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ANALYSIS OF THE PATTERNS AND DETERMINANTS OF HOUSEHOLDS' COOKING ENERGY DEMAND IN YOBE STATE, NIGERIA

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ABSTRACT

The paper investigates household cooking energy consumption pattern in Yobe State, Nigeria utilizing secondary data sourced from Nigeria's COVID-19 national longtitudinal phone survey (NLPS, 2020). Descriptive statistics and ordinarily least squares estimation technique were employed in the analysis of the data. The findings indicate that about 66.7% of the households in Yobe are multiple fuel users. Additionally, among the specific fuel users about half (50%) of the users relied on fuelwood for their household needs. With regards to the determinants of energy sources, income, household size and age were found to be positive and statistically significance at 1% for all the energy sources. The influence of income was the most substantial for charcoal. Household size has the most influence on fuelwood. Similarly, Older households seem to consume more of all fuels. The results for area of residence was only positive and and statistically significance at 1% for kerosene demand while Gender does not significantly affect any fuel type demand. The study concludes that socio-economic factors influence cooking energy demand in Yobe State.Hence, recommends that various stakeholders should support economic empowerment, energy education and promote outreach for specific demographics.
Key Words: Consumption, Cooking, Demand, Household Socio-economic.

Introduction

In developing countries, more than 80% of households rely on energy for primary usage, with over two million of these depending on biomass, stock, and dung as energy sources (EIA, 2015; Kroon, Brouwer & Beukering, 2014). In Nigeria, approximately 86% of rural households utilized fuelwood for their energy needs. The lack of electricity and limited access to conventional fuels like petroleum products, often due to inadequate road networks, are primary reasons for this dependency (Maina et al., 2021b). Additionally, petroleum-based fuels such as kerosene and Liquified petroleum Gas (LPG) are often unaffordable and scarce, causing the rural population to lean heavily on traditional fuels like fuelwood. Urban low-income households also predominantly use biomass fuels, including wood and dung, especially in regions with a fuelwood supply/demand disparity. In the Northeast region, charcoal is highly used for cooking, heating, ironing, and

even for aromatic purposes in households (Abdulkarim, 2021, Maina, 2018& Maina et al., 2019c).

However, the prevalent use of such inefficient cooking methods poses serious health risks, especially for women and children who are primarily responsible for cooking. This exposure results in Indoor Air Pollution (IAP) and increases atmospheric emissions, impacting local environments and the global climate (WHO, 2018). Additionally, excessive fuelwood collection contributes to soil erosion, desertification, and biodiversity loss, with significant economic repercussions seen across various ecological zones in Nigeria (Ogunniyi, Adepoju, & Olapade-Ogunwole, 2012). For instance, desert encroachment at a moderate to severe rate affects the northern region, with desertification impacting approximately 63.83% of Nigeria's land area (Olagunju, 2015).

Addressing the adverse effects of primitive household energy usage requires a comprehensive understanding of consumption patterns to shape effective energy policies. While numerous studies, including those by Abdulkarim (2021) and Maina et al. (2019b), have explored household energy demands, they primarily focus on cooking fuel consumption in Maiduguri and at macro level which is the entire Northeast Nigeria. This study is a deviation of the previous studies because it limits itself to cooking energy sources among households in Yobe state. The study therefore investigates the application of energy ladder model and fuel stacking model in analysisng the patterns and determinants of households' cooking energy demand in Yobe State.

2.0 Literature Review

Energy consumption patterns and decisions within households are shaped by a combination of socio-economic factors and the household's financial capacity. Various studies worldwide have delved into understanding these dynamics, revealing two prominent theories: the energy ladder model and the fuel stacking models.

The energy ladder model illustrates a linear progression of fuel choices as household incomes rise. Initially, with limited income, households rely heavily on "dirty" fuels, such as crop waste and dung. As income slightly improves, there is a transition to slightly better fuels like firewood. As households

ascend the economic ladder, they adopt cleaner energy sources. For instance, middle-income households might opt for kerosene and coal, influenced by urbanization and other socio-economic factors. Ultimately, as financial stability is achieved, households move towards the cleanest fuels like LPG, electricity, and natural gas, given they can bear the associated costs (Hosier & Dowd, 1987; Heltberg, 2005). The major achievement of the model is its ability to capture the strong income reliance of fuel choices (Bello, 2011).

However, the fuel stacking model, as evidenced by numerous global studies, proposes that households often consume multiple energy sources simultaneously, known as fuel stacking or multiple fuel use. Instead of entirely transitioning from one fuel type to another, households utilize a mix of energy options from various levels of the energy ladder. Even with the introduction and promotion of modern fuels, traditional energy sources are not entirely phased out, indicating the deep-rooted nature of this consumption pattern (Maina, 2018 and Maina et al, 2019a).

