Influence Of Socio-Economic Factors In The Use Of Biomass Fuels In Enugu State, Nigeria

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ABSTRACT

Biomass fuels are used by a large proportion of households in most developing countries, including Nigeria, because they are readily available or relatively inexpensive. The purpose of this study was to determine how socioeconomic factors influence the use of biomass cooking fuels in Nigeria's Enugu State. The survey was cross-sectional, and multistage sampling was used. The samples included 502 respondents from 232 households in 6 of Enugu State's 17 Local Government Areas. The sample size was calculated using Fisher's formula. A structured questionnaire was distributed to the respondents, and observations were made. To arrive at results, data was collected and analyzed using SPSS version 21.0. According to the study, 94% of respondents use biomass fuels, with 73% using unprocessed wood. Only 6% of them use fossil fuels. Ninety-one percent (91%) of households earn less than ₦61,000 per month on average, with only about 1% earning more than ₦90,000 per month. It was also discovered that 88% of respondents had no more than a secondary school education, and 75% lived in rural areas. This study found a high level of poverty and a low level of education among the study population in Enugu State, which translates to a high use of biomass fuels, particularly unprocessed wood (firewood). The study's findings confirmed that socioeconomic factors such as household income level and educational status influence the use of biomass fuels, especially when these fuels are readily available at low or no cost.

Keywords: Biomass, cooking fuels, households, socio-economic factors

INTRODUCTION

Biomass fuels are used by a large proportion of households in most developing countries, including Nigeria, for cooking and space heating. Biomass fuel, also known as biofuel or biomass energy, is the energy produced by biological substances such as wood and agricultural wastes,

including other plant materials and animal residues. Biomass fuels account for approximately 90% of household energy consumption in Nigeria and other Sub-Saharan African countries (Das *et al*., 2016). Despite being rich in diverse modern energy resources, Nigeria's total energy supply is dominated by fossil energy and biomass (Eleri, 2021). Other sources of energy include oil products (24%), gas (17%), crude oil (4%), and renewable energy (including hydro, wind, and solar), which accounts for less than 1% of total energy supply (Eleri, 2021).

Biomass fuel is widely available in most communities because it is largely free or relatively inexpensive, and this may be responsible for the commodity's widespread use in countries with high level of poverty. In Nigeria, it is estimated that 68.3% of all households use solid biomass for cooking, compared to 10.5% who use gas and 19.8 percent who use kerosene and only 1% of Nigerian households use electricity to cook (Das, *et al*., 2016; Gujba *et al*., 2015). According to current population estimates, more than 180 million Nigerians do not have access to clean-cooking fuels and technologies such as liquefied petroleum gas (LPG), kerosene, and electricity, as they are more expensive than biomass, which is readily available at low or no cost. With over 60% of Nigerians earning less than $1 per day, biomass is the preferred source of cooking energy in the majority of Nigerian communities (Gujba *et al*., 2015). The implications of this affect the economy, the environment, health, and education – particularly for women and children (Eleri, 2021; NBS, 2019).

The high level of poverty in developing countries is also manifested in a lack of access to energy. In the midst of abundant natural energy resources, Nigeria suffers from a severe lack of access to electrical energy or other forms of renewable energy (Sanusi and Owoyele 2016). Energy poverty is a daunting challenge for the country and the West African sub-region as a whole. Traditional, transitional, and modern energy sources are the most commonly used by households for cooking, heating, and lighting. Households that can only access or use traditional energy sources and non-clean fuels like biomass fuels are considered to be energy poor. This entails the use of low-tech energy sources such as firewood (traditional biomass), charcoal, kerosene, plant residue, and animal waste. Furthermore, a household is considered energy poor if it must spend more than 10% of its disposable income to meet its energy needs (Teller-Elsberg, *et al*., 2016; IEA, 2017; Ismail, 2015). The use of wood is not necessarily understood as a choice by households but rather a necessity borne out of economic circumstances. However, it is also known that wood fuel is used

across all income levels, as households make wood fuel their first choice for a variety of reasons ranging from easy availability to the type of meal to be prepared and the occasion to be prepared for. This is critical for our understanding of energy transitions as well as the willingness of Nigerian households to switch from one cooking fuel or technology to another (Eleri, 2021).

