2014), the following multinomial logit model was adopted for analyzing household energy choice for cooking purposes in public housing estates in Maiduguri.

$$Prob(Yi = j) = \frac{e^{\beta jXi}}{\sum_{k=0}^{4} e^{\beta kXi}}, \; j = 1,2,3,4 \ldots \ldots ..$$

Where:

e is the exponential function

$Y_i$ denotes the observed energy (fuel) used by households

i denotes observation of household

j denotes the energy type chosen by the household

$\beta$ is the coefficient's vector

$X_i$ is a vector of household characteristics,

Where

X1 represents the gender of the household head

X2 represents age of the household head

X3 represents education of the household head

X4 represents occupation of the household head

X5 represents household size

X6 represents income of the household head

X7 represents location of residence

X8 represents kitchen type of household

X9 represents ownership of dwelling

X10 represents fuel prices

The Maximum likelihood estimation technique as suggested by Ogwumike *et al*. (2014) and Greene (2003) was used in the estimation of the MNLR model. The maximum likelihood estimation technique, unlike other models such as log-linear regression and discriminant analysis, does not rise by a constant amount but approaches zero at a slower rate when the value of an explanatory variable decreases.

It can also be employed when a mixture of numerical and categorical variables are present (Mperejekumana, *et al.*, 2021). The variables used in the model was based on existing literature on household energy consumption, which were reviewed for the purpose of this study.

## RESULTS

### Estimated coefficients of Multinomial Logistic Regression for household cooking energy source

Table 2 presents the estimated coefficients of the multinomial logistic regression (MNLR) of the economic and socio-demographic determinants of household energy choice for cooking end uses in public housing estates in Maiduguri, North-east Nigeria. The diagnostic statistics indicated that the model has a good fit in assessing the economic and socio-demographic determinants of household energy choice for cooking. The likelihood ratio Chi-square value of 329.70 statistically significant at 1% indicates that the predictor regression coefficient are significantly different from zero. Additionally, the high pseudo R squared value of 34% above the McFadden (1979) satisfactory range of a minimum of 20% equally confirms that the model has an excellent fit.

The estimated MNLR indicates that for gender, when the household head is male, the multinomial log-odd for adopting LPG instead of fuelwood is higher by about 0.82 units when other variables are held constant. This is statistically significant at 10% level of probability. On the other hand, the multinomial log-odd for choosing charcoal decreases by 0.43 units. However, this coefficient is not statistically significant when it comes to household's decision to adopt kerosene as the main cooking energy source respectively.

The result of the estimated MNLR indicates that age of household is statistically significant at 10% level of probability. The age of household heads had a positive multinomial log-odd for choosing LPG but decreases the multinomial log-odd for charcoal. In other words, the higher the age of the household head, the higher the multinomial log-odds for households adopting LPG compared to fuelwood. It shows that a one year rise in the age of the household head increases the multinomial log-odd of adopting LPG by 0.08 units and significantly decreases the multinomial log-odd of charcoal by 0.02 units, when all the other variables are held constant.

The result of the estimated MNLR reveals that educational level of household head is statistically significant for LPG and electricity at 5% and 10% significance level respectively. It shows that a one year increase on the level of education attainment of the household head increases the multinomial log-odd of adopting LPG compared to fuelwood as the main cooking energy source by about 0.24 units. Similarly, a one year increase in the level of education attainment of the household head, when other factors are held constant, increases the multinomial log-odd of adopting electricity as the main source of cooking energy compared to fuelwood by about 0.18 units.

The estimated coefficient of occupation of household head is statistically significant and positive for LPG at 5% level of probability. It shows that when the household head is employed, the multinomial log-odd of choosing LPG compared to fuelwood increases by about 0.79 units. On the other hand, the multinomial log-odd for choosing charcoal decreases by 0.25 units, when all other variables are held constant.