2.1 Empirical Review on the Determinants of Fuel Demand

Households' socio-economic factors have proved to play an intrinsic role in energy source choices, consequently Olaleye & Akinbode (2012) highlighted the gender of the household head as a determining factor. The finginds reveal that female-led households, primarily due to their central role in cooking, favor cleaner energy. This is in stark contrast to male-led households which might lean more towards conventional fuels (Maina & Kyari, 2020). Family size influences energy choices. Larger families, faced with the economic challenge of catering for more members, typically opt for cost-effective, albeit less clean, energy sources (Buba et al., 2017 & Maina *et al,* 2019a;). Meanwhile, smaller households cannot afford to prioritize clean fuels like electricity and LPG. Additionally, rural households, due to the ease of access to materials like animal dung, straws, and fuelwood, might prefer these over the cleaner alternatives, unlike their urban counterparts (Maina *et al*, 2019a). Income, undoubtedly, is a massive driver in these choices. Lower-income households, irrespective of their urban or rural setting, tend to choose energy sources like fuelwood, plant residues, and

animal dung. On the opposite spectrum, households with better financial standing prioritize eco-friendly energy options (Danlami & Islam n.d & Buba *et al*. 2017). Other factors, like the age of the household's primary earner, their educational level, and profession, also play definitive roles. For example, the more educated a household leader is, the more likely they are to opt for clean energy, understanding its environmental benefits (Maina *et, al* 2019a). Interestingly, a study of Nigerian households unveiled a prevalent trend of using mixed fuels for cooking across all income levels. Yet, as prosperity rises, a shift towards cleaner fuels, especially LPG, becomes evident. Furthermore, urban higher-income households exhibit a propensity to use power generators, specifically those running on petrol or diesel, for lighting (Olaleye & Akinbode, 2012; Omolade, Nwosa, & Amassoma, 2019; Maina, *et al*, 2019c and Maina, *et al*, 2020).

Ifegbesan, Rampedi & Annegarn (2016) invstigate the types of cooking fuels and factors that influence their choice by households in Nigeria, using cross national data etraacted from Nigeria Demographic and Health Survey (NDHS) 2013. Descriptive and inferential statistics were used. The results indicate that 55% of sampled households have access to electricity, while about two-third (66.3%) of households depends on biomass as fuel cooking. The chi-square analysis revealed that there is a significant statistical relationship existed between geo-political regions, place of residence, access to electricity, educational level, wealth index and type of cooking used.

Similarly, Ali., Jimoh & Rilwanu (2020) conduct a study on the analysis of the commercial fuelwood sector in potiskum, Yobe state, Nigeria using face-to-face interview of 150 households, with stratified sampled fuelwood value chain players. Data were analyse using descriptive statistics and thematic analysis. The findings revealed that two gengerized fuelwood supply chains recognized fuelwood as formal and informal. The findings also show that fuelwood harvesting practices are not sustainable. Audu, Melemi & Musa (2023) investigate the economic analysis of fuelwood consumption in Yobe state, Negeria using questionnaires, focus group discussions and personal interview. A purposive sampling technique was employed. The findings revealed that more that 85% of the respondents use

fuelwood collection as their second major source of livelihood after farming.

3.0 Methodology

3.1 Study Area

The study was conducted in the Yobe state. The state lies between latitudes 11.0943° N and 13.0935° N, and between longitude 10.9625° E and 13.3268° east of the Greenwich meridian. It has a total land area of about 45,502 square kilometers. The state is sharing boarders with Borno State to the east, Gombe State to the south, Bauchi State to the southwest, Jigawa State to the west, Niger State to the northwest and Diffa Region in Niger Republic to the north The combined population were approximately 2,321,591 as at the end of 2006 (NPC, 2006), which was projected to rise to 3,649,600, by the end of 2022. With 2.9% annual population change. The state economy primarily revolves around agriculture, trade and government servces.

3.2 Type and Sources of Data Collections

The study used secondary data sourced from the Nigeria COVID-19 National Longitudinal Phone Survey (COVID-19 NLPS, 2020) For the purpose of this study, data from 120 households interviewed in Yobe were extracted. The information gathered encompassed household socio-economic aspects, farming, non-agricultural activities, avenues of income, as well as food and non-food expenditures. Given the vastness of the data, descriptive statistics were applied utilizing averages and graphical illustrations to encapsulate and analyze the sample within the framework of two leading energy demand theories.

