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Unclean Energy Source Dependence and Sustainability in Nigeria: Consumption Dynamics and Impact of Contextual Factors

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ABSTRACT

Fuelwood is the primary energy source for throughout the developing world. This, indiscriminate use of fuelwood as energy jeopardizes the environment, and well-being of the people. Despite Nigeria being the energy giant in Africa, most of her people still depend on unclean energy [fuelwood] for cooking, heating, and boiling. This article underlines the dynamics and essential impacts of social cum economic and demographic indexes on household unclean energy dependence. We interviewed 994 household fuelwood consumers, using a two-stage stratified random sampling technique. We used the delineated Enumeration Areas for Katsina State, Nigeria for socioeconomic data. The test re-test reliability method (trustworthiness assessment of the questionnaire) and Cronbach Alpha test (internal constancy) resulted in a value of 0.70 and 0.875 respectively. Using descriptive statistics and logit regression, findings indicate a high level of fuelwood energy dependence among households. Findings show that education level, employment status, and household structure have an opposite and highly statistically substantial relationship with the likelihood of household dependence on fuelwood, while age and household size move in the same trajectory and highly statistically substantial association with the likelihood of family dependence on fuelwood. Thus, the most difficult challenge facing Nigeria as per household dependence on unclean energy (fuelwood) is that the use of fuelwood increase economic, environmental, and health dangers. dangers and It has therefore become imperative for a paradigm shift in policies to change the current narrative toward clean energy.

Keywords: Consumption, Energy, Fuelwood
JEL Classifications: C1; D1; D6; E2; O2

1. INTRODUCTION

Energy policy is an important factor in economic development and developing countries, it is an important part of the overall regulatory framework that determines their increase in global attractiveness and the incorporation of the private business sector. Furthermore, Fuelwood plays a major role in supplying energy to the rural masses and the poorest groups. The term "fuelwood" comprises firewood, charcoal, and other wood-derived fuels and accounts for between 70% and 75% of total energy usage and 80% of household energy utilization across Asian countries. This energy source (Bad Energy) occupies a special place in rural energy systems owing to the importance of the domestic consumption for which it is mainly used and the fact that it is produced within the system itself. Wood is considered humankind's very first source of energy and today it is still the most important single source of renewable energy providing about 6% of the global total primary energy supply. However, studies in many developing countries have found unclean energy (fuelwood) consumption to be one of the causes of indoor air pollution that results in various health issues. Research in Africa has established a robust linkage between fuelwood consumption and health challenges, especially among women and children (Oguntoke et al., 2013; Sanyal and Maduna, 2000). More importantly, indiscriminate use of fuelwood has significantly added to carbon emissions causing a serious negative impact on the environment (Orimoogunje and Asifat, 2015; Maconachie, 2015; Taibbi, 2013). Nevertheless, fuelwood has continued to provide domestic energy to many households in Nigeria despite its status as an energy giant in Africa. Existing information on household energy consumption shows that the popularity of fuelwood as domestic energy is increasing in Nigeria. In the year 2013, fuelwood consumption escalated to about 72%, consisting of 86% in rural households and 42% in urban households from 60% in 2003 (NPC and ICT international, 2014; Abdullahi et al., 2017). The huge growing number of people that consume fuelwood in Nigeria led Maconachie (2015) to argue that "it is true at the moment as it was, more than two decades past when "the role of fuelwood (was) so predominant that any realistic energy analysis was essentially a fuelwood analysis". Furthermore, results from a study, by Maconachie et al. (2009) on trends of fuelwood consumption amongst families in Kano, Northern Nigeria in the last two decades indicate that more families are reverting to fuelwood for domestic activities despite the experience of using other modern cooking fuels in the fast. The reason given was that the high prices of kerosene and other domestic petroleum products made fuelwood an attractive substitute ffor households in the area.