The results shows that the estimated coefficient for household size is negative and statistically significant at 5% level of probability for kerosene and LPG respectively. It indicates that an increase in household size by one individual reduces the multinomial log-odd of choosing kerosene compared to fuelwood as the main cooking energy source by about 0.07 units when all other factors are held constant. Similarly, an increase in household size by an additional one person decreases the multinomial log-odd of adopting LPG compared to fuelwood by 0.56 units. However, it is positive and statistically significant for charcoal at 1% level of probability implying that an increase in household size by an additional person increases the multinomial log-odd of adopting charcoal by about 0.93 units, when all the other variables are held constant.

The regression shows that the estimated coefficient for income is positively significant for LPG adoption but negative for charcoal at 5% level of probability. It reveals that a unit rise in income of the household head leads to an increase in the multinomial log-odd of choosing LPG compared to fuelwood by about 0.66 units, all things being equal. However, a unit increase in the income of the household head leads to a decrease in the multinomial log-odd of the choice of charcoal as the main cooking energy source compared to fuelwood by about 0.56 units, when all other variables are held constant.

Estimated coefficient of location of housing units was found to be statistically significant at 5% and 10% level of probability for LPG and charcoal respectively. It shows that households living in public housing estates that are within the urban core (city centre) of Maiduguri had a higher multinomial log-odd of adopting LPG compared to fuelwood by about 0.76 units but had a lower multinomial log-odd of choosing charcoal by about 0.48 units relative to those households living in public housing estates that are outside the city centre of Maiduguri.

The result of the estimated MNLR for "Kitchen-type" reveals a positive and statistically significant association with LPG adoption by households at 5% level of probability. It shows that household heads living in housing units with internal kitchen facilities have a higher multinomial log-odd for adopting LPG as the main cooking energy source by about 0.46 units compared to households living in housing units with external kitchen facilities. In the same vein, the multinomial log-odd for charcoal adoption by households with internal kitchen facilities is reduced by about 0.58 units compared to households living in housing units with external kitchen facilities., when all other variables are held constant.

The results of the estimated MNLR shows that ownership status of dwelling is statistically significant at 10% and 5% level of probability for kerosene and LPG respectively. It reveals that households that live in their own houses have a higher multinomial log-odd of adopting kerosene and LPG as their main cooking energy source compared to fuelwood by about 0.58 and 0.64 units respectively than those households living in rented houses, when all other variables are held constant. The result is positive for electricity but not statistically significant.

The estimated coefficient for price of fuelwood was statistically significant at 5% and 10% level of probability (for charcoal and LPG adoption). It shows that a unit increase in the price of fuelwood per kilogramme will increase the household's multinomial log-odd of adopting charcoal compared to fuelwood by about 0.61 units, when all other variables are held constant. This is expected given that charcoal is a substitute of fuelwood. All things being equal, when the price of fuelwood increase, households will switch to its alternative being charcoal considering that it is more convenient and less bulky compared to fuelwood.

The result further shows that a unit increase in the price of fuelwood decreases the multinomial log-odd of choosing LPG as a main cooking energy source compared to fuelwood by about 0.55 units. This is expected given that despite the rise in prices of fuelwood, it is still relatively cheaper compared to LPG. Besides, the additional upfront cost involved in the acquisition of LPG cylinders and other accessories may have constituted a huge financial burden for many households in the study area.