The ostensibly normal developmental progression from traditional biomass use to alternatives such as kerosene, LNG, and electricity does not occur in Nigeria, and it is nearly impossible to determine whether the root causes are on the demand or supply side (Saad, 2016). This factor may have contributed to the widespread use of biomass fuel for household energy in Nigeria, with the attendant health consequences from household air pollution (HAP).

With the widespread use of solid biomass fuel in Nigerian communities, and the potential negative impact on the environment and human health, this study was carried out to ascertain the influence of socioeconomic factors on the use of solid biomass fuels among residents of Enugu State, Nigeria.

MATERIALS AND METHODS

Scope of Study: This study assessed households and their occupants in 6 Local Government Areas (LGAs) spread across the (3) Senatorial Zones in Enugu State, Nigeria. Male and female members of the selected households took part in the study. Participants under the age of 14 and those over the age of 70 were excluded from the study.

Study Area: This cross-sectional study was conducted in 6 LGAs across Enugu State's 3 senatorial districts. According to NPC, (2006), Enugu State is a state in Nigeria's southeastern region. It has 17 LGAs and a total population of 3,267,837 people. Fourteen (14) of the seventeen (17) LGAs are primarily rural. Some urban towns are concentrated mainly within the State capital. The state's economy is predominantly rural and agrarian, as it is mostly covered by open grassland with occasional woodlands and clusters of oil palm trees. Farming employs a sizable proportion of the working population, but trading (18.8%) and services (12.9%) are also important [11]. Enugu State and other states in Southeastern Nigeria are commonly referred to as Igbo land because the people are primarily Igbos with distinct ingenious characteristics. Because of the abundant rainfall in the State, trees and shrubs grow rapidly, ensuring an abundant supply of biomass fuel for cooking in the communities, thus the selection of the area for this study.

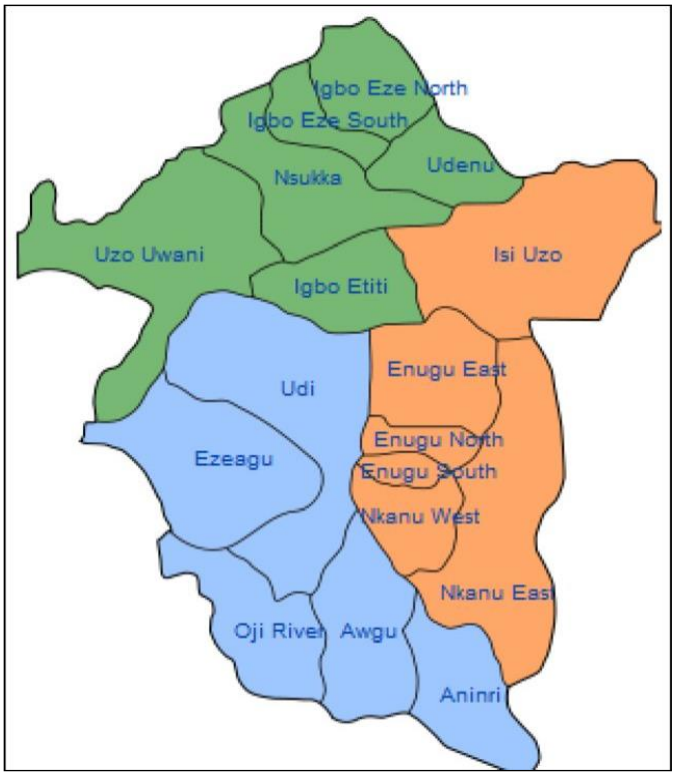

Figure 1: Map of Enugu State Showing the 17 Local Government Areas (Anejionu and Okeke, 2011)

Sample Size: In the determination of sample size for this research work, the Fisher's formula: $n = Z^2 q(1-p)/d^2$ for a large population (>1,000) was adopted (Fisher *et al*., 1998). Where n = minimum sample size; Z = standard normal deviation usually set at 1.96 which corresponds to the 95% confidence level; p = assumed population prevalence in % (the population of the study is estimated to be 50% to represent the target population in this study); q = 1-p; d = maximum acceptable random sampling error in %. In this case, P= 50%= 0.5; q = 1- 0.5 =0.5; d = 5%= 0.05.

