



Household Energy Fuel Choice in Nigeria Residential Urban Area

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ABSTRACT

In most Nigerian cities, there have been an increased number of trading in charcoals, firewood, and sawdust. Yet, the fast citing of cooking gas refilling stations in these areas requires much to be studied since their increasing number suggests great demand for cooking gas. The knowledge of the different household fuel choices and the drivers of this choice was lacking in Nigerian cities, thus the inability of energy policymakers to predict and plan household fuel agenda in Nigeria. The thrust of this paper was to analyze the household energy fuel choice and the pattern of consumption as well as analyze the household socioeconomic factors that influenced the fuel choice in the Abakaliki urban area of Ebonyi State, Nigeria. Stratified and simple random sampling was adopted in the study. Regression was used to consider the relationship between energy fuel choice and household socioeconomic factors. It was revealed that there was a mixture of traditional and modern energy fuel choices in the study area, with the modern energy fuel choices (gas and electricity) having higher patronage. There was a significant relationship between energy fuel choice and household socioeconomic factors. It was recommended, among others, that a clear energy fuel policy that will adopt the identified explorable household socioeconomic factors that influence the choice of energy fuel be developed.

INTRODUCTION

Heating, lighting, and cooking are part of basic human needs that involve energy consumption. The various energy forms required for lighting and heating, cooking, and other like tasks, according to UNDP & WHO (2009), are gas, coal, electricity, charcoal, dung, and wood, among others. Unfortunately, though, there is still much dependency on traditional biomass fuels from persons in various third-world and developing countries. These biomass fuels are mainly used for light sources such as kerosene, and candles have also been used for cooking. It has been an enormous challenge to expand access to modern energy services, especially in third-world countries. As of 2019, about three million people in developing countries of the world depend on solid fuels for cooking, while 1.2 persons do not have access to electricity (UNDP & WHO 2009).

Figures have it that the annual firewood consumption in Nigeria stands at 50 million metric tons, and this exceeds the replenishment rate through the reforestation program (ICDD 2000). With the ongoing situation of consumption of fuel wood in Nigeria, it is important to find alternative ways of cooking without exhausting our forest resources. Degradation of forest resources is increasing daily, which has affected the Nigerian economy as a result of the loss of

properties due to flooding and arable farmland in the process. The multiplier effect of this has already become clear, as seen in different ecological spheres in the country, and that has resulted in great economic losses (Sambo 2009). Studies also indicate that 74% of households in Asia rely on traditional energy sources like biomass. This, according to the World Bank (2007), is contrary to the situation in Nigeria, where 65% of urban household still depends on charcoal, fuel wood, and waste wood to meet the energy demand of households for their cooking. This was collaborated by the study by Madukwe (2014) on domestic energy usage patterns in Enugu State of Nigeria. He found out that while most rural dwellers in Nigeria depend on biomass fuel, a substantial number in urban areas use wood fuel also.

Ebonyi State of Nigeria has Abakaliki as its capital city, and various households in the city have varying energy fuels for lighting and cooking. In Abakaliki urban, the rate of urbanization, industrialization, and increased economic development seems to have caused changes in the consumption patterns of households, which has ultimately led to margin changes in the household energy sector. The seeming shift from modern fuel products to charcoal and saw specks of dust in some parts of the area has raised some concern among urban planners and energy experts. There has been an increased number of trading in

charcoals, firewood, and sawdust in the study area, and this has remained unregulated. Yet, the fast citing of cooking gas refilling stations in the State capital requires much to be studied since this indicates great demand for cooking gas. The understanding of the varying household fuel choices has been seemingly minimal in most Nigeria cities, and the inability of energy policymakers to estimate and propose household fuel agenda in the area is grossly worrisome even at the national level (Nnaji et al. 2012, Energy Commission of Nigeria 2003). The perceived apathy by the Nigerian government in tackling household energy challenges has been linked to the nonexistence of baseline data on energy consumption, and this has seriously affected energy planning and policy-related studies. Various literature searches suggest that in most of Nigeria's newly created State capital cities, no detailed study has been conducted to establish patterns of household energy consumption (Madukwe 2014).