**Table 2: Estimated coefficient of households cooking energy source**

| **VARIABLES** | **(Charcoal) 1=0** | **(Kerosene) 2=0** | **(LPG) 3=0** | **(Electricity) 4=0** |
|---|---|---|---|---|
| Gender | -0.430 | 0.007 | 0.820* | 0.163 |
| | (0.025) | (0.038) | (0.410) | (0.091) |
| Age | -0.019* | 0.018 | 0.030* | 0.038 |
| | (0.013) | (0.017) | (0.026) | (0.024) |
| Education | -0.007 | 0.049 | 0.236** | 0.178* |
| | (0.021) | (0.031) | (0.065) | (0.077) |
| Occupation | -0.250 | 0.001 | 0.791** | 0.153 |

| | | | | |
|---|---|---|---|---|
| | (0.385) | (0.332) | (0.034) | (0.068) |
| Household size | 0.930*** | -0.065** | -0.562** | -0.059 |
| | (0.342) | (0.035) | (0.075) | (0.059) |
| Income | -0.558** | 0.430 | 0.656** | 0.395 |
| | (0.339) | (0.176) | (0.332) | (0.401) |
| Location | 0.481* | 0.272 | 0.764** | -0.695 |
| | (0.232) | (0.372) | (0.460) | (0.430) |
| Kitchen type | -0.582** | 0.278 | 0.458** | 0.251 |
| | (0.286) | (0.213) | (0.153) | (0.032) |
| Ownership status of dwelling | -0.043 | 0.573* | 0.641** | 0.531 |
| | (0.017) | (0.248) | (0.315) | (0.582) |
| Prices of fuelwood | 0.610** | -0.125 | -0.554* | -0.051 |
| | (0.036) | (0.403) | (0.071) | (0.010) |
| Constant | -6.236*** | -7.216*** | -7.582*** | -5.364*** |
| | (1.452) | (1.130) | (1.699) | (1.753) |
| Observations | 355 | 355 | 355 | 355 |
| McFadden Pseudo-$R^2$ | 0.3408 | | | |
| Model fitting information (Chi-square) | $\chi^2$ (26) | = 329.70 | | |
| Probability of likelihood ratio = 0.0000 | | | | |

*Note: Reference category: fuelwood.*

Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

**Source: Field survey, 2022**

### Estimated marginal effects of MNLR for household cooking energy source

The results of the estimated marginal effects of the multinomial logistic regression for household cooking energy choice is presented in table 3. The choice categories consisted of four energy types namely fuelwood, kerosene, LPG and electricity.

The results of the estimated discrete effects of the coefficients reveals that an increase in the proportion of households headed by males is associated with a decrease in the probability of choosing fuelwood as the main energy source for cooking by about 3%. Meanwhile, the probability of a household to adopt LPG as the main cooking energy source is higher with about 2.6% in male-headed households than female-headed households. This is statistically significant at 10% level of probability.

The estimated marginal effects of the coefficient for age indicates that a one year increase in the age of the household head increases the probability of adopting LPG as the main energy source for cooking by about 0.7% and decreases the probability of adopting fuelwood as the main energy source for cooking by about 19.5%. This is statistically significant at 10% level of probability.

The estimated marginal effects for education of household-head is negative and statistically significant at 1% level of probability for fuelwood and positively significant for LPG choice. The result shows that as the educational level of the household head increases by a year, the probability of choosing fuelwood as the main energy source for cooking decreases by about 2.5%. On the other hand, it increases the probability of adopting LPG by about 4.0%. However, higher education had a negative, although non-significant impact on household's likelihood of electricity adoption.

The estimated marginal effects of the coefficient of “occupation of household head” reveals an inverse relationship with fuelwood choice as the main energy source for cooking by 0.4% significant at 1% level of probability but with an increase in the probability of adopting LPG as the main cooking energy source by 4.7% for households where the head is a civil servant compared to household heads in other occupations.

The marginal effect estimates also show that household size had a positive and statistically significant ($p<0.05$) effect on the choice of fuelwood as a main source of cooking energy. It indicates that when the size of the household increases by one individual, the probability of choosing fuelwood as the main source of cooking energy increases by about 1.5% while the probability of kerosene and LPG adoption decreases by about 0.9% and 0.6% respectively. The probability of choosing kerosene is negative and statistically significant at 10% level of probability.

