HOUSEHOLD ENERGY CONSUMPTION AND INDOOR AIR POLLUTION IN BAYELSA STATE: ANALYSIS OF 2018 NIGERIA DEMOGRAPHIC HEALTH SURVEY

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Abstract

Household energy consumption and indoor air pollution have caused significant environmental and health issues. However, previous studies have mainly focused on energy sources, overlooking differences in their impact based on the rural-urban divide, especially in Bayelsa State, Nigeria. This study conducted a comparative analysis of energy consumption and indoor air pollution between rural and urban households in Bayelsa State, using energy choice theory as the framework. A cross-sectional survey design was adopted, with a sample of 1004 households drawn from the 2018 Nigeria Demographic and Health Survey (NDHS): 266 urban and 738 rural households. The data were analysed using descriptive statistics and Chi-Square tests at $P<0.05$. The average age of household heads was 44.64±16.02 years in urban areas and 44.29±15.82 years in rural areas. The results showed that more rural households (59.3%) used wood for cooking, while kerosene use was higher in urban areas (39.1%). Urban households also had a greater proportion (24.8%) of those cooking indoors, compared to rural households (16.1%). There was a statistically significant relationship between energy use and indoor air pollution in rural (x^2=195.705) and urban (x^2=97.12) households. The study concluded that households without a separate kitchen, regardless of location, are at greater risk of indoor air pollution. It was recommended that stakeholders raise awareness of the importance of separate kitchens and support the adoption of cleaner cooking fuels.

Keywords: Rural and urban, Household energy, Indoor air pollution, Bayelsa State

Introduction

Globally, there has been disproportionate exposure to indoor air pollution due to household energy consumption. Numerous studies have linked disparities in exposure to this environmental burden with social inequality, which, in turn, contributes to health inequalities, particularly regarding housing conditions (Braubach, Savelsberg & World Health Organization, 2009). Shrubsole et al. (2014) have suggested that policy interventions to improve the built environment may lead to unintended health consequences for occupants, due to the tension between increased energy efficiency and indoor air quality (Broderick et al., 2017).

According to Shrubsole et al. (2016), insufficient resources, particularly among those with low socioeconomic levels, impede people's ability to shift and adjust to altering environmental circumstances. The unintended repercussions of home renovation measures have disproportionately impacted this demographic. As a result, it is critical to identify persons susceptible to the effects of high indoor pollutant levels, particularly across the rural-urban gap, to inform tailored actions such as housing upgrades.

A major health danger to household inhabitants is indoor air pollution, which is mostly brought on by the use of combustible bioenergy for heating and cooking. The World Health Organization has brought attention to this issue (WHO, 2018). According to recent research by Ipek and Ipek (2021), using biomass fuels for indoor cooking and heating, such as coal, wood, dung, and agricultural waste, can cause several health problems for locals. These fuel sources' regular use adds to poor indoor air quality, which may harm the health of those who live there. Indeed, more than three billion people, mostly from rural and suburban regions, depend on these fuels, which are dangerous for their health since they produce air pollution levels that are higher than those required by global indoor air quality guidelines (WHO, 2018).

Several studies have demonstrated a connection between socioeconomically impoverished neighbourhoods and elevated levels of outdoor air pollution. For instance, Samoli et al. (2019) discovered that jobless rates and population density were key indicators of NO_2 exposure in nine European urban areas. Pinault et al. (2016) also noted that Canadian children from poor families were more prone to higher nitrogen oxide levels. In Britain, deprived areas, including parts of London, have been linked to high PM_{10} levels (Tonne et al., 2008). Indoor air pollution puts household members at risk of serious health issues like chronic lung diseases, lung cancer, low birth weight, pneumonia, stroke, asthma, and cataracts in both grown-ups and youngsters (Bruce et al., 2002).

Acknowledging the impact of particulate matter and nitrogen oxides (NO_x), particularly among lower socioeconomic groups (Fairburn et al., 2019), it is evident that environmental health inequalities persist due to widespread breaches of air quality guidelines (European Environmental Agency, 2019). The WHO (2019) report confirmed that environmental health inequalities have arisen from exposure to outdoor air pollution, despite improvements in air quality.