Even though, the study of Taibbi and Hearley (2013) associated the trend with the disparity in the trajectory of fossil-fuel supply within the country, Orimoogunje and Asifat (2015) attributed the phenomenal increase in fuelwood consumption to unstable electricity. Contrary to these studies, the Nigerian National Bureau of Statistics (2013) shows that the high level of fuelwood consumption has a strong nexus with the poverty level in Nigeria. For instance, the northeast and North-west regions where the poverty rate is uppermost utilized more fuelwood than the other regions (95.9% and 95.3%). The Southwestern and Southeastern regions that are more buoyant economic wise use less fuelwood (54.9% and 78.0%). Besides, price, poor energy infrastructure, and poverty, other factors may influence household dependence on fuelwood in Nigeria. Studies have shown that culture, the family-head age, household number, family employment status, and education level can have either positive or negative influences on household fuelwood dependence (Baiyegunhi and Hassan, 2014; Özcan et al., 2013; Muller and Yan, 2016). Tropical Africa depends on fuelwood for about 90% of its energy supply (Boahene, 2008), because it is still far cheaper than most alternative available forms of fuel. Several factors influence the extent and use of fuelwood for energy and its consumption rates. These include climate, forest cover, attitude, energy demand, and household size. Households preferentially invest their limited financial resources into fuelwood rather than electricity to meet their domestic energy needs (Davis, 1998; Thom, 2000). This preference is linked to various socio-economic factors such as prohibitive costs of monthly electricity tariffs (relative to household incomes) and the costs of purchasing electrical appliances that need to be maintained efficiently. The cost of electricity relative to the financial income earned by these households is a major factor preventing these households from switching exclusively to electricity. Various studies on Nigeria's fuelwood situation suggest that households are reverting to the use of fuelwood despite the experience of using modern energy in the past. Additionally, most poor families receive under $2 per day and $0.4 is spent daily on energy. The above scenario represents about 20-40% of the revenue accruing to families being used for energy issue Nria-Dappa, 2009). Not only that, but 40% of the populace in Nigeria also does not have an electricity supply because of the weak energy structure, and the fossil fuels supply is also unreliable. From all indications, fuelwood is becoming inescapable energy for households in Nigeria like in many developing countries. Concerning this, the most difficult challenge facing Nigeria as too high fuelwood consumption can be seen from two perspectives, first, the unsustainable production and use of fuelwood for energy, signify health, environmental and economic hazards for countryside and city dwellers. Furthermore, the insufficient supply of modern energy sources made many households unable to access energy making households' fuelwood consumption continue unabated. This situation has become a source of concern for the Nigerian government.

Fuelwood issues are now widely acknowledged as being difficult to generalize. Fuelwood shortage and use reflect complex and varied relationships between local production systems and the natural resources that support them. Fuelwood concerns in a semiarid location like sections of the Sahel differ greatly from those in a mountainous region like Nepal or a high-density/high-productivity place like the Kenyan highlands. There is also a clear disparity between rural locations (where fuelwood is typically a free good obtained locally) and urban ones (where fuelwood is a commodity produced elsewhere). Fuelwood issues have a wide range of origins and manifestations. These issues in rural areas are a result of shifting economic and environmental interactions that impact local supply and demand (Armitage and Schramm, 1989). These changes can be gradual, such as land colonization eroding local woods; higher herd sizes in semiarid locations; increased fuelwood exports to meet growing urban demands; or reduced quantities of wastes available as fuel as a result of changing farming techniques. Large-scale deforestation linked with massive development programs; enormous influxes of migrants; and environmental collapse associated with droughts, floods, or other extreme climatic occurrences are examples of sudden and catastrophic changes. These changes, whether slow or abrupt, are at the root of fuelwood issues and place clear restrictions on the options available to successfully address them.

Energy is one of the most important inputs for economic development. From a physical viewpoint, the use of energy drives economic productivity and industrial growth and is central to the operation of any modern economy. The major concerns about the large-scale modern use of wood energy include production sustainability in the context of land-use change and the impact on food security; the net greenhouse gas emissions of the wood energy system (i.e., biomass production, harvesting, processing, transport, and use). Furthermore, burning wood pellets for heat and electricity might be increasing carbon emissions and may endanger forest biodiversity. Burning wood for energy is thought to be carbon neutral: trees soak up carbon dioxide from the atmosphere, and burning wood puts the greenhouse gas back in the air. Most rural communities in Nigeria and throughout Africa rely on wood collected from communal lands surrounding their village for their household energy needs. In addition to providing fuel for cooking and heating water, harvested wood is also used for building fences, walls, and roofs. However, the pertinent question remains if rural communities should keep harvesting wood indefinitely? Would this option in the rural ecosystems keep pace with the constant demand, particularly in the face of global climate change? The collapse of wood supply predicted from studies conducted in the early 1990s has not materialized in rural areas in Nigeria, but the potential for a collapse soon remains, particularly with the advent of global climate change. Demand for firewood remains strong, despite the roll-out of electricity to most rural households. It is quite likely that the ecosystems in question are still in a process of responding to the cutting that has been occurring over the past decades and will soon cross a threshold and enter a degraded state with much lower rates of wood production. Furthermore, global climate change is likely to bring unprecedented heat waves and droughts, which may damage these ecosystems to the point that the wood supply is permanently reduced. Understanding what determines the ability of rural ecosystems to produce wood, therefore, remains a key question for Nigeria's ecology.

Because of the negative effects of biomass use on human and environmental health, several governments have worked to limit biomass use by providing potentially cleaner fuels, the most common of which is electricity. However, studies documenting changes in fuelwood consumption after the arrival of electricity, particularly in rural parts of Africa, are surprisingly sparse. Therefore, understanding the level of household dependence on unclean energy (fuelwood) will shed light on energy policies and programs as they provide an estimate of how household fuelwood energy consumption will be affected by socioeconomic/demographic variables and government policies. More importantly, household fuelwood dependence is a very important indicator of the level of economic development and standard of living of a country. Katsina state is in Northern Nigeria and is economically and educationally backward compared to many states in southern Nigeria. The State is rated as the second poorest in Nigeria with a poverty level of about 80%. Poverty and the precarious supply of modern energy have forced most people to depend on fuelwood for domestic activities. Katsina state covers an expanse of 23,938 sq km and the state borders the Niger Republic to the north, to the east, it borders Jigawa and Kano States and to the South, it borders Kaduna State, and in the west Zamfara State. While the creation and utilization of wood energies in different areas (North America, Latin America, Europe, and Asia) are declining, the converse is the situation in sub-Saharan Africa, particularly Northern Nigeria. Consequently, there is a need for an exact examination and resulting strategy ideas as the worldwide weight of biomass utilization-related illnesses as indicated by WHO (2005) is extremely huge and on the ascent, particularly in sub-Saharan Africa. This study has some viable importance. At the present, the utilization of wood fuel in Northern Nigeria is high and on the ascent. The interest in it is projected to increment further in the next few decades if elective current energies are not made accessible and affordable to individuals of the region.