Therefore, sample size (n) = $(1.96)^2$ (0.50) (0.50) / $(0.05)^2$ = 384

Because this is a cross-sectional study of Enugu State residents, households and their occupants constituted the sample population. As a result of using the Fisher's formula, which yielded a single figure (384), we balanced the research's interest by sampling 232 households and 502 individual respondents. It was thought to be a good representation of the population under study.

Sampling Techniques: This was cross-sectional study, and multistage sampling was employed. The LGAs in Enugu State were stratified into Senatorial Districts before selecting two LGAs from each Senatorial District using simple random sampling. Simple random sampling was also used to select the Wards and settlements for the study. Systematic sampling technique was used to select households within the settlements where the research instruments were administered. The households sampled in each settlement were determined using McCombes' systematic sampling technique model, in which the first household is chosen at random and the subsequent ones are chosen at intervals of 10th household in a defined order (McCombes, 2019). Stratified random sampling was used to select 6 LGAs from Enugu State's 17 LGAs (that is, 2 LGAs from each of the 3 Senatorial Districts of the State). Enugu-East and Isi-Uzo LGAs were

selected from the Enugu-East Senatorial District; Nsukka and Igboeze South LGAs were selected from the Enugu-North Senatorial District; and Aninri and Awgu LGAs were selected from the Enugu-West Senatorial District. The same random sampling method was used to select 3 Electoral Wards each from Enugu-East, Isi-Uzo, Igboeze-South, and Aninri LGAs, and 2 Electoral Wards each from Nsukka and Awgu LGAs, totaling 16 Wards studied. Nine (9) settlements were selected from Enugu-East, Isi-Uzo, Igboeze-South, and Aninri LGAs, while 5 settlements were selected from Nsukka and 4 settlements were selected from Awgu LGA, totaling 45 settlements studied.

Using a systematic sampling method, an average of 5 households from each of the 45 settlements were visited for administration of the research instruments, as well as personal assessment and observations, for a total of 232 households. This study enlisted the participation of 502 people, including 146 males and 356 females. The data gathered from these sources was analyzed to arrive at the study's findings.

Data Collection: For data collection, a pretested semi-structured questionnaire was used. Respondents provided information on socio-demographics, type of house, type of cooking fuel used, family structure, type of cooking apparatus/stove, ventilation status of the house, cooking hours/day, cooking years, and average family income. The questionnaires were distributed to members of the household who were at least 14 years old but not older than 70.

Statistical Analysis: All the data collected were compiled and analyzed using Statistical Package for Social Sciences (SPSS) version 21.0.

Ethical Consideration: The Ethics and Research Committee of the Abia University Teaching Hospital in Aba, Nigeria, granted ethical approval (**ABSUTH/MAC/117/Vol.1/61**) for the study. Each respondent provided informed written consent. Respondents' confidentiality and privacy were maintained throughout the study.

RESULTS

To assess the influence of socioeconomic factors on the use of biomass cooking fuels in Enugu State, Nigeria, 502 respondents from 232 households in 45 settlements spread across 6 Local Government Areas (LGAs) of the 3 Senatorial Districts in the state were surveyed.

Results in Table 1 shows that 75% of respondents live in rural areas. Majority of those who took part in cooking for the household were females (71%). Larger proportions (28%) of respondents

were between the ages of 34 and 43 years, followed by 25% of respondents who are in the age range of 14 – 23 years. This implies that 14 – 43years age range constitute 96% of those that participate in cooking for the household. Farming is the predominant occupation of the respondents (32%), followed by traders (28%), and then students (17%). It was also shown that majority of the respondents (48%) had only secondary school education, followed by 25% with primary school education and only 12% had university education, whereas 15% had no formal education.