Moreover, studies have noted that household energy consumption and the risk of indoor air pollution significantly increase child and young adult mortality (Perera, 2017). Bartington et al. (2017) revealed that smoke from inefficient cooking fuels contains numerous toxins and particulate matter, such as carbon monoxide, nitrogen dioxide, and methylene chloride, which increase the risk of disease among children. Dasgupta et al. (2006) found that using fuel made from biomass was also associated with pulmonary and respiratory illnesses, especially for women and children who spend more time near flames for heating and cooking.

Although researchers from a variety of fields have recognized these findings, little is known about how much indoor air pollution and household energy use differ between rural and urban areas, especially in Bayelsa State. This study intends to fill this knowledge gap by examining the variations in energy types used, indoor air pollution sources, and the connection between indoor air pollution and energy consumption in homes in Bayelsa State's rural and urban districts. Recent secondary data from Nigeria's 2018 Demographic and Health Survey (NDHS), which was nationally representative, will be used for this.

Theoretical Framework

The Energy Choice Theory (ECT), on which this work is based, is frequently described using two important models: the "energy stack" and the "energy ladder." According to the energy stack concept, households should select a mix of sources of energy from the list of alternatives. This model highlights how households can choose from a variety of energy sources according to their demands and situations. The energy ladder model, on the other hand, shows an ordered connection between the types of energy utilized for heating and cooking, household income, and social position. This model classifies fuels according to their prices, efficiency, and pollution impact. Low-cost, ineffective, and extremely polluting fuels like dry animal excrement, fallen branches, and grasses are found at the bottom of the ladder and are frequently utilized by the poorest households. The households are more likely to use fuels like coal, kerosene, and charcoal as they go up to the second rung. Although these fuels are a little more efficient, they nevertheless pose serious dangers to human health and the environment. On the third rung, higher-income households tend to prefer modern fuels like electricity and liquefied petroleum gas (LPG). The movement up the ladder is closely tied to the growth of household income, as noted by Barnes and Floor (1999).

Developed countries have transitioned from traditional biofuels to petroleum products like kerosene and LPG, as well as increased reliance on electricity. However, in many developing countries, even when cleaner and more advanced fuels are available, households often continue to depend on biomass sources (Smith, 1987). Poverty remains a significant barrier to the adoption of cleaner fuels. The slow pace of economic growth in many countries suggests that biofuels will likely remain the primary energy source for poorer households in the foreseeable future. Therefore, it is important to consider the potential harmful effects of indoor pollution on human health, which are closely linked to household energy choices and the socioeconomic characteristics of the families involved.

Prior research has demonstrated that affluent households are more likely than their impoverished counterparts to cook using greener energy sources. However, little is known about the precise household energy usage trends in the context of this investigation. An empirical study of household energy usage trends and their effects on indoor air quality is therefore important. Numerous sociodemographic traits should be considered in this research since they have a big impact on nutritional decisions and health outcomes. Therefore, tackling the problems caused by indoor air pollution and its effects on health requires an understanding of the dynamics of energy choice. Through an analysis of the correlation among the income of households, sources of energy, and well-being, we can better understand the obstacles preventing the use of cleaner fuels. This knowledge is crucial for creating interventions and policies that improve energy availability and lower the health hazards related to indoor pollution. The knowledge gathered from the research will help advance our knowledge of energy consumption trends and how they affect public health, especially in low-income homes.

Materials and Methods

This study used a comparative cross-sectional survey research approach, analyzing secondary data quantitatively from the 2018 Nigerian Demographic and Health Survey (NDHS). However, for this study, only Bayelsa State-specific data were retrieved and used. In 2018, the National Population Commission and ICF International conducted a nationwide survey called the Demographic and Health Survey (DHS), which provided the quantitative secondary data used in this study. The same sample population nationwide was used to get these cross-sectional data.

The population for this study comprised households in Bayelsa State. However, women of childbearing age provided household information for the analysis, drawn from the NDHS 2018 dataset. In the 2018 DHS, questionnaires were administered to several women from 42,000 households across Nigeria (NPC & ICF International, 2019). The sample was designed to represent the nation's capital, Abuja, and each state of the federation. For this study, the analysis focused specifically on the Bayelsa population.