Therefore, it is imperative to ascertain how the continuous reliance on wood fuel by states in Northern Nigeria affects the living standards of the people. Even though some gains are seen in terms of income creation for the wood fuel operators and rural poor, who rely on wood fuel extraction as the means of livelihood. There are costs linked with its consumption through the unfavorable health effects, which may affect the economy. Thus, examining its real impact will assist in providing details to the policymakers about the level and magnitude of the impact, for them to provide applicable policy action. This study contributes to knowledge and literature in forest economics and biomass-related literature. Thus, it is vital to determine how the constant dependence on wood fuel by states in Northern Nigeria influences the expectations for everyday comforts of the general population. However, there are a few advantages that are found as far as per age for the wood fuel administrators and rustic poor, who depend on the wood fuel extraction as the method for business, there are expenses related with its utilization through the antagonistic wellbeing impacts, which may conceivably influence the economy. This study will add to the collection of information and writing on wood financial matters and biomass-related writing. Based on the foregoing, the following pertinent questions have become imperative; what are the dynamics of household consumption of fuelwood energy in Northern Nigeria? What is the level of household fuelwood energy dependence in Northern Nigeria? and what are the impacts of socioeconomic and demographic variables on the level of household fuelwood energy dependence in Katsina State, Northern Nigeria? Against the backdrop of the questions, the objectives of the article are to analyze the dynamics of household fuelwood consumption. Secondly, to estimate the level of household fuelwood energy dependence. Thirdly, to appraise the effect of contextual factors on the level of household dependence on fuelwood energy.

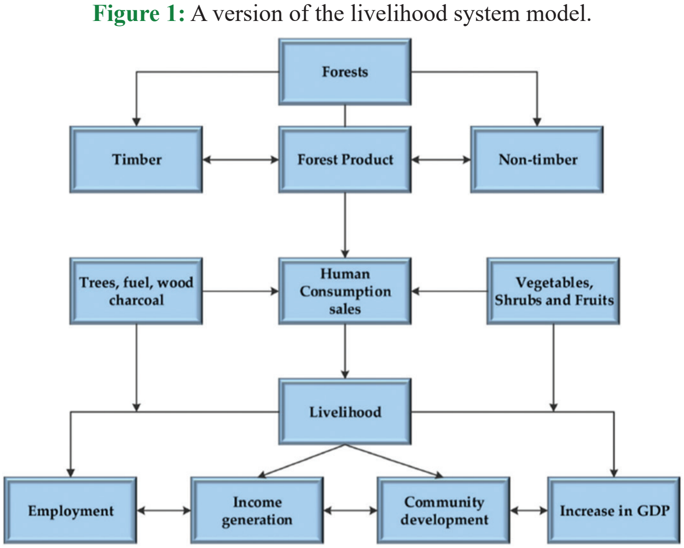
1.1. Theoretical Framework (Livelihood System Model)

This model is essentially related to the livelihood system and was developed to represent the livelihood process and function. In most forested areas of the world, households' livelihoods are improving through the rights and loyalty of available capital investments such as the harvesting and sale of timber and non-timber resources. Different households have different proportions of household wealth in the same area. The poorest people will have to rely on their resources and co-ownership claims to survive. For most rural residents, agricultural activity can be said to be their main profession and livelihood, but most of them see the harvest of forest products and resources as a great opportunity to improve their income base. This means a proven improvement to support rural life, which has emerged as a prominent economy and brings clear socio-economic benefits to the forest community (Fonta and Ayuk 2013). Forest product harvesting can be an important supportive activity for individuals and families in forested areas, as non-agricultural livelihoods are particularly vulnerable to seasonal fluctuations in demand. Changes in eligibility/access conditions can have a significant impact on the lives of rural residents, as it is difficult to create situations where there is a fair sharing pattern that guarantees fair sharing of shared assets for all. Livelihood system models show that forestry contributes to improving and improving the well-being of forest communities in a variety of ways (consumption and sale of forest products such as trees, firewood, charcoal, vegetables, shrubs, and fruits). The basic aspect of this model is to provide templates to help scientists and planners understand livelihood issues. This model emphasizes that livelihoods provide employment opportunities, income generation, community development, and increased GDP (Figure 1).