Descriptive statistics served to delineate the data's attributes in a comprehensible manner. Its application was particularly suited given the extensive nature of the dataset. By utilizing means and graphical presentations, the data were condensed into succinct summaries, facilitating a clearer understanding for readers. Furthermore, insights from two renowned energy demand theories were drawn upon, juxtaposed against the descriptive outcomes obtained.

3.3 Model Specification

This study employed theOrdinary Least Squares (OLS) model, a commonly used statistical approach to ascertain linear correlations between variables. The OLS method is straightforward in its application

and interpretation, and it adeptly accounts for potential confounding variables. Using this model, the study sought to understand the relationship between the expenditure allocation for specific cooking energy sources and five chosen independent variables. The study focused on three primary energy sources: firewood, charcoal, and kerosene, due to insufficient data on LPG and electricity for cooking purposes. The employed model aligns with the approach taken by Maina (2018) to explore the determinants influencing demand for the chosen energy source. The model is specified as:

$Y = F(X_i, X_2, X_3, X_4, X_5 \ldots X_n)$ …… *(1)*

The above model is transformed into;

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + U$ ……*(2)*

Where;

Y = Household monthly expenditure on a particular cooking energy type (₦)

X_i = Household income(₦)

X_2 = Age of household head

X_3 = Sex of respondent

X_4 = Area of residence

X_5 = Household size

U = Error term

A priori expectation

The coefficient of household income is expected to be positive for kerosene with negative coefficients for area of residence rural and family size positive for Charcoal and firewood. On the contrary the coefficients of sex of household head, and age on the other hand would be positive for charcoal and fuelwood, and negative for kerosene.

4.0 Results and Discussions

The result show that different households exhibit distinct socio-economic traits which significantly influence the pattern of energy demand, both in terms of quantity and preferred fuel type. The following results illustrate the variations in demand for different energy products. These findings were organized and presented in a bar chart in figure 1 on the types of energy consumed by households.

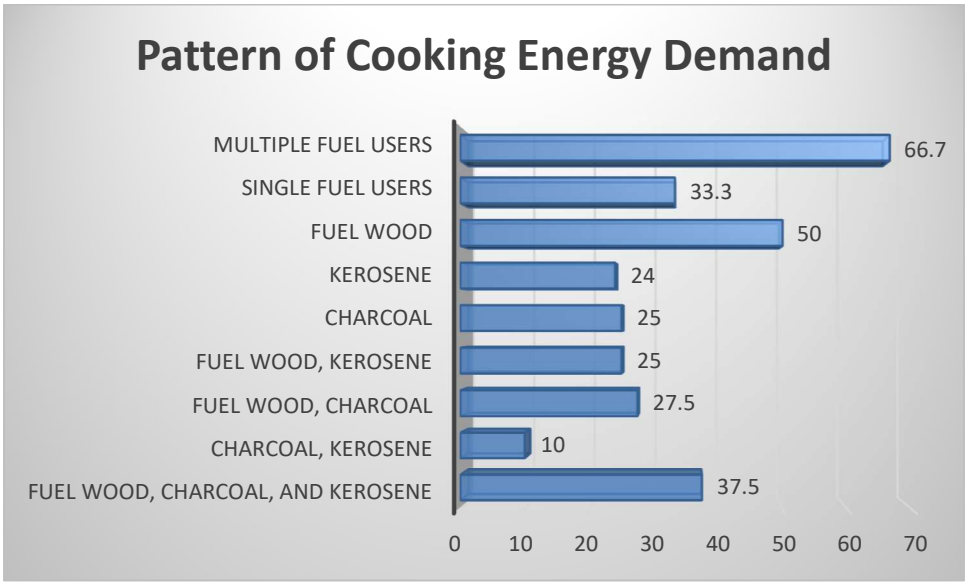


Figure 1: The pattern of cooking energy demand in Yobe State, Nigeria

Source: Generated from (COVID-19 NLPS) Data 2020)

From figure 1, the bar-chart illustrastes the pattern of cooking energy demanded in Yobe State, Nigeria. The result shows that multiple fuel users constitute the highest percentage (66.7%) while about 33.3% relied on a single type of fuel for their cooking needs. The high percentage of multiple fuel users in the study area indicates a prevalent pattern of fuel stacking, where households use a combination of different fuels rather than relying on a single source. This coincides with the findings of Maina (2018) for household fuel choices in the Northeast Nigeria. However, the remaining single fuel users. Among the specific fuels, about half (50%) of the users relied on fuel wood, while the rest relied on Kerosene and charcoal at 24% and 25% respectively. Other households combine the use of fuel wood and kerosene (25%) others 27% mix fuel wood and charcoal and a slightly higher percentage of 37.5% utilise, fuel Wood, charcoal, & kerosene while only 10% combine charcoal and kerosene. Similar patterns were reported by Maina et al (2019c) for households in Borno State, Nigeria The implication of these findings is that the pattern of fuel usage in Yobe State, Nigeria is more complex pattern than energy ladder model, thus it aligns more closely with the fuel stacking theory. Instead of completely transitioning from one type of fuel to a cleaner alternative, many households appeared to be using multiple fuel sources concurrently, selecting the best-suited one,