Table 1: Demographics of the Sample Population

Social Demographic of Respondents		Aninri	Awgu	Enugu-East	Igboeze-South	Isi-Uzo	Nsukka	Total
Social Setting	**Rural**	80(16%)	0(0%)	50(10%)	100(20%)	80(16%)	64(13%)	374(75%)
	Urban	0(0%)	40(8%)	88(18%)	0(0%)	0(0%)	0(0%)	128(25%)
	Subtotal	80(16%)	40(8%)	138(27%)	100(20%)	80(16%)	64(13%)	502(100%)
Gender	**Male**	22(4%)	5(1%)	38(8%)	34(7%)	27(5%)	20(4%)	146(29%)
	Female	58(12%)	35(7%)	100(20%)	66(13%)	53(11%)	44(9%)	356(71%)
	Subtotal	80(16%)	40(8%)	138(27%)	100(20%)	80(16%)	64(13%)	502(100%)
Age Distribution (in years)	**14 – 23**	7(1%)	15(3%)	26(5%)	44(9%)	25(5%)	8(2%)	125(25%)
	24 – 33	19(4%)	5(1%)	24(5%)	10(2%)	13(3%)	8(2%)	79(16%)
	34 – 43	19(4%)	5(1%)	46(9%)	30(6%)	19(4%)	24(5%)	143(28%)
	44 – 53	3(1%)	10(2%)	24(5%)	12(2%)	17(3%)	4(1%)	70(14%)
	54 – 63	29(6%)	5(1%)	16(3%)	4(1%)	6(1%)	20(4%)	80(8%)
	64 - <70	3(1%)	0(0%)	2(1%)	0(0%)	0(0%)	0(0%)	5(1%)
	Subtotal	80(16%)	40(8%)	138(27%)	100(20%)	80(16%)	64(13%)	502(100%)
Occupation	**Farmer**	53(11%)	15(3%)	14(3%)	24(5%)	29(6%)	28(6%)	163(32%)
	Trader	17(3%)	5(1%)	52(10%)	32(6%)	17(3%)	20(5%)	143(28%)
	Artisan	3(1%)	5(1%)	34(7%)	14(3%)	4(1%)	4(1%)	64(13%)
	Civil Servant	2(1%)	8(2%)	16(3%)	4(1%)	11(2%)	8(2%)	49(10%)
	Student	5(1%)	7(1%)	22(4%)	26(5%)	19(4%)	4(1%)	83(17%)
	Subtotal	80(16%)	40(8%)	138(27%)	100(20%)	80(16%)	64(13%)	502(100%)
Educational/ literacy level	**No formal Edu.**	24(5%)	3(1%)	8(2%)	14(3%)	6(1%)	20(5%)	75(15%)
	Primary	29(6%)	12(2%)	30(6%)	24(5%)	21(4%)	12(2%)	128(25%)
	Secondary	24(5%)	20(4%)	70(14%)	58(12%)	48(10%)	20(5%)	240(48%)
	Tertiary	3(1%)	5(1%)	30(6%)	4(1%)	5(1%)	12(2%)	59(12%)
	Subtotal	80(16%)	40(8%)	138(27%)	100(20%)	80(16%)	64(13%)	502(100%)

Table 2 shows that, overall, 94% of the population use biomass as their primary cooking fuel (unprocessed wood, charcoal, and sawdust), while only 6% use fossil fuels. 73% of all the

biomass used is unprocessed wood, 21% is charcoal, while only 1% is sawdust. Despite the fact that LPG is the cleanest energy among the cooking fuels used by respondents from Enugu State's six local government areas, only 4% of the sample population uses it and 2% use kerosene for cooking.

Table 2: Types of Cooking Fuel Used by the Respondents

Fuel Types		Aninri	Awgu	Enugu East	Igboeze South	Isi-Uzo	Nsukka	Total
Biomass	**Unprocessed Wood**	53(11%)	32(6%)	80(16%)	80(16%)	71(14%)	48(10%)	364(73%)
	Charcoal	20(5%)	8(2%)	30(6%)	20(5%)	9(2%)	16(3%)	103(21%)
	Sawdust	0(0%)	0(0%)	6(1%)	0(0%)	0(0%)	0(0%)	6(1%)
	Subtotal	73(15%)	40(8%)	116(23%)	100(20%)	80(16%)	64(13%)	473(94%)
Fossil fuel	**LPG**	3(1%)	0(0%)	18(2%)	0(0%)	0(0%)	0(0%)	21(4%)
	Kerosene	4(1%)	0(0%)	4(1%)	0(0%)	0(0%)	0(0%)	8(2%)
	Subtotal	7(2%)	0(0%)	22(5%)	0(0%)	0(0%)	0(0%)	29(6%)
Total (n)		80(16%)	40(8%)	138(27%)	100(20%)	80(16%)	64(13%)	502(100%)