2. REVIEW OF RELATED LITERATURE

The increasing utilization of timber and fuelwood for energy production has been largely influenced by many socioeconomic factors that affect the livelihood of most households across the world. The development of timber and fuelwood extraction, processing, and utilization for energy production creates huge business opportunities and a reliable source of income that decreases the challenges of unemployment (Arent et al., 2011). In addition to the environmental subsistence and economic importance of timber products, they also provide food security to the majority of rural residents in most developing countries (Haddaway et al., 2016; Gavaskar et al., 2012). These factors make up the reason why the utilization of fuelwood has a site and situation-specific energy option. The choice for many users depends on its availability and affordability over other sources of energy. In the past, most developing countries used wood and non-wood timber forest products mainly for domestic consumption while dry branches and trunks of trees and shrubs were also utilized to produce domestic energy. In Nigeria, fuelwood consumption has been used to produce fuelwood to generate energy for domestic consumption and to some extent commercial purposes. Notably, charcoal, which is a forest product and a major source of household energy production, has slowly become an important commodity for the majority of low-income earners. It is also very relevant to note that fuelwood contributes significantly to national energy balances and is an important source of income for households and a potential source of renewable energy capable of boosting significant economic growth while at the same time reducing the dependence of poor developing countries on expensive energy imports (Arnold and Persson, 2003).

Figure 1: A version of the livelihood system model.



Source: Ullah et al. 2021

Numerous quantitative studies have investigated the effects of socioeconomic and demographic factors on a household's dependence on fuelwood as energy. It is envisaged that households with more persons depend more on fuelwood for energy than households with smaller family members. Larger households prefer fuelwood energy or dirty fuels over clean energy (Pandey and Chaubal, 2011; Özcan et al., 2013; Muller and Yan, 2016). One possible explanation is that poor households often have a larger household population that does not have enough to afford modern energy, as a result, they must depend on fuelwood. However, Baiyegunhi and Hassan (2014) have shown the opposite trend, that established larger households decided to choose modern fuels instead of fuelwood or dirty fuels. While Jawail and Bhattacharya (2017) indicated that family size and other factors determine the household's dependence on fuelwood, Heltberg (2004) provided a middle course where households combined dirty fuels (fuelwood) and modern fuels (i.e., fuel stacking). These arguments suggest that the association between the size of the household and the consumption of fuelwood moves in the same direction.

Furthermore, education level may affect the possibility of families depending on fuelwood for domestic energy. Households easily perceive and respond to information faster on innovation if well-educated (Feder et al., 1985). Meaning that information regarding the environmental and health implications associated with fuelwood consumption can easily be understood with a high level of education. According to, educational attainment is a factor affecting psychogenic needs that arise as a result of association with other people and the need for affiliation, achievement, and power. Thus, the consumption pattern of people depends on their associates and reference groups. The level of education determines the level of exposure of the household to different technologies, lifestyles, social classes, and statuses in society. It could be hypothesized that educated households are more likely to depend on modern clean energy like electricity and LPG for cooking, boiling, and heating than fuelwood. Likewise, more education generally implies higher income. In India and Nigeria, higher education was found to have induced households to abandon fuelwood and use LPG and kerosene (Baiyegunhi and Hassan, 2014). In addition, households with a higher education level in Ethiopia were found to have less likelihood of choosing fuelwood, while more likely to choose electricity for their domestic consumption (Gegreegziabher et al., 2012). Additionally, Lay et al. (2012) study in Kenya shows that families with an advanced level of education have a higher likelihood of using clean energy such as electrical energy or solar energy for domestic purposes than fuelwood and kerosene. On the contrary, Rahut et al. (2019) posit that where a lower level of education is predominant in a household, in addition to its being a lower-income category, the probability of dependence on fuelwood energy becomes high.

In terms of the age of the household, age is said to be an important demographic factor that potentially affects household dependence on fuelwood. Even though there is still contention in the literature as to what extent age can explain household fuel use (Muller and Yan, 2016) However, many studies have established that household-head age can positively affect household fuelwood dependence. This is seemingly plausible because older persons often stay at home, hence they need to consume more energy, particularly for heating purposes. In Guatemala, Edwards and Langpap (2005) reported a positive and substantial link between family-head age and fuelwood dependence. Similarly in Bhutan, Rahut et al. (2014) indicated that older heads of the household chose fuelwood against electricity. According to Démurger and Fournier (2011), the average family-head age has a substantial influence that is positive on fuelwood dependence in pastoral homes of Northern China. The impact of household structure such as house size, the number of accommodations, water drinking source, ownership of a house, electrification of house, and type of house were all found to significantly affect household energy consumption. Baiyegunhi and Hassan's (2014) study shows that unclean energy (fuelwood) is the foremost energy for households that are living in traditional houses in Nigeria, hence they are less probable to use electricity and natural gas usage. Consequently, the challenges of fuelwood utilization in Nigeria are gradually becoming unbearable over time, as there has been an observed rapid increase in deforestation activities which has made most forest products scarce and has caused their extinction.