The results of the estimated marginal effect of the independent variable “household income” of respondents is positive and statistically significant for kerosene and LPG at 5% level of probability. This means that a unit rise in the monthly income of the household head would increase the likelihood of choosing kerosene and LPG as the main energy source for cooking by 1.2% and 3.8% respectively, while decreasing the probability of choosing fuelwood as the main energy source for cooking by 4.9%. This is statistically significant at 1% level of probability.

The estimated marginal effects of the independent variable “location of housing unit” was positive and statistically significant for LPG at 5% indicating that households living in public housing estates that are within the city centre of Maiduguri have a higher probability of choosing LPG as the main energy source for cooking by about 14.1% compared to households living outside the city centre. Meanwhile, the likelihood of choosing fuelwood as the main energy source for cooking by households living in public housing estates within the city centre of Maiduguri decreased by about 12.5% compared to households living outside the city centre.

For the independent variable “Kitchen type”, the estimated marginal effects of its coefficient reveals that households with internal kitchen facilities have a lower likelihood of choosing fuelwood as the main cooking energy source by 3.4% (at 5% level of probability) compared to households with external kitchen facilities. However, there is a higher probability of choosing LPG as the main energy source for cooking among households with internal kitchen facilities by 3.9%.

The results of the estimated marginal effect of the independent variable “ownership status of dwelling” was found to be inversely related to the choice of fuelwood but positively and statistically related to the adoption of LPG at 10% level of probability. It shows that households living in their own houses have a lower probability of choosing fuelwood as their main energy source for cooking by about 10.8%. It also reveals that households living in their own houses have a higher likelihood of adopting LPG as their main energy source for cooking by about 6.2% compared to households living in rented houses.

The marginal effects of the coefficient of fuelwood prices indicates that a 100 Naira rise in the price of fuelwood per kilogramme reduces the probability of households choosing fuelwood as the main cooking energy source by 0.1%. It however increases the likelihood of adopting kerosene as the main source of energy for cooking by about 0.2% with a similar negligible rise in the likelihood of choosing LPG and electricity by 0.05% and 0.03% respectively when all other factors are held constant. None is however statistically significant.

**Table 3: Estimated marginal effects of households cooking energy choice**

| **VARIABLES** | **Fuelwood 0** | **Kerosene 1** | **LPG 2** | **Electricity 3** |
|---|---|---|---|---|
| Gender | -0.030* | 0.0009 | 0.026* | -0.0001 |
| | (0.044) | (0.007) | (0.005) | (0.001) |
| Age | -0.195* | 0.002 | 0.007* | 0.001 |
| | (0.002) | (0.001) | (0.0004) | (0.001) |
| Education | -0.025*** | 0.003 | 0.040*** | -0.0004* |
| | (0.003) | (0.008) | (0.001) | (0.002) |
| Occupation | -0.004*** | 0.008 | 0.047** | 0.0002 |
| | (0.001) | (0.008) | (0.032) | (0.0001) |
| Household size | 0.015** | -0.009* | -0.006** | -0.0002 |
| | (0.003) | (0.003) | (0.001) | (0.0002) |
| Income | -0.049*** | 0.012** | 0.038** | 0.008 |
| | (0.019) | (0.006) | (0.007) | (0.008) |
| Location | -0.125** | 0.028 | 0.141** | -0.017 |
| | (0.037) | (0.007) | (0.034) | (0.013) |
| Kitchen type | -0.034** | 0.008 | 0.039** | 0.003 |
| | (0.001) | (0.010) | (0.024) | (0.002) |
| Ownership of dwelling | -0.108* | 0.032 | 0.062* | 0.0005 |
| | (0.043) | (0.022) | (0.036) | (0.010) |
| Fuelwood price | -0.001 | 0.002 | 0.005 | 0.003 |
| | (0.004) | (0.003) | (0.001) | (0.002) |
| Observations | 355 | 355 | 355 | 355 |

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
**Source: Field survey, 2021**