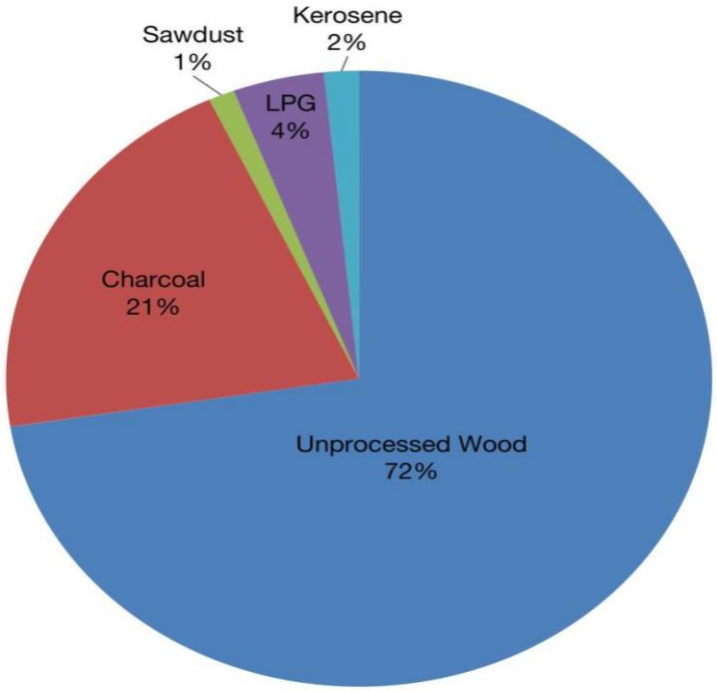

Figure 2: Primary Cooking Fuels used by Respondents in Enugu State

It can be observed from Table 3, that the majority of the households (91%) earn monthly income ranging from ≤₦30,000 to ₦60,000. 52.6% earn ≤ ₦30,000 and 38% earn between ₦31,000 and ₦60,000. Only 0.4% of the households earn more than ₦120,000 per month.

Most importantly, Table 3 describes the relationship between use of biomass fuels and the level of household income in Enugu State. It can be seen that majority of the 232 households sampled (74%) use unprocessed wood as cooking fuel. The majority of households who use unprocessed wood, (68%) have a monthly income ranging from ≤ ₦30000 to ₦60,000. Only 0.4% of the households that use unprocessed woods have a monthly income of up to ₦120,000 per month. Out of the 74 % of the households that use unprocessed wood for cooking, 41% earn less than ₦30,000 per month, followed by 27% that earn between ₦31,000 – ₦60,000 per month. This indicates that 68% of those that use unprocessed wood earn less than ₦60,000 per month.

The proportion of households that use charcoal is 20%, with 11.2% earning monthly incomes of ≤₦30,000, and 10% earning incomes ranging from of ₦31,000 to ₦60,000 per month. Only 0.4% of charcoal-using households earn more than ₦120,000 per month. Only 1.3% of the 232 households polled use saw dusts as a cooking fuel.

Table 3: Relationship Between Biomass Fuel Use in Enugu State and Household monthly Income Level

Fuel Type		**LGA**	**≤ ₦30,000**	**₦31,000 – 60,000**	**₦61,000 – 90,000**	**₦91,000 – 120,000**	**≥ ₦121,000**	**Total**
Biomass Fuels	**Unprocessed Wood**	Aninri	16(7%)	7(7%)	0(0%)	0(0%)	0(0%)	23(10%)
		Awgu	14(6%)	5(2%)	3(1.3%)	0(0%)	0(0%)	22(9.5%)
		Enugu East	12(5.2%)	7(3%)	2(0.8%)	1(0.4%)	0(0%)	22(9.5%)
		Igboeze South	16(7%)	26(11%)	3(1.3%)	0(0%)	0(0%)	45(19%)
		Isi-Uzo	25(11%)	9(4%)	2(0.8%)	0(0%)	0(0%)	36(16%)
		Nsukka	11(5%)	9(4%)	3(1.3%)	09)%)	0(0%)	23(10%)
	Subtotal		94(41%)	63(27%)	13(5.6%)	1(0.4%)	0(0%)	171(74%)
	Charcoal	Aninri	14(6%)	4(1.7%)	0(0%)	0(0%)	0(0%)	18(7.8%)
		Awgu	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Enugu East	4(1.7%)	5(2.2%)	2(0.8%)	0(0%)	1(0.4%)	12(5.2%)