Furthermore, household drivers on these cooking fuel preferences have not been robustly determined, especially as it relates to residential densities. Hence, understanding household fuel choice and its drivers will serve as the basis for formulating a sustainable household fuel agenda. The thrust of this paper was to analyze the household cooking energy fuel choice in the Abakaliki urban area. This is to evolve policy design and interventions that will serve as the basis for a sustainable household fuel agenda in the State and ensure improved quality lives of households in Nigeria. The study also considered the household socioeconomic factors that drive energy fuel choice in the study area. It was hypothesized that the household socioeconomic factors did not influence different household cooking energy fuel consumption.

PAST STUDIES

Energy consumption Effect on the Users

The various energy resources have different impacts on their users. Traditional biomass has the most hazardous effect as it produces excessive smoke, which has an adverse effect on its users. Indoor air pollution that emanates from the use of solid waste, according to the World Health Organization (WHO 2010), has been linked to the premature death per annum of an estimated 1.5m globally. In developing nations, there is over-dependency on biomass fuel as a result of the low standard of living that exists there. The impact of socio-cultural and gender inequality has made more women victims of energy choices made by households in the world as they are the major users, followed by little children who are, at one point or the other, charged with the responsibility of cooking household meals. Women and children who are predominant

users of biomass in traditional stoves are prone to high levels of indoor air pollution (Dzioubinski & Chipman 1999).

The importance of clean fuels cannot be over-emphasized as it is crucial in the health of households that give very little or no smoke. The health of the users is as important as the entire household, which therefore means that more attention should be given to selecting household fuels so as to reduce health crises that may surround their users. This is crucial since, according to studies done by Toole (2015) and Muller & Yan (2016), it was revealed that the consumption of traditional biomass is linked to indoor air pollution and greenhouse gas emissions.

However, the presence of clean fuel services in homes opens better economic opportunities to the end users who have been identified as women and children in that it improves their political, economic, and social status, thereby reducing the effort and time they are engaged in domestic chores, thus, providing better educational and health conditions as well as increasing generating opportunities (UNDP 2006). Among the various household energy sources, the most effective are electricity and gas, which do not produce smoke. However, most people in developing nations choose not to use it simply because they are expensive and scarce in some localities. Apart from the direct impact it has on users, it also affects the water in which we drink due to deforestation. Deforestation affects water as plants have been cut down, and the tendency for erosion also increases as water washes the uppermost surface of the earth into a nearby river or water bodies. The content that has been washed might have some fertilizer and insecticide content, which might be poisonous to man, thereby causing water pollution.

The Concept of Household Energy Consumption Pattern

Right from the inception of man into this world, energy has been a key factor in his existence as it helps in providing fundamental needs such as lighting, cooking, and heating, which is a fundamental requirement in sustaining human life. Generally, the amount of energy resources consumed by homes in different appliances in the home is referred to as household energy consumption. A nation's stage of economic growth and development, as well as its social status, is always a function of its pattern of energy consumption. The increase in population has been traced to be the underlying factor for the rise in household energy consumption, along with growth in the economy and a rise in per capita income. Bhattacharyya (2011), however, posited that the use of energy fuel differs from country to country, and this difference could be attributed to the country's level of economic growth, certain government policies, and varied climatic conditions.

Among the various sectors (industrial, household, commercial, etc.), Wang et al. (2011) noted that the household sector was rated the most important in the energy consumption sector. Swan and Ugursal (2008) posited that energy consumption of the residential sector accounts for approximately 30% of the total world energy consumption. The importance of energy in the world cannot be over-emphasized because of its fundamental usefulness to every mankind in every sector. Table 1 below represents household energy consumption from a few of the world countries in which Nigeria has the highest rate of energy consumed by her residential sector at 65%. This was adopted by Swan & Ugursal (2008). The statistics show how important household energy consumption is to Nigeria compared to other sectors.

Studies have shown that 2.5 billion people depend on nuclear fuels in developing countries for their domestic use. (IEA 2006). In the same vein, it was recorded that 3 billion people rely on solid fuels globally for their domestic needs. In Nigeria, a developing economy, the major sources of cooking fuel are kerosene, cooking gas, electricity (electric cookers, electric stoves, electric heaters), charcoal, and firewood (fuel wood). Expectedly, though, Maduka (2011) stated that Nigeria depends on more traditional sources of energy like fuel wood, crops, and plant residues, as well as firewood for their regular energy needs. This is despite the abundance of great natural resources like gas and oil. He further estimated that 55% of Nigeria's primary energy demand comes from animal waste, biomass, firewood, and

Table 1: Residential energy consumption for some countries.