3. DATA AND METHODS

We used a two-stage stratified random sampling technique because of its simplicity. The technique is known for taking a large sample in a small group of a population. The first stage was the delineation of clusters of Enumeration Areas (EAs) from housing units. In the second stage, we adopted simple random sampling in choosing the families residing in the housing units in the EAs. It is important to note that in the year 2015, one hundred and twenty Listing Areas (LAs) were delineated for Katsina State by the Nigerian National Bureau of Statistics (NBS). NBS is the custodian of Nigeria's socio-economic data. The agency is tasked with the development and management of official statistics in the country. Katsina State is among the 36 States in Nigeria with thirty-four local government areas. Out of the 120 Enumeration areas (EAs) demarcated, ten (10) households (HH) were arbitrarily chosen in each Enumeration Area, and questionnaires were administered to 1200 households (HH). Afterward, 992 questionnaires were returned giving a response rate of 82%. Frequency tables and logit regression were used to analyze the results.

Data from the interview schedules were collated and analyzed using SPSS software Discrete variables were summarized by determining the frequency of each code within the question. Frequency analysis was undertaken, and summary statistics were calculated for all numeric variables. Normality for all the data was tested using the Shapiro and Wilks test. We adopted the Binary Logistic Regression technique for our analysis. The framework is in support of models that calculate categorical outcomes with two or extra categories. The predictor factors can be both categorical or continuous, or a combination of both in the model. The *Forced Entry Method*, which is a basic procedure in SPSS software was used because all predictor factors are investigated in one block while monitoring for the influences of other forecasters in the model. However, other options allow the specification for a large cluster of probable forecasters, but they have been criticized because they can be severely influenced by the arbitrary discrepancy in the data, (Tabachnick and Fidell, 2001).

4. FINDINGS AND DISCUSSION

4.1. Dynamics of Household Fuelwood Consumption

4.1.1. Frequency of using fuelwood as a major energy source

According to Maconachie (2015), Nigeria is the single major manufacturer and consumer of fuelwood. The country's consumption is about 85% of the total wood consumed in West Africa. Table 1 below, shows the frequency of fuelwood consumption as the main source of energy. It shows that out of the 992 respondents, 1.1% said they use fuelwood as their means of energy once, a day, 7.3% said twice a day and 72.2% said fuelwood serves as an energy source thrice a day. This shows that more people use fuelwood three times a day. Based on the result, the use of fuelwood in northern Nigeria surpasses the use of other categories of energy despite the country being so rich in crude oil. Nigeria has more than 50% of the domestic refining capacity in Africa to meet the growing demand for modern energy for household consumption. Unfortunately, there is still a deficit due to the smuggling of petroleum products and poor refineries maintenance. That is the main reason fuelwood consumption becomes very high in Nigeria surpassing all the countries in Sub-Saharan Africa, including South Africa.

4.1.2. Level of household fuelwood energy dependence

Human Development Index (HDI) scores for Nigeria have consistently been among the lowest in the world since 1980, revealing a slow underlying rate of improvement and painting a clear policy challenge facing the country (NHDR, 2015). Living in Nigeria entails a day-to-day struggle against starvation and the absence of housing and health facilities this prevailing situation has serious ramifications on energy use among Nigerian households. Respondents were asked to state the reasons for the consumption of fuelwood as a major energy source. Table 2 below indicates that 62.4% of them said it was affordable as an energy source. 13.7% said it is very reasonably priced, 2.5% said it is a bit within their means while 4.0% said it is reasonable. This indicated more persons use fuelwood in Nigeria because it is within their means. This result corroborated that of Maconachie et al., (2009), Abd, Razaq, et al. (2012), and Zaku et al. (2015) that showed modern energy prices have increased over the years making fuelwood viable alternative energy as many deprived households cannot afford the cost of modern energy. It is estimated that from 1991 to 2012 about 73% of families in Nigeria were impacted by the

Table 1: Fuelwood usage

Valid	Frequency	Percent	Valid percent	Cumulative percent
Once a day	13	1.1	1.3	1.3
Twice a day	88	7.3	8.9	10.2
Trice a day	866	72.2	87.4	97.6
Other	24	2.0	2.4	100.0
Total	991	82.7	100.0	
Missing				
System	208	17.3		
Total	1199	100.0		

incessant surge in contemporary energy prices (Abd'Razaq, et al., 2012).

4.1.3. Reason for the mixture of fuelwood and other energy categories

Respondents were asked to state their reason for combining fuelwood with other energy types (fuel stacking). 48.6% of the respondents said family size is the reason for combining fuelwood with electricity. 43.6% said price is the reason and 5.5% combined fuelwood with electricity because of culture as indicated in Table 3. The result is in tandem with the study of Pandey and Chaubal (2011) and Özcan et al., (2013) which indicated that bigger size families favored dirty energies over clean energies. Comparatively, the size of the family and price are the major drivers of fuel stacking behavior among households in Nigeria. While culture and price are the major drivers for fuel stacking in South Africa. The possible explanation of the influence of family size among Nigerian respondents is the faith and ethos of the research zone have allowed the marriage of many wives to one man (polygamy) as a result, many people have larger families.