Although the total sample size for the 2018 NDHS was 40,427 respondents, consisting of over 20,000 households, only 1,004 respondents were drawn from Bayelsa State, with 266 from urban areas and 738 from rural areas. A probability sampling technique was employed for the collection of NDHS 2018 data to ensure that a representative sample was drawn from the population, allowing for the generalisation of the results. The sampling frame for the 2018 NDHS was derived from the 2006 National Population and Housing Census, conducted by the NPC. Nigeria was administratively divided into states, and these states were further subdivided into Local Government Areas (LGAs), often referred to as wards. Additionally, the 2006 census divided localities into smaller areas known as enumeration areas (EAs). For the 2018 NDHS, the Primary Sampling Units (PSUs), also referred to as clusters, were defined using enumeration areas from the 2006 census.

In Bayelsa State, similar sampling procedures were adopted, employing a stratified sampling method. The sample was drawn from each stratum in two stages. At each administrative level, implicit stratification was achieved by arranging the sampling frame before selecting the sample in an administrative sequence. A systematic sampling approach was employed in the second stage, where thirty households were randomly selected from each cluster using mobile devices and computer-assisted random selection. The survey included all women aged 15 to 49 years from the sampled households. Individuals who resided permanently in the selected households, as well as any guests present in the household on the night before the empirical exercise, were eligible to participate in the interviews.

This study utilised secondary data from the 2018 NDHS for the analysis of variables of interest. The data were collected using a survey questionnaire that consisted of four sets: questionnaires for women, men, biomarkers, and households (NPC & ICF International, 2019). Data were collected through computer-assisted personal interviews (CAPI) to streamline the process. Although a wide range of variables were captured, only the relevant variables — including Bayelsa State, age, education, religion, place of residence, types of cooking fuels, and kitchen location — were selected for analysis in this study.

The 2018 NDHS primarily employed a quantitative methodological approach. The variables selected for this study were analysed using quantitative methods. Descriptive and inferential statistics were employed as analytical tools, using the Statistical Package for Social Sciences (SPSS, version 25.0). Descriptive statistics were used to show the percentage distributions of relevant variables, while inferential statistics employed Chi-Square tests at a 95% significance level.

This study adhered strictly to ethical standards for social research. During the NDHS data collection process, ethical guidelines were carefully observed. The DHS programme in Nigeria, as in other countries, has strict privacy standards for respondents and household members in all surveys. In the 2018 survey, interviewers ensured that interviews were conducted in private. In households with multiple eligible respondents, separate interviews were conducted to ensure confidentiality. The procedures, protocols, and questionnaires for the 2018 NDHS were reviewed and approved by ICF's Institutional Review Board (IRB), ensuring compliance with the regulations on the protection of human subjects, as stipulated by the United States Department of Health and Human Services. Ethical clearance for the use of the dataset was also obtained from the ICF archive officer after the abstract of the study was submitted via email for approval.

Results

Socio-demographic characteristics of households

Table 1 shows the distribution of respondents by socio-demographic characteristics. On the sex of the household head, there were more male household heads (69.2%) in rural areas than those in urban centres, but there were more female household heads (32.0%) in urban centres than those in rural areas. On the age of the household head, average age of the household head was 44.38±15.87 years old. The highest proportion of household age were those whose ages were 50 years and above (37.6%), but there was a higher proportion of those in their 50s and above in the urban centres than those in the rural areas.

Regarding education, the largest proportion had completed secondary school (40.6%). However, in urban areas, a greater percentage of people attained higher education (36.5%) compared to those who only completed secondary school. The wealth index revealed that the largest proportion of respondents belonged to the middle wealth category, at 33.5%. However, among urban respondents, a higher proportion fell into the richer wealth category, accounting for 37.2%, compared to those in the middle and poorer wealth categories.