		Igboeze South	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Isi-Uzo	6(2.6%)	3(1.3%)	0(0%)	0(0%)	0(0%)	9(3.9%)
		Nsukka	2(.08%)	5(2.2%)	0(0%)	0(0%)	0(0%)	7(3%)
	Subtotal		26(11.2%)	17(7.3%)	2(0.8%)	0(0%)	1(0.4%)	46(20%)
	Saw Dust	Aninri	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Awgu	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Enugu East	1(0.4%)	1(0.4%)	1(0.4%)	0(0%)	0(0%)	3(1.3%)
		Igboeze South	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Isi-Uzo	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Nsukka	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Subtotal		1(0.4%)	1(0.4%)	1(0.4%)	0(0%)	0(0%)	3(1.3%)
	Total for Biomass Fuels		**121(52.2%)**	**81(35%)**	**16(6.9%)**	**1(0.4%)**	**1(0.4%)**	**220(95%)**
Fossil Fuels	**Kerosene**	Aninri	0(0%)	2(0.9%)	0(0%)	0(0%)	0(0%)	2(0.9%)
		Awgu	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Enugu East	0(0%)	1(0.4%)	0(0%)	0(0%)	0(0%)	1(0.4%)
		Igboeze South	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Isi-Uzo	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Nsukka	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	LPG	Aninri	0(0%)	1(0.4%)	1(0.4%)	0(0%)	0(0%)	2(0.9%)
		Awgu	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Enugu East	1(0.4%)	3(1.3%)	2(0.9%)	1(0.4%)	0(0%)	7(3%)
		Igboeze South	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Isi-Uzo	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
		Nsukka	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Subtotal for Fossil Fuels		1(0.4%)	7(3%)	3(1.3%)	1(0.4%)	0(0%)	12(5.2%)
Grand Total			**122(52.6%)**	**88(38%)**	**19(8.2%)**	**2(0.9%)**	1(0.4%)	**232(100%)**

DISCUSSION

According to the Economic Community of West African States' (ECOWAS), the Centre for Renewable Energy and Energy Efficiency (ECREEE, 2021), approximately 80% of the ECOWAS population still cooks with traditional biomass. This is mostly done inefficiently, leaving children and women vulnerable to health issues that can lead to death. Nigeria is not immune to this problem, as more than 75 percent of the Nigerian population, particularly in rural areas, still uses the traditional cooking method of using wood fuel (ICREEE, 2016). The Federal Republic of Nigeria's "Sustainable Energy For All Action Agenda" (SE4ALL-AA) aims to promote the use of cleaner cooking fuels. According to the SE4ALL-AA, under the energy access target, the use of modern cooking fuels such as electricity, LPG, kerosene, biogas, and solar cookers will increase significantly, rising from the current estimate of 10% to 50% by 2020 and reaching 80% of the population by 2030. Improved wood cook stoves and efficient charcoal production will provide cooking fuels in households to the remaining 20% of the population [16]. However, only time will tell whether this organization's lofty goals will be realized.

This study examined the role of socioeconomic factors in the use of biomass cooking fuels among residents of Enugu State, Nigeria. By assessing respondents from households spread across 6 LGAs in the state. This study's findings revealed the population's demography and socioeconomic status (income levels and literacy) and how they influence their cooking fuel choices.

Demography of Study Population

According to the demographics of the study population (Table 1), the respondents are primarily females (71%), rural dwellers (75 %), largely between the ages of 34 and 43 (28%), and farmers (32%). In terms of educational exposure, those who have completed secondary school account for 48% of the study population. It has been established that socio-demographic factors such as marital status, gender, level of education and age of the household's head, gender composition in the household (female/male ratio), and household size, influence their cooking fuel consumption behavior (Danlami, *et al*., 2016).

According to the findings of this study, majority of the study participants are females, and majority of the households use biomass cooking fuels (94%), with unprocessed wood being the preferred choice (74%). Previous research, on the other hand, found no significant relationship between the gender of the household head and the household's cooking fuel consumption behavior (Danlami, *et al*., 2016; Nlom and karimov, 2014;

Jumbe and Angelsem, 2010). However, it has been reported that as the female to male household member ratio increases, the household adopts biomass cooking fuel sources (Danlami, *et al*., 2016; Heltberg, 2005).