To improve the accuracy of this prediction, the Omnibus test (Goodness of Fit Test) was carried out and shown in Table 4. In the test, a significant value of 0.000 is observed ($P < 0.0005$). Therefore, the model is better than the analysis in (Block 0). This is because not all 95.9% of the respondents are high fuelwood energy dependents. The Chi-square value in the test is 33.725 with 7° of freedom which indicated that there is a high association between the variables. Hosmer and Lemeshow's test result in Table 4 showed there is a significant value of 0.231, $P > 0.05$. This indicated that the model used is worthwhile. The Chi-square value in this test is 16.879 with 6° of freedom which is also signifying validity for the model. Our model summary for Cox and Snell R square and Negel-kerke R-square values are 0.134 and 0.427 respectively. Indicating that 13.4% and 42.7% of the changeability is described by our set of variables. This also gives us the usefulness of the model.

Table 2: Reasons for fuelwood

Valid	Frequency	Percent	Valid percent	Cumulative percent
A bit affordable	30	2.5	3.0	3.0
Relatively affordable	48	4.0	4.8	7.9
Affordable	748	62.4	75.5	83.4
Very affordable	164	13.7	16.5	99.9
6	1	0.1	0.1	100.0
Total	991	82.7	100.0	
Missing				
System	208	17.3		
Total	1199	100.0		

Table 3: Combination of energy types

Valid	Frequency	Percent	Valid percent	Cumulative percent
Price	433	36.1	43.6	43.6
Culture	55	4.6	5.5	49.2
Family	482	40.2	48.6	97.8
Other	22	1.8	2.2	100.0
Total	992	82.7	100.0	
Missing				
System	207	17.3		
Total	1199	100.0		

Determination of impacts of Socioeconomic and demographic variables on the level of household dependence on fuelwood.

Table 5 above is the base test which is used to compare Table 6 to see improvements in the model. When comparing Tables 5 and 6, it shows how much improvement there is when the predictor variables are included in the model. Table 6, (variables in the equation) shows evidence of the influence on the model by each predictor (independent variable). The Wald test shows the statistics. The variable that has <0.05 in the column leveled Sig. are the variables that influence pointedly to the prognostic capability of the model. Based on this, the following variables have results <0.05, namely, age category ($P = 0.038$), education level ($P = 0.047$), household size ($P = 0.33$), and household structure ($P = 0.44$) and employment status ($P = 0.002$) significantly explains respondents' dependence on fuelwood energy. While other variables marriage category (0.537) and Monthly income (0.995) did not contribute significantly to fuelwood energy consumption in the study area.

Furthermore, the B values in Table 6 found *age* to move in the same trajectory (0.138) with the likelihood of fuelwood energy consumption and highly statistically significant ($P = 0.038$). This infers that an increase in the household head age will possibly increase dependency on fuelwood as a means of energy. This fact has been established in the work of Njong and Johannes (2011). They posited that a rise in the average household age will possibly increase the chances of consumption of traditional fuel when compared to that of modern fuel. Furthermore, Baiyegunhi and Hassan (2014) conclude that an increase in the household head age in rural Nigeria made the household change consumption to fuelwood from natural gas. Rahut et al. (2014) indicate that more mature heads of the household choose fuelwood over electricity in Bhutan. This clearly shows that older people have the habit of retaining the old tradition of relying on traditional energy more than young people (Muller and Yan, 2016). However, other studies have found that preference for modern fuels is instead positively associated with age. For example, a study in Turkey indicated the likelihood of households that are headed by older people to shift from using fuelwood to natural gas, kerosene, or electricity, Özcan et al. (2013). Similarly, older household heads in rural Ethiopia prefer to use modern energy over traditional energy Guta (2012). Muller and Yan (2016. p13) argue that the reason old people use modern energy instead of traditional energy is that they can afford clean energy more easily than young people who are facing liquidity constraints that make them resort to cheaper energy.

The study found that there is a substantial association between *education* and the dependency of households on fuelwood energy at a ($P = 0.047$) level of significance. However, the B value in the second column is negative at (–0.691). This shows a rise in the education status of the household decreases the odds of fuelwood dependence on household activities. Rahut et al. (2019) confirmed

Table 4: Classification and test of model coefficients'

Classification Table[b]				
Step 0	Observed	Low fuelwood energy dependence	High fuelwood energy dependence	Percentage correct
	Energy source			
	Low fuelwood energy dependence	0	40	0.0
	High fuelwood energy dependence	0	945	100.0
	Overall percentage			95.9

[a]Constant is included in the model, [b]The cut value is 0.500

Omnibus Tests of Model Coefficients				
		Chi-square	df	Sig.
Step 1	Step	33.725	7	0.000
	Block	33.725	7	0.000
	Model	33.725	7	0.000

Model Summary			
Step	-2 Log-likelihood	Cox and Snell R Square	Nagelkerke R Square
1	300.929[a]	0.134	0.427

[a]Estimation terminated at iteration number 20 because maximum iterations have been reached

Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	16.879	6	0.231

Table 5: Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	3.162	0.161	383.763	1	0.000	23.625

this finding in Pakistan, their study shows that educated families were more probable to consume cleaner energy instead of those with lower-level education households. Heltberg (2003) confirmed that a rise in the education level of families increases the odds of using clean and modern energy city India and pastoral Brazil. Similarly, Mekonnen and Kohlin (2008) show that households that have members that are educated more in number are likely to use modern energy instead of fuelwood in Ethiopia.