Table 1: Distribution by household characteristics (Row %)

Variables	Urban (n=266)	Rural (n=738)	Total (n=1004)
Sex of the household head			
Male	181 (68.0)	511 (69.2)	692 (68.9)
Female	85 (32.0)	227 (30.8)	312 (31.1)
Age of household head			
Less than 20	5 (1.9)	16 (2.2)	21 (2.1)
20 – 29	48 (18.0)	138 (18.7)	186 (18.5)
30 – 39	67 (25.2)	175 (23.7)	242 (24.1)
40 – 49	41 (15.4)	140 (19.0)	181 (18.0)
50 and above	105 (39.5)	269 (36.4)	374 (37.6)
Highest educational level			
No education	27 (10.2)	191 (25.9)	218 (21.7)
Primary	36 (13.5)	153 (20.7)	189 (18.8)
Secondary	97 (36.5)	311 (42.1)	408 (40.6)
Higher education	106 (39.8)	83 (11.2)	189 (18.8)
Wealth index combined			
Poorest	-	26 (3.5)	26 (2.6)
Poorer	16 (6.0)	134 (18.2)	150 (14.9)
Middle	77 (28.9)	259 (35.1)	336 (33.5)
Richer	99 (37.2)	193 (26.2)	292 (29.1)
Richest	74 (27.8)	126 (17.1)	200 (19.9)
Wealth index for urban/rural			
Poorest	57 (21.4)	6 (0.8)	63 (6.3)
Poorer	64 (24.1)	39 (5.3)	103 (10.3)
Middle	63 (23.7)	106 (14.4)	169 (16.8)
Richer	40 (15.0)	236 (32.0)	276 (27.5)
Richest	42 (15.8)	351 (47.6)	393 (39.1)
Has generator			
No	183 (68.8)	507 (68.7)	690 (68.7)
Yes	83 (31.2)	231 (31.3)	314 (31.3)
Has electricity			
No	112 (42.1)	463 (62.7)	575 (57.3)
Yes	154 (57.9)	275 (37.3)	429 (42.7)

Source: NDHS 2018

On the wealth index for urban/rural, the highest proportion of the households were of the richest wealth index category (39.1%) overall, but those of poorer seem to be higher in the urban centre than other categories, while they were of highest with those in the richest category (47.6%) in rural households.

On whether households had a generator, the majority indicated that they did not have a generator (68.8%) in the households, but the majority of those in the urban centres (31.2%) had a generator than those who had in the rural areas. On whether the household has electricity, it was revealed that the majority (57.3%) did not have electricity, but the majority of those in the urban centre had electricity supply when compared to those in the rural areas.

Types of energy consumed in rural and urban households

Table 2 shows the distribution of households by energy used in rural and urban for cooking. It was revealed that the majority of households (53.7%) used wood for cooking in the household, followed by those who used kerosene.

Table 2: Distribution by energy in rural and urban households

Type of cooking fuel	Urban (n=266)	Rural (n=738)	Total (n=1004)
Electricity	15 (5.6)	5 (0.7)	20 (2.0)
LPG	46 (17.3)	50 (6.8)	96 (9.6)
Kerosene	104 (39.1)	244 (33.1)	348 (34.7)
Charcoal	-	1 (0.1)	1 (0.1)
Wood	101 (38.0)	438 (59.3)	539 (53.7)

Source: NDHS 2018

On urban versus rural household energy consumption, it was revealed that those in the urban had the highest proportion of those who used kerosene as cooking fuel, followed by wood (38.0%) and LPG (17.3%). For those in the rural areas, it was revealed that the majority still used wood as cooking fuel (59.3%).

Types of indoor air pollution experience in rural and urban households

The types of indoor air pollution experienced in rural and urban households were also determined through the lens of the place of cooking whether the food was being cooked in the house/separate building/outdoors. Table 3 shows the distribution of by rural-urban dichotomy. It was revealed that the majority of the urban households (55.3%) had their food cooked in a separate building as well as those in the rural areas (66.3%). The table further revealed that those who cooked in the house in urban centres (24.8%) were higher than those who cooked in the house in the rural areas (16.1%).