Country	Percentage of Energy Consumption by Residential Sector (%)
Saudi Arabia	50
Malaysia	19
Japan	26
Jordan	29
Turkey	31
Italy	17
Norway	21
Sweden	19
Finland	16
Brazil	26
Mexico	23
Usa	25
Canada	24
Nigeria	65
World	31

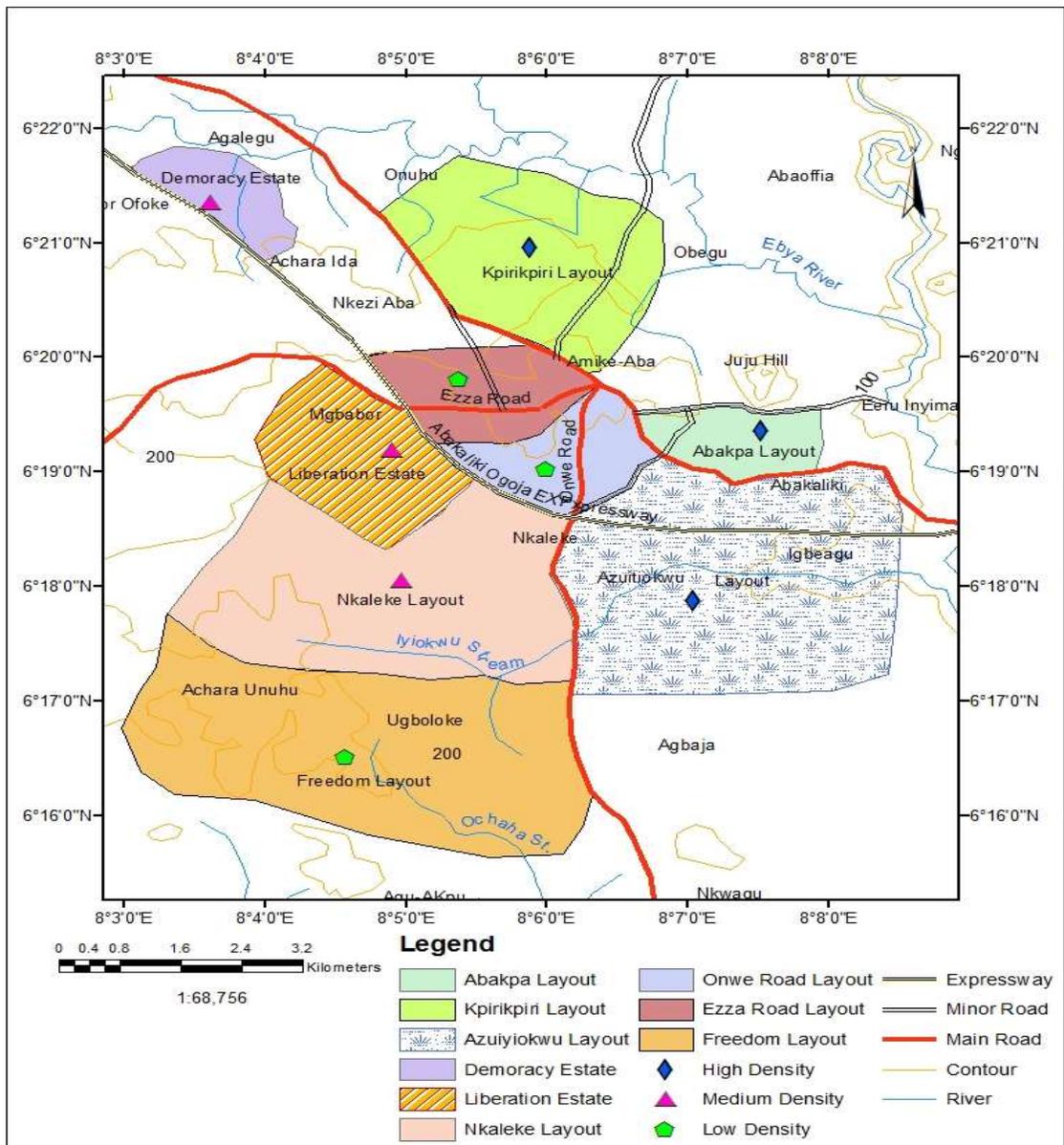
Source: Adapted from Swan and Ugursal (2008)