Household size was found to have a positive Z-value at (0.531) and a very statistically substantial association with the odds of consuming fuelwood energy at (P = 0.033) level of significance. The result showed that as the family number rises, the odds of fuelwood energy consumption will correspondingly rise. Largely, contemporary fuel does not satisfy the cooking requirements of a big family, the expectation is that many households will more likely rely on fuelwood instead. Heltberg (2003), found that larger households depend more on dirty traditional energy (fuelwood) while smaller households use more modern energy such as LPG and kerosene in city India and pastoral Brazil. Njong and Johannes (2011) alluded that larger households use the comparative advantage fuelwood has in terms of its cheapness and ability to cook for many people relative to other alternative energy. Also, the study of Kuunibe et al. (2013) confirmed that many larger households have the tendency of depending on fuelwood for energy than clean modern energy in the upper-west province of Ghana.

There is a reverse and substantial association between the household structure and the likelihood of fuelwood energy consumption at B-value (–376) and (P = 0.044) level of significance. This implies that those who use modern structures are less likely to consume fuelwood energy. For example, Muller and Yan (2016) argue that households that have building structures that have materials that can easily be set on fire may not use fuelwood as an energy means. In the same path, Arthur et al. (2010) argue that the size of a house as calculated by the bedrooms is linked with electricity use on one hand, and access to piped water may tend to make households use electricity in Mozambique.

Respondents' *Employment status* moved in the opposite direction with the likelihood of relying on fuelwood energy (–0.1.276) and (P = 0.002) level of significance. Meaning that gainfully employed household members are expected to have more income than unemployed household members. Numerous studies have shown that a rise in revenue push families to consume modern energy (Muller and Yan, 2016). For example, the study of Kuunibe et al. (2013) shows that as a family's scheduled salary rises, the tendency of the households to consume dirty traditional energy decreases. The Exp (B) column or OR values in Table 6 showed the values for variables are greater than 1, meaning that the more the independent variables the more the dependent variables. Except for monthly income with the p-value of 0.000 suggesting the more the monthly income the less likely the dependent variable. Overall, this result disapproved of the energy ladder hypothesis. Furthermore, for each of the (OR) values, there is a lower and upper confidence interval (95%) oscillating from 0.000 to 15.536. This is a quite wide range of values indicating that the result is statistically not significant since the confidence intervals contain a value of 1.

4.2. Economic Policy Implications of Fuelwood Consumption

The effect of indoor air pollution from wood fuels on health can lower the income level of households, because of a decrease in the population's productivity due to illnesses. Also, the adverse effect of wood fuel usage can be associated with an increase in morbidity and mortality among the population (Sulaiman et al., 2017). Yeh (2004) revealed that an increase in traditional biomass

Table 6: Variables in the equation

Step 1[a]	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP (B)	
							Lower	Upper
Age category (1)	0.138	0.344	3.160	1	0.038	3.871	1.644	10.711
Marriage category(1)	0.657	1.064	0.381	1	0.537	1.929	0.239	15.536
Education level(1)	−0.691	0.367	6.558	1	0.047	2.397	1.673	9.095
Household size(1)	0.531	0.445	3.423	1	0.033	3.588	1.546	8.809
Household structure(1)	−0.378	0.411	3.845	1	0.044	1.859	1.452	7.264
Monthly income(1)	−18.933	3294.489	0.000	1	0.995	0.000	0.000	
Employment status(1)	−1.276	0.417	9.349	1	0.002	3.582	1.581	8.116
Constant	20.048	3294.489	0.000	1	0.995	509271343.077		

[a]Variables entered in step 1: Age category, marriage category, education level, household size, household structure, monthly income, and employment status

usage increases infant and child mortality rates in developing countries. It, therefore, reduces the availability of the workforce and increases the social health cost of pollution. Thus, the economic growth rate experienced by most sub-Saharan African countries can be potentially negated by the health cost sustained by indoor air pollution. To strengthen this argument, Gangadharan and Valenzuela (2001) demonstrated that most developing countries have their increased income wiped away by the social health cost of pollution from traditional biomass consumption. In another study by Maji et al. (2019), renewable energy, which is mainly dominated by wood fuel in sub-Saharan Africa, was found to hurt economic growth in West Africa. Furthermore, the pollution from fuelwood results in loss of workdays by the able-bodied persons due to illness or taking care of sick ones suffering from wood fuel smoke-related illnesses. Rehfuess et al. (2006) maintained that falling sick from indoor air pollution resulting from consumption of traditional biomass or caring for sick children lessen earnings and can result in increased private health care expenditure and medication expenses. This, in turn, leads to what is called the "poverty vicious circle for traditional biomass consumption." Sub-Saharan is a leading region with the highest disease burden of indoor air pollution-related complications from traditional biomass use. The economic burden of it is put between 0.5% and 2.5% portions of the world's GDP. This is equivalent to $150–$750 billion per annum (EIA, 2009). In terms of mortality, it is estimated that about 600,000 lives are lost each year from exposure to biomass smoke in sub-Saharan Africa(Lambe et al., 2015); while the cost of too much dependence on biomass fuel mostly wood in the region is US$36.9 billion annually. Also, the productive time lost from gathering wood fuel is estimated to be US$29.6billion. Thus, there is a need for an empirical investigation and subsequent policy suggestions as to the global burden of biomass consumption-related diseases according to WHO (2005) is very significant and on the rise, especially in sub-Saharan Africa. It is therefore on this premise that the current study investigated the dynamics of wood fuel consumption in Nigeria. This study has some practical significance. At the present, the consumption of wood fuel in this region is high and on the rise. The demand for it is projected to increase further in the coming decades if alternative modern fuels are not made available and affordable to the people.