Table 3: Distribution by food being cooked in the house/separate building/outdoors

Place of cooking	Urban (n=266)	Rural (n=738)	Total (n=1004)
In the house	66 (24.8)	119 (16.1)	185 (18.4)
In a separate building	147 (55.3)	489 (66.3)	636 (63.3)
Outdoors	53 (19.9)	130 (17.6)	183 (18.2)

Source: NDHS 2018

Figure 1 also revealed that over two-thirds of the households had separate rooms (83.2%) for cooking and 16.8% of them did not have separate rooms for cooking. While a higher percentage of those who were in urban households had their food cooked in separate buildings (75.2%), 24.8% of them had no separate room where they cooked their food. For the rural households, it was reported that over two-thirds (83.9%) of the households had no separate room for cooking but 16.1% of them had separate room for cooking in the household.

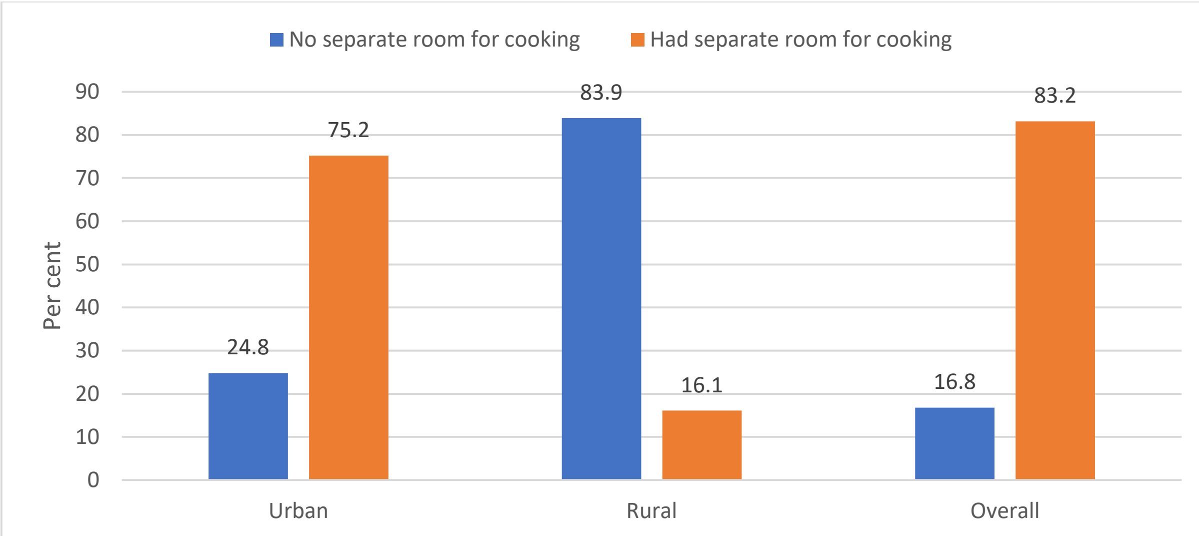

Figure 1: Percentage distribution by household having separate room used as kitchen

Relationship between energy consumed and indoor air pollution among rural and urban households

The relationship between energy consumed for cooking and indoor air pollution was explored. Table 4 first explored the relationship between energy consumed and indoor air pollution in overall. The table shows that there was a statistically significant relationship between energy consumed and indoor air pollution at x^2=302.293, p<0.05.

Table 4: Relationship between energy consumed and indoor air pollution in the overall

Types of cooking fuel	**Place of cooking/indoor air pollution**		**Total**
	Had separate kitchen	**Cooked in the house**	
Electricity	8 (1.0)	12 (6.5)	20 (2.0)
LPG	28 (3.4)	68 (36.8)	96 (9.6)
Kerosene	257 (31.4)	91 (49.2)	348 (34.7)
Charcoal	1 (0.1)	-	1 (0.1)
Wood	525 (64.1)	14 (7.6)	539 (53.7)
Total	819 (100.0)	185 (100.0)	1004 (100.0)

x^2 **= 302.293; P<0.05**

Table 5 presents the relationship between energy consumed and indoor air pollution in rural areas. The table reveals that there was a statistically significant relationship between energy consumed and indoor air pollution at x^2=195.705, p<0.05.