charcoal. He concluded that this fuel is used for cooking and heating homes. There is pressure on forests as a major source of firewood for cooking because of the low standard of living among the populace and the ever-growing population. Globally, there is this continued increase in energy demand observed in both developing and developed countries of the world, and this increased demand has been attributed to an improved standard of living among the populace, a growing number of manufacturing industries, a high urbanization rate, as well as increased population (Adedayo et al. 2008).

Study Area - Abakaliki Urban

Abakaliki is among the new State capitals in Nigeria. It is the capital city of Ebonyi state, which is in the eastern part of Nigeria. It is located on latitude 06°18' North and longitude 08°07' East; It is situated on a seemingly highland located in the lower belt of Niger, covering a land mass of about 2463 hectares (2.8 km radius). Since the elevation of Abakaliki Local Government Headquarters to the Ebonyi State capital, the town has witnessed a substantial influx of population and economic activities. The population of Abakaliki urban center in the 2006 census was 276,909; this was projected to be 383,443, with a gross density of 742 persons per hectare in 2022. Also, Abakaliki city, due to rural-urban migration, urbanization, and industrialization, has experienced a steady and speedy increase in her population. There has been an increased number of trading in charcoals, firewood, and sawdust in this area, yet there are increased citing of cooking gas refilling stations in and around this city center. Abakaliki has many higher educational institutions and many housing estates located in it, which indicates a great demand for cooking gas.

The Abakaliki urban has a combination of highland and scarp land terrains. The mineral deposits made the topography slightly undulating. The dominant land uses in Abakaliki are commercial, residential, industrial, institutional, transportation, and recreational land uses. Residential land uses represent the ubiquitous and largest land use within the core area. The various residential neighborhoods in the study area are seen in Fig. 1. The labor force in Abakaliki Capital Territory is made up of skilled, semi-skilled, and unskilled personnel. The majority of the labor force is engaged in agriculture, agro-based industries, hawking, and petty trading. The rest are engaged in mining, processing, and other self-employed activities. The private sector dominates the employment structure within the planned area. These private sectors employ semi-skilled workers in order to maximize their profit. Only very few are employed by the government in different ministries, schools, and parastatals.



Source: Microsoft Encarta (2004)

Fig. 1: Map of Abakaliki urban showing the residential neighborhoods.

MATERIALS AND METHODS

Research Methodology

This study employed an analytic cross-sectional survey and descriptive research design. Data collected were cross-sectional data which were collected from primary sources. The population was drawn from the neighborhoods in the metropolis of Abakaliki, and the study population comprises residents who have lived more than one year in the city. Williams, 1978 Sample Determination Size formula was used

to get 585 respondents for the study. Abakaliki was stratified into low, medium, and high residential density areas, and simple random sampling techniques were further used to select the respondents from nine neighborhoods in the study area. The study was analytic since the a priori hypothesis, which sought to ascertain the relationship between household energy fuel choices and household socioeconomic variables in the study area, was proposed. Five hundred and forty (540) copies of questionnaires were successfully received from the study area out of the 585 that were randomly distributed

in the selected neighborhoods. Inferential and descriptive statistics were used to analyze the collected data using the SPSS 25 version. Frequency count and percentage were normally used to analyze the demographic data and personal information of the respondents. These descriptive statistical tools are necessary for such analytical study. Regression statistical techniques were used to test the hypothesis (the dependent variable was the quantity of use of each energy fuel resource while the socioeconomic attitudes (age, number of years in school, income, sex, and marital status) were the independent variable. Some of the variables, like sex and marital status, were measured as dummy variables of either 0 or 1. Equally, educational attainment was measured as a dummy variable – illiterates = 0 and others = 1).