## DISCUSSION

The findings indicated that gender of household head was positively associated with the main energy source for cooking in public housing estates in Maiduguri (Table 2 and 3). The study found that male-headed households have a higher probability of choosing LPG and kerosene as their main energy source for cooking compared with female-headed households. This implies that households that are headed by males are financially stronger and therefore have a higher propensity for cleaner energy sources for cooking. The result is in contrast with Rao and Reddy (2007) and Rahut *et al*. (2014), which found that female-headed households preferred modern fuels to traditional fuels. It however supports the view by Soltani *et al*. (2019) and Ogwumike *et al*. (2014) that male-headed households were more likely to use LPG underscoring the influence of gender as an important socio-demographic factor in determining household energy choices.

The results indicated that age was a significant determinant of household energy choice for cooking in the study area. An increase in the age of the household head significantly decreased the probability of adopting fuelwood as the main energy source for cooking (Table 2 and 3). The implication of this finding is that as time goes on, income levels of household heads increases, which enables them to afford higher energy sources for cooking. This is consistent with studies by ozcan *et al*. (2013); Couture *et al*. (2012) and Gupta and Kohlin (2006), which provided evidence showing that older household heads were more likely to prefer cleaner fuels to fuelwood in Indian households. It is however contrary to Gebreegziabher *et al*. (2012) who found in Ethiopia that older household heads were more likely to consume solid fuels.

The study found that higher educational level of the household head was positively related to LPG choice but negatively correlated with the choice of fuelwood for cooking purposes (Table 2 and 3). In other words, household heads with higher educational level were more likely to choose LPG rather than fuelwood as the main source of cooking energy. This is evident since a highly educated respondent is likely to be aware of the health consequences of solid fuels. This finding is in line with Bisu *et al.* (2016); Nlom and Karimov (2015); van der Kroon *et al*. (2013); Kowsari and Zerriffi (2011); Peng *et al.* (2011); Njong and Johannes (2011) that highly educated households were more likely to adopt non-solid fuels and to transition away from lower rung fuels. Studies by Mekonnen and Köhlin (2008), Narasimha and Reddy (2007), Heltberg (2005) have also shown that higher education level leads to a decrease in the use of solid fuels such as fuelwood.

However, the results found that higher education had a negative impact on households' likelihood of switching to electricity. This is however not surprising given that most parts of Maiduguri have been cut off from electricity supply due to destruction of the power lines by Boko Haram insurgents and even where it is available, the supply is poor and very erratic that it is seldom used as a primary energy source for cooking by most households.

Occupation of household head was also found to have an inverse relationship with fuelwood choice, but increased the probability of adopting LPG as the main cooking energy source for households when the household head is a civil servant compared to other occupations (Table 3). The implication of this finding is that household heads with sustainable income especially civil servants were more likely to use modern energy types than their counterparts. This behaviour may be attributed to improvements in income, which elevates household heads in white collar jobs to relatively higher social class. Hence the choice of higher fuels for household cooking activities. The results supports an earlier study by Anyiro, *et al.* (2013), which found strong correlation between fuel choice and occupation of household heads.

The results indicated that household size had a positive and statistically significant effect on the choice of fuelwood as a main source of cooking energy (Table 3). This implies that a higher household size is positively associated with the likelihood of choosing traditional fuels as a primary energy source for cooking. This is not surprising given that cultural factors such as those in the study area which allows the marrying of up to four wives thereby having a tendency of an increased family size coupled with extended family ties, which often necessitates frequent visitations particularly during festive periods have a major influence on the choice of the primary energy source for cooking. Cooking in households with large family size can therefore be expensive with cleaner and higher fuels thereby necessitating the consumption of alternative fuels that are cheaper such as charcoal and fuelwood. This finding is in line with previous studies by Adetunji *et al.* (2007), Ezemonye and Emeribe (2016), Adamu *et al.* (2017) which found that household size was a significant variable that influenced energy use by households. Similarly, Pandey and Chaubal (2011), Ngui *et al*. (2011) found that as household size increases, the household switches to unclean energy types such as fuelwood and charcoal to meet increased demand for energy.