A larger proportion of the study population (28%) is between the ages of 34 and 43, followed by those between the ages of 14 and 23 (25%) and those between the ages of 24 and 33 (16%). As majority of the population (69%) fall between the ages of 14 and 43, the population can be classified as youthful.

The age of the household head has been previously reported to have a negative relationship with clean fuel adoption (Danlami, *et al*., 2016; Nlom and karimov, 2014), implying that households use biomass fuels when the head is older. However, majority of the young people in this study used biomass as their primary cooking fuel. This situation could be attributed to other factors, such as income levels, which play a significant role in determining what kind of cooking fuel an individual, regardless of age, can afford.

In terms of literacy levels, the study population, which consists primarily of secondary school leavers (48%), primary school leavers (25%), and those without any formal education (15%) with only 12% having tertiary education, can be considered uneducated. The level of education of the household head has a positive relationship with the use of clean fuel. The more educated the household head, the more he realizes the negative impact of biomass fuels and, as a result, the less likely it is to be adopted. Many studies have found this assertion to be true (Danlami, *et al*., 2016; Nlom and karimov, 2014; Heltberg, 2005; Rahut, *et al*., 2019).

Education is a critical factor influencing the choice of fuel for cooking purposes (Rahut *et al.*, 2019). Households with a higher level of education are more likely to use clean fuel for cooking, whereas those with a lower level of education are more likely to use dirty fuels. Individuals are more aware of the negative effects of dirty fuel and are less likely to use it as a result of education. The respondents' low educational status influenced their extensive use of biomass fuels in this study. Educated households are more likely to have higher incomes, allowing them to purchase clean fuel (Rahut, *et al*., 2019).

There is also a link between the type of occupation of the household head and the type of cooking fuel source that a household will use. Farmers make up the majority of the study population (32%), followed by traders (28%). Previous research has shown that those in white collar jobs (executives and entrepreneurs) prefer modern clean fuels, whereas those in blue collar

jobs (such as farming and trading) prefer firewood and other biomass fuels (Heltberg, 2005; Ozcan, *et al*., 2013). This is consistent with the findings of this study, as 60% of the population in this area is comprised of blue-collar workers, resulting in a remarkable reliance on biomass fuels.

Income Level of Households

The monthly income of a household determines its economic status. It is expected that the greater the household income, the greater the flexibility of shifting to the desired household fuel. In this study, a larger proportion (91%) of households earn monthly incomes ranging from ≤₦30,000 to ₦60,000, with 52.6% earning less than ₦30,000 per month and 38% earning between ₦31,000 and ₦60,000 per month (Table 3).

Majority of the 232 households sampled in Enugu State use biomass cooking fuels. Eighty-seven percent (87%) of them have a monthly income of ≤₦30,000 to ₦60,000. Only 5.2% of households use fossil fuels (Kerosene or LPG) for cooking, with 3% of fossil fuel users earning between ₦31,000 and ₦60,000 per month, followed by 1.3% earning between ₦61,000 and ₦90,000 per month, and 0.4% earn up to ₦120,000 per month.

This study, like previous ones (Rahut, *et al*., 2019; Nnaji, *et al*., 2012; Ogunniyi, *et al*., 2012; Oyekale, *et al*., 2012; Mohammed, 2018), demonstrates the direct proportional relationship that exists between household income levels and biomass fuel use. According to Varrella, (2021), the average monthly cost of living in Nigeria for an individual is ₦34,200, and this figure adds up to approximately ₦137,600 for a family of four. With the current national minimum wage in Nigeria set at ₦30,000 (about $66) (John, 2019), a large proportion of the households examined in this study can be considered as poor.

Majority of the study population's poverty explains their high reliance on traditional biomass, owing to the relative accessibility and affordability of these fuels compared to the more clean fossil fuels. As majority of the study population has low-income, biomass, particularly wood, is expected to be their primary source of cooking fuel. It is understandable that the cost of cooking fuel will influence household decisions. The price of gasoline has a negative relationship with the amount of gasoline consumed. When the price of a particular fuel source rises, households switch to other available alternative fuels. This is consistent with the law of demand and supply, as well as previous research (Nlom and Karimov, 2014; Lee, 2013; Ganchinmeg and Harvrland, 2011).