RESULTS

Data Analysis and Results

Table 2 summarises the socioeconomic features of the 540 respondents that were used for the study. The study revealed respondents who were household heads and those who were not. Household heads were 54% of the respondents. This balanced sampled respondents ratio increases the internal validity of the study. Furthermore, 55% were female household heads, while 45% were males. This shows the absence of bias in respondents' representativeness in the study. However, it was not surprising that the former constitutes the majority because female folks are traditionally associated with the use of this household fuel energy use in most African cities. It is always assumed that the kitchen is made for women (Anyim et al. 2021). The study revealed the various types of kitchens of the sampled respondents in the study area. 55.0% of the respondents use an in-house kitchen type, 24.4% use an outdoor kitchen type, and 20.6% use a separate-house kitchen. The study further revealed the various kitchen floor materials used by the various respondents in the study area. 40.6% of the sampled population uses cemented floors, 36.1% uses tiles, 12.2% of the respondent uses terrazzo, 5.6% uses un-cemented floors, and 3.9% of the sampled population uses mud. In comparison, 1.7% of the respondent uses woodwork on their kitchen floors.

The study made some further interesting revelations, as presented in Table 2. The study, as seen in Table 2, shows that 95.0% of the respondents do not use charcoal as a household fuel for cooking, while only 5.0% do. Again, only 34.4% use kerosene for cooking, as against 65.6% of the sampled population that do not. The study also revealed that 40.6% use gas as their source of energy for cooking, which was the highest. Summarily, the percentage of energy consumption usage aside from gas was 34.4%, 20.6%, 7.8%, and 5.0% for

Table 2: Respondents' socioeconomic data.

Features	(540)	%
Respondents		
<i>Household head</i>	422	54
<i>Not household head</i>	118	46
Sex of the household head		
<i>Male-headed household</i>	190	45
<i>Female-headed household</i>	232	55
Age		
20-40 Years	237	43.9
41-60	198	36.7
Above 60	105	19.4
Marital status		
<i>Married</i>	482	89.2
<i>Never married</i>	43	8
<i>Widowed</i>	3	0.8
<i>Divorced</i>	12	2.
Dwelling categories		
<i>Block/corrugated iron roof</i>	418	77.3
<i>Block/grass roof</i>	82	15.1
<i>Other types</i>	40	7.6
Educational level		
<i>Illiterate</i>	72	13.3
<i>Primary education</i>	32	5.9
<i>Secondary education</i>	263	48.7
<i>Above secondary education</i>	173	32.1
Main occupation		
<i>Public servant</i>	98	18.1
<i>Employee</i>	82	15.2
<i>Causal labourer</i>	17	3.2
<i>Artisan</i>	52	9.6
<i>Herder/cultivator/agriculturist</i>	201	37.2
<i>Others</i>	90	16.
Ownership of dwelling		
<i>Rented</i>		84
<i>Owned</i>		484
Income month-1 (Naira)		
	N	%
<=₦18,000	168	31.1
₦18,500-₦30,000	114	21.1
₦30,500-₦70,000	72	13.3
₦70,500-₦130,000	30	5.6
₦130,500-₦200,000	111	20.6
Above ₦200,000	45	8.3
Type of material used in your kitchen floor		
<i>Tiles</i>	195	36.1
<i>Woodwork</i>	9	1.7
Mud		
<i>Terrazzo</i>	66	12.9
<i>Cement floor</i>	219	40.6
<i>Un-cemented floor</i>	30	5.6
Kitchen type		
<i>In-house kitchen</i>	297	55.0
<i>Outdoor kitchen</i>	132	24.4
<i>Separate house kitchen</i>	111	20.6

Table 3: Total fuel energy choice.

S/N	Energy sources	Frequency	Percentage
1.	Charcoal	27	5.0
2.	Firewood	42	7.8
3.	Gas	219	40.6
4.	Kerosene	186	34.4
5.	Electricity	111	20.6

Source: Researcher's Field Survey (2022)

kerosene, electricity, firewood, and charcoal, respectively. In view of the above statement, charcoal has the lowest used in the study area, as shown in Table 3

The study considered the reasons for the various household cooking fuel choices, which are diverse. The major reasons for people's choice have been found to be associated with the time factor, in which 41.1% of the sampled respondents said they preferred energy fuel that is time efficient. Other reasons adduced were cost efficiency

Table 3: Regression Analysis.