Table 5: Relationship between energy consumed and indoor air pollution in rural areas

Types of cooking fuel	Place of cooking/indoor air pollution		Total
	Had separate kitchen	Cooked in the house	
Electricity	1 (0.2)	4 (3.4)	5 (0.7)
LPG	16 (2.6)	34 (28.6)	50 (6.8)
Kerosene	176 (28.4)	68 (57.1)	244 (33.1)
Charcoal	1 (0.2)	-	1 (0.1)
Wood	425 (68.7)	13 (10.9)	438 (59.3)
Total	619 (100.0)	119 (100.0)	738 (100.0)

x^2 **= 195.705; P<0.05**

Table 6 presents the relationship between energy consumed and indoor air pollution in urban centres. The table shows that there was a statistically significant relationship between energy consumed and indoor air pollution at x^2=97.116, p<0.05.

Table 6: Relationship between energy consumed and indoor air pollution in urban centre

Types of cooking fuel	Place of cooking/indoor air pollution		Total
	Had separate kitchen	Cooked in the house	
Electricity	7 (3.5)	8 (12.1)	15 (5.6)
LPG	12 (6.0)	34 (51.5)	46 (17.3)
Kerosene	81 (40.5)	23 (34.8)	104 (39.1)
Charcoal	-	-	-
Wood	100 (50.0)	1 (1.5)	101 (38.0)
Total	200 (100.0)	66 (100.0)	266 (100.0)

x^2**=97.116; P<0.05**

Discussion of Findings

According to the results, most homes utilized wood as their main cooking fuel, with kerosene coming in second. When comparing the energy consumption of urban and rural homes, it was found that the largest percentage of kerosene users were found in urban households, followed by those that used wood and LPG (17.3%). On the other hand, wood remained the main cooking fuel in most rural households. This suggests that, in comparison to their urban counterparts, rural households are more likely to be subjected to indoor air pollution. This result is consistent with

Chen and Liao's (2018) study, which showed that China's use of coal, straw, and firewood has detrimental impacts such as indoor air pollution and related home issues.

The findings align with those of Qiu et al. (2019), who observed that biomass fuels such as wood, straw, and dung continue to be the most popular options for the most impoverished and vulnerable households, even in the face of significant economic expansion in many developing nations. High energy prices, insufficient infrastructure, and income inequality are some of the main causes of this.

The results also showed that most rural and urban households prepared their meals in a separate structure. Additionally, it was discovered that 16.8% of all families lacked a separate cooking area, although more than two-thirds had one. 24.8% of urban homes lacked a distinct cooking room, despite a larger percentage of cooking in a separate structure. While 16.1% of rural families had a dedicated cooking area, more than two-thirds lacked a distinct space. Variations in morbidity and death rates could be a result of this discrepancy. The energy ladder model, which asserts a stacked connection between household earnings, status in society, and consumption of energy that is apparent in both urban and rural contexts, is supported by these data and is part of the energy choice theory (Barnes & Floor, 1999).

Conclusion

This study compared and contrasted household energy use and indoor air pollution among urban and rural households in Bayelsa State. Although there were significant differences in the use of household energy, this was not a result of location; it was rather based on the socioeconomic status of household heads. This explains inequalities and financial differences between the rich and the poor, particularly in urban and rural settings in the state. Although the effects vary by rural-urban households, the poor in both settings are more likely to experience indoor air pollution than the rich households. The cause of indoor air pollution in both settings, however, is associated with the socioeconomic power in the possession of households where the poor households were more vulnerable than the rich households.

Recommendations

Based on the findings of this study, it is recommended that:

1. Occupants of both rural and urban households are sensitized not to encourage cooking in the households or otherwise encourage cooking in the household among those with separate rooms for the kitchen and with improved cooking fuels through the media and community sensitization medium.
2. The very poor household should be supported by the government and all stakeholders in the provision of improved cooking fuels at subsidized rates in both the urban and rural centres.
3. Through the Ministries of Environment and Agriculture, sanctions should be placed on indiscriminate felling of trees for firewood. This can be achieved through a community policing system to reduce the risk of indoor air pollution resulting from the use of firewood as a source of cooking fuel in households.

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