The findings revealed that monthly income of household head had a significant and positive impact on both kerosene and LPG choice with decreasing likelihood of choosing fuelwood as the main energy source for cooking (Table 2). The finding corroborates the results of Campbell *et al*. (2003), which found that in the four largest cities in Zimbabwe, higher income households were less likely to use fuelwood as their primary cooking fuel. The finding is also consistent with Ouedraogo's (2006) study, which showed that fuelwood utilization rate decreased with increasing household income in the capital city of Burkina Faso. Similarly, Mbaka *et al.* (2019), Nlom and Karimov (2015) also reported a statistically significant relationship between household income level and clean cooking fuel choice.

The location of respondents' housing units was found to be statistically significant for LPG choice as the main energy source for cooking for households living in public housing estates within the city centre of Maiduguri compared to households living in the outskirts of city (Table 2). This may be due to availability of modern cooking energy sources in core urban areas. This supports the findings of previous studies by Ogwumike *et al.* (2014), Ozcan *et al.* (2013), Mensah and Adu (2013), Osiolo (2010) and Suliman (2010).

The study found that households with internal kitchen facilities had a lower probability of adopting fuelwood as the main energy source for cooking but had a higher probability of choosing LPG as the main energy source for cooking (Table 3). This implies that households with external kitchens were likely to have more space to accommodate traditional fuels such as fuelwood thereby utilizing more of it in their cooking activities. This finding is in line with Bisu *et al.* (2016), which found that external kitchens in buildings encouraged the use of lower and cheaper fuels due to the availability of convenient spaces for fuel storage by households.

The results indicated that ownership status of dwelling was inversely related to the adoption of fuelwood but positively and statistically related to LPG choice (Table 3). A simple explanation for this could be that owning a house is seen as a measure of economic status, which translates to more income and ability to afford cleaner energy sources. Besides, since all the housing estates are still under the control and management of Borno State Housing Corporation, their occupation of the housing units may be subject to some terms and conditions particularly with regards to the general aesthetics and maintenance of the buildings. This finding supports Lay *et al*. (2013), which found that house-owners were more likely to shift towards cleaner fuels as compared to tenants. It is however contrary to studies by Bisu *et al.* (2016) and Ouedraogo (2006), which found that rented dwellings tend to use higher and cleaner fuels than personally owned households. Similarly, Labendeira *et al.* (2006) found that owning a personal house contributed to the use of fuelwood, which contradicts the findings of this study.

The study found that the price of fuelwood had a negative relationship with fuelwood adoption but was positively related with kerosene and LPG choice as the main energy source for cooking (Table 2). This is in consistent with the general demand theory that as prices of a commodity increases, consumers will look for other close substitutes. This is in line with previous studies by Nlom and Karimov (2015) and Lee (2013).

## CONCLUSION AND RECOMMENDATIONS

The study examined the economic and socio-demographic determinants of household cooking energy choice in public housing estates in Maiduguri, North-east Nigeria. The findings indicated that beyond income, there were other economic and socio-demographic factors that influenced households' cooking energy choice in the study area. It is recommended that stakeholders and policy makers in the energy sector should take adequate and proactive steps that will promote access to cleaner, efficient, affordable and modern sources of energy for household cooking activities. This will facilitate households' transition to modern energy sources and reduce the health and environmental consequences associated with the use of traditional energy sources. Furthermore, government intervention is necessary to encourage the use of clean energy sources such as LPG and electricity by reducing the upfront cost of acquisition of LPG cylinders and its accessories as well as boosting electricity supply for households. Finally, given the strong influence of income on energy choices, government should provide incentives for households through ready availability of credit facilities and subsidies to help them acquire technologies for clean energy utilization.

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