While the production and consumption of wood fuels in other regions (North America, Latin America, Europe, and Asia) are declining, the reverse is the case in sub-Saharan Africa. Therefore, it is paramount to ascertain how the continuous reliance on wood fuel by countries within the region affects their economies. Though some benefits are seen in terms of income generation for the wood fuel operators and rural poor, who rely on wood fuel extraction as the means of livelihood, there are costs associated with its consumption through the adverse health effects, which may potentially affect the economy. Thus, researching its real impact on the economy assists in providing details to the policymakers about the level and magnitude of the impact, for them to provide appropriate policy action.

5. CONCLUSION

The study confirms that income earned by people plays a major role in determining their type of energy use. Among the types of energy available to the communities, electricity and fuelwood are paramount, but they mostly use fuelwood, despite having access to electricity. The use of fuelwood for electricity is influenced by several socio-economic factors. Community members that are employed or self-employed use electricity more often in their households, though some also use fuelwood. Unemployed community members are the main users of fuelwood, given that it is freely available. Although grid electricity is available in, there is a need to encourage the community to use alternative energy sources, especially renewable energy. Nonetheless, burning wood produces smoke with a variety of irritant pollutants, some of which are known carcinogens. More than 1.5 million deaths a year are caused by acute respiratory infections from breathing smoke from indoor cooking fires. Almost 70% of the population in northern Nigeria relies on firewood and charcoal as a source of energy for cooking and heating, thus leading to Dirty smoke because when burning it gives off smoke and soot, environmental pollution through the gases it emits, exploitation leads to deforestation and problems of soil erosion and global warming, and shortage of water. The results presented in this study show that 95.9% of the respondents are high fuelwood dependents and it may likely remain so. The correlation examination conducted indicated a highly positive relationship between household dependence on fuelwood energy with age and household size on one hand and on another, the analysis pointed to a negative relationship between household dependence on fuelwood with education level, household structure, and employment status.

Following the above, the most difficult challenge facing Nigeria as per high fuelwood dependence can be seen from two perspectives, first, the unsustainable production and use of fuelwood for energy create health, economic and environmental threats to the people at all levels. The second is the inadequate supply of modern clean energy sources made many households unable to access energy resulting in households' dependence on fuelwood continuing unabated. However, results in the study have identified an increase in education level, household structure, and employment among households will decrease the level of household fuelwood dependence.

Creating employment would empower the people, and a realistic subsidy option can be followed, which will not be more of a burden. The use of renewable energy will change people's lives, especially those of the women and children who must walk long distances in search of fuelwood. Saved time and money could be channeled into productive activities and education. Sustainable energy transitions require the formulation of effective policies that promote biomass resources, increase the use of renewable and low carbon sources, and penalties as well as discourage the use of fossil fuels and unsustainable natural resource use.

In summary, it is important to note that the significance of the economic environment in affecting fuelwood energy consumption cannot be overemphasized. Thus, ways of ensuring household energy accessibility, especially for low-income households is to provide:

1. A sustainable means of income that will give them the ability to afford modern clean energy to reduce their dependence on the environment for domestic energy. The fact that the data used is limited only to one state (Katsina) and does not have information on the other eighteen states that are made up of Northern Nigeria is a limitation of the present analysis. Perhaps, incorporating data from the rest of the other states could have altered the findings
2. Policy emphasis should be on developing education curricula that promote information to households on the benefits of adopting clean fuels as well as the necessity for more integration of these components into a comprehensive public-oriented domestic energy framework. This will end the predominant energy poverty phases that connect high fuelwood consumption levels to localized environmental dilapidation, with an ever-growing cost to the well-being of the households. The Nigerian government must use a policy that seeks to reduce black-marketing of subsidized petroleum products. optimal exploitation of domestic energy resources and vigorous exploration and acquisition of energy assets abroad, so that energy security can be attained effectively
3. Most households in northern Nigeria villages rear domestic animals and they should be encouraged and trained to use the dung for energy production through biogas technology. Solar energy remains the best option, however, because the area lies at the lower latitudes within the tropics and has average short-wave radiation relatively higher than other parts of the country. Because of poverty, however, government assistance, to subsidize the purchase, installation, and maintenance of technologies would be necessary to realize the advantages of harnessing solar power and biogas for cheaper and cleaner energy.

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