this could be based on factors such as cooking needs, availability, and cost. The dominance of multiple fuel users (66.7%) in Yobe State, Nigeria reinforces this theory. The fact that a significant portion of households still rely on fuel wood, either alone or in combination with other fuels, might indicate economic constraints, cultural preferences, or limited access to cleaner energy sources. At the same time, the use of multiple fuels, including kerosene and charcoal, suggests that there is some level of transition but it is not a linear move up the energy ladder.

Table 1:Socio-economic Factors Determining Cooking Energy Demand

Variables	Coefficient	Standard error	T value	p>[t]	R^2
Fuelwood					**0.76**
Constant	2.010818	.3998224	5.03	0.000*	
Area of Residence	-.0445569	.0679714	0.66	0.516^{NS}	
Monthly Income	.267645	.0736114	3.64	0.001*	
Household size	.4667975	.0614818	7.59	0.000*	
Sex	-.0122971	.0540011	0.23	0.821^{NS}	
Age	.0550237	.0142047	3.87	0.000*	
Kerosene					**0.82**
Constant	2.249779	.5423767	4.15	0.000*	
Area of Residence	.4427947	.047667	9.29	0.000*	
Monthly Income	.2117395	.0048713	43.47	0.000*	
Household size	.0248132	.0020876	11.89	0.000*	
Sex	.0139242	.0386758	0.36	0.720^{NS}	
Age	.0559535	.0148515	3.77	0.000*	
Charcoal					**0.99**
Constant	.1308916	.0393795	3.32	0.001*	
Area of Residence	.0028348	.0026083	1.09	0.278^{NS}	
Monthly Income	.4738387	.0637321	7.43	0.000*	
Household size	.0214989	.0214989	2.90	0.004*	
Sex	.004598	.0054193	0.85	0.397^{NS}	
Age	.0242072	.0020785	11.65	0.000*	

Source: Generated from (COVID-19 NLPS) Data 2020)

Table 1 presents the results from an Ordinary Least Squares (OLS) regression analysis, which examines how various socio-economic factors influence the demand for the three different cooking energy sources selected for this study in Yobe State, Nigeria, namely fuelwood, kerosene, and charcoal.

Fuelwood: The coefficients of area of residence and sex were found to be negative, while monthly income, household size and

age of household heads were found to be positive and significant. This agrees with the apriori expectation.Thisimplies that for every unit increase in monthly income, the demand for fuelwood increases by 0.267645 units. Also, for any addition of one household member the demand for fuelwood would increase by 0.4667975 and for every year increase in age, the demand for fuelwood increases by 0.0550237 units. These coincide with the findings of (Abdulkarim, 2021, Bello, 2011, Adepoju *et al*, 2012& Maina et al., 2019c). The implication of these could suggests that higher income often correlates with improved living standards, which might translate into more extensive cooking or heating needs. They might host more gatherings, cook more elaborate meals, or just have larger homes that require more heating. Also, in many households especially in northern Nigeria (DHS, 2018) food are cooked on open flames using fuel wood and, in some cultures, food cook in such method are considered to have a superior taste thus, with increased disposable income, households might indulge more in these traditional cooking methods. Another reason for increase in fuelwood demand due to increase in income might still be that fuelwood is the most cost-effective source of energy available, especially when compared to alternatives like electricity or gas. Also, even with increased income, people might continue using fuelwood out of habit. With regards to increase in fuelwood demand due to larger households this could be because larger households have higher energy requirements, likely because of more significant cooking or heating needs. Similarly, older household heads might have traditional cooking methods or preferences that use more fuelwood.

Kerosene: The coefficients of the area of residence, income, household size and age are found to significantly affect kerosene demand while sex was insignificant. The coefficients show that an increase in area of residence urban would lead to 0.4427947 unit increase in kerosene demand. Likewise, an increase in monthly income, household size and age would result to 0.2117395, 0.0248132 and 0.0559535 units increase in kerosene demand respectively. These findings agree with that of (Maina, 2018, Maina et al 2019b& Olaleye& Akinbode, 2012). The implications might be that urban areas have a higher preference or need for kerosene compared to rural areas, perhaps due to better access, urban lifestyles, or the specific energy needs of urban dwellings.