This situation is explained by the energy ladder hypothesis, which states that in response to higher income and other factors, households will

transition from the use of biomass and other solid fuels to modern and clean fuels such as natural gas and electricity (Rahut, *et al*., 2019). Income and relative fuel prices are thought to be the engines of transition in the energy ladder (Rahut, *et al*., 2019; Barnes and Floor, 1999; Rahut, *et al*., 2014). Aside from the amount of fuel used for cooking, the type of fuel consumed changes with income, with a preference for clean fuels, particularly the use of electricity (Rao and Reddy, 2007; Daioglou, *et al*., 2012; Hills, 1994). Low-income households use dirty fuels that are harmful to the environment and human health; as incomes rise, they generally, but not always, switch to cleaner fuels (Rahut, *et al*., 2019).

This study therefore agrees with and confirms previous findings that report the link between household income level and the use of biomass cooking fuels. It has also been agreed that the higher the income level of the household, the more likely they will switch to a cleaner cooking fuel, and vice versa.

Choice of Cooking Fuels

According to the findings of this study, almost all respondents (94%) use biomass as their primary cooking fuel (unprocessed wood, charcoal, and sawdust) (Table 2). Among the three biomass fuels investigated (unprocessed wood, charcoal, and sawdust), unprocessed wood was used as a cooking fuel by the vast majority (73%) of the sample population. Only 6% of the population uses fossil fuels (kerosene or LPG), with LPG being used by 4% of the sample population (which could be considered as the cleanest cooking fuel in this study).

Studies have shown that rural households in Nigeria rely heavily on natural forest resources for survival, for the simple reason that trees provide many basic needs for life, such as medicine, food, fuel, fodder, timber, environmental protection and sustainability, and so on (Mohammed, 2018; Inoni, 2009). The majority of these wood fuels are derived from preferred trees, owing to availability, efficiency, affordability, and cultural considerations (Akpan *et al*., 2010; Wakili, *et al*., 2012). The widespread use of wood as a fuel source for the majority of households has negative environmental consequences for communities and the nation as a whole. The systematic destruction of the state's forest reserves and woodlands is the first negative impact of using wood as the primary source of cooking fuel. Environmental problems such as soil erosion and the persistent and progressive desertification are the consequences of felling of trees (Danlami, *et al*., 2016; Nura, *et al*., 2011. As a result, Nigeria is likely to continue grappling with all of the health and socioeconomic consequences of biomass use until the country lives up to its responsibilities

and climbs the energy ladder to begin use of cleaner and more sustainable energy.

CONCLUSION

Socioeconomic status of the households influenced the households' decision to use cooking fuel, according to the findings of this study. Gender, age, household income, occupation of the household heads, and literacy level are among the variables. Poorer households use firewood, charcoal, and other biomass cooking fuels, whereas wealthier households tend to use modern cooking fuels such as kerosene and LPG. This is not the case for uneducated people who may be unaware of the inherent health risks associated with the use of biomass cooking fuels, necessitating intervention (sensitization) to change the narrative.

The findings of this study suggest that the demographic characteristics of households (particularly income levels and literacy) have a strong influence on the likelihood of household choice for energy consumption in Enugu State, Nigeria. Poverty and education are two social forces that have a significant influence on households' energy consumption choices in the country.

It is critical that Nigeria invests in the education sector of the economy in order to improve access to affordable and high-quality education outcomes, as well as to ensure equitable and balanced distribution of socioeconomic resources, which will go a long way towards empowering various households. Higher literacy levels in the population will ensure that they are aware of the health risks associated with the use of biomass fuels in the home, as well as their impact on the environment. This awareness will effectively shift households' energy preferences toward more environmentally friendly alternative sources. There is a need for a strong policy push to reduce the incidence of poverty through the provision of social security insurance schemes and the implementation of policies that will improve the living conditions of vulnerable groups (e.g. female headed households).

Nonetheless, because firewood is the fuel of choice for the majority of the rural population, Nigeria and other third-world countries should implement a permanent and deliberate reforestation program that includes the planting of wood species that are ecologically suitable, socio-culturally compatible, and economically viable. The products should be harvested using controlled and best practices, and the government should use them to address rural energy demand issues as well as other interconnected concerns such as food production, soil erosion, and desertification.

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CONFLICT OF INTEREST

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