No.	Energy choice/type	Household socioeconomic factors	T value	P-sig	Remarks
1.	Charcoal	Age	2.003	0.046*	Significant
		Sex	-0.401	0.688	Insignificant
		Marital	2.232	0.026*	Significant
		School Completion	2.536	0.012*	Significant
		Monthly income	-1.024	0.030*	significant
2.	Firewood	Age	0.446	0.656	Insignificant
		Sex	0.778	0.437	Insignificant
		Marital	1.887	0.060	Insignificant
		School Completion	1.251	0.011*	Insignificant
		Monthly income	-3.595	0.000*	Significant
3.	Gas	Age	0.120	0.904	Insignificant
		Sex	-0.950	0.342	Insignificant
		Marital	1.334	0.183	Insignificant
		School Completion	3.876	0.000*	Significant
		Monthly income	0.325	0.745	Insignificant
4.	Kerosene	Age	-2.904	0.004*	Significant
		Sex	1.211	0.227	Insignificant
		Marital	-0.677	0.499	Insignificant
		School Completion	-3.816	0.000*	Significant
		Monthly income	-3.447	0.001*	Significant
5.	Electricity	Age	2.211	0.027*	Significant
		Sex	0.637	0.525	Insignificant
		Marital	-0.259	0.795	Insignificant
		School Completion	-1.198	0.032*	Significant
		Monthly income	6.067	0.000*	Significant

Source: SPSS Regression Output

(18.3%), easy to use (13.9%), safety (5.0%), neatness, 5.0%, manageable (8.8%), affordability (3.3%), convenience (2.8%) and comfort (1.7%)

The research revealed some of the challenges encountered by fuel users: 20.0% of the respondents posited that the matter of high risk of fire accident, 11.1% stated that it causes indoor air pollution, 7.8% declared it causes deforestation, 2.8% stated it is usually inconvenient to use. In comparison, 1.1% agreed that it was usually scarce.

The study further presented the regression result of the hypothesis, which sought to ascertain the relationship between household energy fuel choices and household socioeconomic variables. The result is presented in Table 3 below.

DISCUSSION

Electricity, gas, and kerosene were the major alternative energy sources that were consumed by households in Abakaliki. The study shows a descriptive analysis indicating

that families use a mixture of modern and traditional energy fuel choices and consumption patterns. It was observed that the modern energy choices, which comprise gas and electricity, were more pronounced in the usage than the traditional sources. It was also noted that greater patrons of these modern sources of energy were younger couples, youths, and students. The use of kerosene was seen as a temporary and emergency alternative to electricity and gas. Multiple fuel use has been revealed by many studies as prominent in most urban areas of developing countries (Taylor et al. 2011, Ngui et al. 2011, Mekonnen & Kohlin 2008). Taylor et al. (2011) stated in their study that despite the nearly universal ownership of stoves by many households in Guetamelia, 77% maintained the use of fuel wood as their main fuel energy source. This agreed with the finding of Ngui et al. (2011), which revealed in their study that most households in Kenya use multiple fuel energy. The situation was not different from the study by Mekonnen & Kohlin (2008), which was conducted in Ethiopia, where they concluded that the best way to describe the choice of energy use by households was multiple. These findings contradict the popular thought, which theoretically would assume that sources of energy fuel that are inconveniencing – charcoal and firewood are usually the source of energy for low-expenditure households, which were generally believed to live mostly in high-density areas.

Surprisingly, this study revealed that modern energy sources dominated household energy choices despite the seemingly increased trading of charcoal and sawdust in some precincts in the study area. The implication of this is rather encouraging as it portends minimal environmental damage (Meried 2021). In other words, environmental issues like declining agricultural productivity, felling of trees, soil erosions, and distortion of natural habitat for the wildlife in the area would be seemingly reduced and avoided (Ehirim & Emeka 2020). Thus, this trend is quite good as it depicts that Abakiliki city was accepting modern fuel as a substitute for traditional energy sources, which the area was known for before its status as a State capital.

The study further revealed the household socioeconomic factors that influenced the individual fuel choice and consumption in the study area. Table 3 shows the households' socioeconomic variables that significantly influenced the different fuel energy choices.