With regards to rise in income, it could be when households earn more, they tend to consume more kerosene because of increased cooking or heating needs, or a preference for kerosene as a cleaner or more efficient fuel source as income rises among the three fuel sources as income rises. Similarly, larger households are more likely to have greater cooking or heating requirements, leading to increased kerosene consumption. With regards to the positive relationship between older headed households and increased kerosene demand, it could suggest that older household heads might have specific energy consumption patterns or preferences that lead to a higher kerosene usage, potentially due to long-held habits or the perceived benefits of kerosene.

Charcoal: The coefficients of area of Residence and gender were insignificant determinants of charcoal demand while monthly income, household size and sex have been found to be statistically significant and positively related to charcoal demand. The coefficients show that for every unit increase in monthly income, charcoal demand rises by 0.4738387 units. Similarly, an addition of one household member would increase the demand for charcoal by 0.0214989 units while an increase in the age of the household head by one year would increase charcoal demand by 0.0242072. These findings agree with that of (Okunade, 2012 & Maina et al, 2019b). The implication of suggest findings could be as households earn more, they tend to consume more charcoal. This might be because charcoal is perceived as a more efficient or superior cooking fuel than firewood. Similarly, larger households, with more members, could have greater cooking needs, and would thus consume more. Also, older household heads might have specific consumption patterns or preferences that lean towards using a better fuel than firewood due to the beliefs in the benefits of charcoal as a cooking source.

In general, the implication of the results for the three energy sources showed that as monthly Income rises, the demand for all the three cooking sources increases, moreover the most substantial effect observed was for charcoal.This could suggest that as households have more disposable income, they diversify their energy sources, but charcoal becomes a preferred choice. With regards to household size, the results show that larger households tend to consume more of all energy types, but the influence is most prominent for fuelwood. Larger families might need more extensive cooking sessions,

leading to higher fuel demand. Older households seem to consume more of all fuels, suggesting traditional cooking methods or preferences that are retained with age. The results for area of residence were only significant for kerosene indicating that urban households might have more access to kerosene or prefer it due to smoke or health concerns associated with other fuels. Gender doesn't significantly affect any fuel type demand. This indicates that energy decisions might be a household choice rather than influenced by gender roles.

5.0 Conclusions and Recommendations

The OLS regression results revealed the intricate interplay of socio-economic factors in determining cooking energy demand in Yobe. Monthly income consistently emerges as an important determinant for all fuel types, suggesting that economic considerations significantly influence energy choices. Household size and age further reinforce this pattern, with larger and older households showing increased energy demands. Notably, while the area of residence significantly affects kerosene consumption, possibly reflecting urban preferences, gender does not markedly influence any of the fuel choices. Collectively, these findings reveal the multifaceted nature of energy decisions in Yobe, driven by economic status, household demographics, and potentially traditional practices.

The analysis further indicated the relationship between socio-economic factors and cooking energy demand in Yobe. Economic growth, reflected in monthly income, emerges as a cardinal driver of energy consumption across all fuels, especially charcoal. This emphasis on economic development dovetails with the importance of addressing the unique needs of larger households, which exhibit heightened fuelwood and charcoal demands. The role of age cannot be understated, pointing towards entrenched energy habits among older demographics. Geographical considerations further diversify this landscape, with urban and suburban areas demonstrating a particular affinity for kerosene. Interestingly, gender doesn't delineate energy choices, suggesting a uniform approach across sexes. Together, these insights underscore the necessity for a diversified, inclusive, and economically sensitive approach to energy policy in Yobe. The study concludes that socio-economic factors influence cooking energy demand in Yobe State.

i. Various stakeholders which include Government, Private sector, Development partners, NGOs and civil society should support based on their roles and responsibilities economic empowerment and energy education because monthly income has influence over energy consumption, especially for charcoal. Thus, there is a pressing need to not only bolster economic empowerment programs but also to intertwine them with energy education. As households gain more disposable income, they should be guided towards cleaner and sustainable energy choices through awareness campaigns and incentives.

ii. Government, Private sector, Development partners, NGOs and civil society should promote outreach for specific demographics: With larger and older households displaying increased energy consumption, targeted outreach and educational programs should be designed for these specific demographics. This would address their unique needs and potential traditional practices, ensuring they have the knowledge and resources to make informed energy choices. Additionally, considering the geographical influence on kerosene consumption, region-specific interventions, especially for urban areas, should be prioritized to cater to local preferences and infrastructure availability.

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