Some striking revelations from the study show that in the case of gas used for cooking, it was apparent that only one of the five household socioeconomic variables had a significant relationship with gas, which was educational attainment or number of school years. In the case of the use of kerosene as a household energy choice, it was noticed

that three variables out of five had significant relationships, and these were age, number of years in school, and average household head income. Also, in the case of firewood used for cooking, it was observed that only household head income and educational attainment had a significant relationship with the choice of firewood energy fuel. These findings were not in accordance with the findings by Emagbetere et al. (2016), which posited that socioeconomic variables like household size, income, prices of fuel wood, and prices of fuel wood substitutes were significant to firewood used for cooking in his study. However, in the case of charcoal used for cooking, it was apparent that four of the five independent variables had a significant relationship with it, and these include age, marital status, educational attainment (Number of years in school), and monthly income. Whereas, in the case of electricity used for cooking, it was apparent that only age, school completion - education, and monthly income had a significant relationship. This agrees with the study of Abdullahi et al. (2017), where they posited that explanatory indicators like economic status, household demographic profile, social factors, and public campaign (awareness) are significant determinants for household fuel consumption choices in Nigeria. It was noted from this study that in line with the theoretical propositions of the energy ladder model, households whose socioeconomic status threshold was low were the most likely to patronize the fuel wood as their household fuel energy choice. However, Adamu et al. (2020) revealed that beyond income, there are intricate webs of closely interrelated socioeconomic factors that drive household energy choice and transition. It was obvious from this study that educational attainment had a positive significant influence on the choice of all energy choices by households. This portrays the importance of education as an explorable variable in the study. It is little wonder why Chambwera & Folmer (2007) posited that education is a veritable and significant variable that must be considered while evolving policies to manage and handle the demand for household energy choices on a long-term basis. More enlightened household heads are normally more educated to understand the peril of using biogas fuels, and this thereby increases their desire to demand modern fuel use due to its convenience and safety.

Furthermore, the revelation from this study was in accordance with the findings of Ajaq (2011) and Demurger & Fournier (2011), who posited that in households that use firewood as an energy fuel choice, wealth and income have a significant though negative influence in determining their household firewood energy choice. They found out that aside from the matter of household wealth, residents are seen to be generally reluctant to leave traditional cooking habits that they have been used to. Their findings further noted that

floor effect may decrease firewood fuel consumption since households on higher floors in high-rise buildings most times will not prefer firewood usage due to inconveniences. They posited that besides the income effect, own-price effects have significant effects on firewood consumption behavior. They also said that age and academics influence energy choice. In the same vein, the outcome of this study was in sync with the study by Farsi et al. (2007), where they posited that several other socioeconomic demographic variables like education and the gender of the household heads were observed to have the most significant influence in household fuel choice.

CONCLUSION

The study concluded that the choice of household energy fuel and consumption pattern indicates that there was a mixture of traditional and modern energy fuel choices, and the modern energy fuel choice (gas and electricity) had higher patronage in the study area. Again, the paper concluded that the household socioeconomic factors that determined the cooking fuel choice by the household were the age of the head of household, number of years in schools – educational attainment, marital status, and income level of the household. These energy fuel choice parameters are needed for the framework of the policies for cooking fuel choice models in Nigerian cities. Basically, these socioeconomic and demographical factors have significantly yielded an effect on the use of household cooking fuel choice among households. The government should, therefore, develop a clear energy fuel policy that will adopt the identified household socioeconomic factors that influence the choice of energy fuel, as revealed by the study. The study showed that educational attainment, age, and income were the most pronounced factors that drive people to use gas as their source of energy for cooking. Thus, in areas where youths and working-class citizens were found, there should be availability of those gas-based appliances needed.

Furthermore, there should be policies that should discourage using firewood fuel and ashes for cooking. The policy of any country is geared towards making an enabling environment conducive for the people and, as such, for the overall well-being of the present and future generations yet unborn. Thus, policies to dissuade the public from the use of wood should be put in place, but this should come after a cheaper energy source has been made available to the public. There is a need for a price decrease in cooking gas appliances, for example, cooking gas cylinders, gas stoves, and hoses, since many households choose gas as the prominent energy source. There is a need by the government, therefore, to reduce the cost of all appliances that are linked to gas stoves and their appliances in order to make them more

affordable. In achieving this, there is a need for an urgent policy effectuation for the betterment of the households that use gas as energy fuel.

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