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Sociodemographic Factors Associated with Household Air Pollution (HAP) Among Nigerian Households: Insight from 2018 NDHS

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ABSTRACT

Household air pollution (HAP) is a significant public health issue in Nigeria, largely driven by the use of unclean cooking fuels. This study utilized a cross-sectional design to analyse data from the 2018 Nigeria Demographic and Health Survey (NDHS), encompassing 39,735 households across the country. The findings revealed that the prevalence of HAP was highest in the North-West region (23.93%) and lowest in the South-East (11.94%). Cooking outdoors or in separate buildings was associated with a higher prevalence of HAP, while having a separate kitchen significantly reduced the risk (aOR = 0.74, 95% CI: 0.67-0.81). Multivariable analysis using logistic regression identified several significant risk factors for HAP, including urban residence (aOR = 1.52, 95% CI: 1.35-1.70), female-headed households (aOR = 1.38, 95% CI: 1.24-1.54), and lower socioeconomic status (aOR = 2.15, 95% CI: 1.87-2.47 for the lowest wealth quintile). Regional disparities were also noted, with the South-West exhibiting the highest odds of HAP (aOR = 1.61, 95% CI: 1.42-1.82). These findings highlight the urgent need for targeted interventions to mitigate HAP exposure, particularly among vulnerable populations in urban and economically disadvantaged areas.

Keywords: Air pollution, Cooking fuel, Clean Energy, Household, HAP and NDHS

INTRODUCTION

Household air pollution (HAP) is a pervasive public health issue, particularly in low- and middle-income countries (LMICs) where the reliance on solid fuels for cooking and heating remains high. According to the World Health Organization (WHO), nearly 3 billion people globally still depend on biomass, coal, or kerosene for their cooking needs, leading to significant indoor air pollution and associated health risks (WHO, 2023). The combustion of these unclean fuels in poorly ventilated spaces produces a range of harmful pollutants, including particulate matter (PM), carbon monoxide (CO), and polycyclic aromatic hydrocarbons (PAHs), which have been linked to respiratory infections, cardiovascular diseases, and adverse pregnancy outcomes (Balmes, 2019; WHO, 2014).

In Nigeria, HAP is a major contributor to the country's burden of disease. The Global Burden of Disease Study (GBD) ranks HAP as one of the top five risk factors for morbidity and mortality in the country (Dhimal et al., 2021). Despite efforts to promote cleaner cooking technologies and fuels, a substantial proportion of Nigerian households continue to use solid fuels, exacerbating the health risks associated with HAP (Jewitt et al., 2020). The reliance on these fuels is particularly pronounced in rural areas, where access to clean energy alternatives is limited, and poverty levels are high (Sani et al., 2024; Sovacool, 2012).

The distribution of HAP in Nigeria is not uniform, with significant regional and sociodemographic disparities. For instance, the use of unclean fuels is more prevalent in the northern regions of the country, where poverty rates are higher, and access to modern energy sources is limited (Akeredolu, 2018). In contrast, households in the southern regions, particularly in urban areas, are more likely to use cleaner fuels such as liquefied petroleum gas (LPG) or electricity. These regional differences are influenced by a range of factors, including socioeconomic status, education levels, and cultural practices related to cooking (Ogwumike & Ozughalu, 2016; Ozughalu, 2023).

Previous studies have identified various sociodemographic factors associated with HAP exposure. For example, household income is a critical determinant, with wealthier households more likely to afford clean cooking technologies (Dongzagla & Adams, 2022). Education also plays a crucial role, as individuals with higher levels of education are more likely to be aware of the health risks associated with HAP and are more inclined to adopt cleaner cooking methods (Puzzolo et al., 2016). Gender dynamics are also significant, as women, who are typically the primary cooks in Nigerian households, bear the brunt of HAP exposure (Ogwumike et al., 2014). Female-headed households, often more economically disadvantaged, may face greater challenges in accessing clean cooking fuels (Pachauri & Rao, 2013).

Despite the recognition of these factors, there is a dearth of research specifically examining the regional variations in HAP prevalence within Nigeria and the role of cooking locations in influencing exposure levels. The cooking environment, including whether meals are prepared indoors, outdoors, or in separate buildings, can significantly impact the concentration of pollutants and, consequently, the health risks (Ogwumike & Ozughalu, 2016). For instance, outdoor cooking, while often perceived as less harmful, can still result in significant exposure to pollutants, particularly in densely populated areas where outdoor air pollution is high (Ahmed et al., 2019).

This study seeks to address these gaps by conducting a comprehensive analysis of HAP prevalence across different regions of Nigeria and exploring the association between HAP and various sociodemographic factors, with a particular focus on cooking locations. Utilizing data from the 2018 Nigeria Demographic and Health Survey (NDHS), which surveyed 39,735 households across Nigeria, this research aims to provide a detailed understanding of the factors contributing to HAP and to inform targeted interventions that can reduce exposure, particularly among vulnerable populations. By examining both the regional disparities and the specific household characteristics associated with HAP, this study contributes to the broader discourse on energy poverty and public health in Nigeria and offers insights that can guide policy and programmatic efforts to mitigate the health impacts of household air pollution.

MATERIALS AND METHODS

Study Setting

The study was conducted nationwide in Nigeria, encompassing all six geopolitical regions: North-Central, North-East, North-West, South-East, South-South, and South-West. The study included both urban and rural areas, covering a diverse range of population densities.

Data Source and Study Sample

This study utilized secondary data from the 2018 Nigeria Demographic and Health Survey (NDHS), specifically focusing on the Household Vital (HV) files. The NDHS is a nationally representative household survey that employs a stratified multi-stage cluster sampling method. Access to the NDHS

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dataset was secured through an online application and approval process. The analysis concentrated on the HV files, which contain demographic, socioeconomic, and health information for all household members. Only households that reported their type of cooking fuel were included in the analysis. After performing data cleaning and consistency checks, the final sample consisted of 39,735 households.

Study Variables

Dependent Variable: A binary dependent variable was used to indicate the presence or absence of household air pollution (HAP). Cooking energy sources such as electricity, LPG, natural gas, and biogas were classified as "clean" due to lower emissions, while kerosene, coal, charcoal, wood, biomass fuels, and animal dung were categorized as "unclean" based on higher emission profiles (Abila et al., 2021; Ang'u, 2023). This classification allowed for the analysis of HAP and the factors influencing it among Nigerian households.

Independent Variables: The study primarily focused on household characteristics as independent variables. These included the age of the head of household, education level, wealth index, residence, sex of household head, household members, and region. Additionally, variables related to energy use were considered, such as the place where food is cooked (e.g., in the house, separate building) and the presence of a separate kitchen.

Data Analysis

Descriptive statistics, including frequencies and proportions, were used to characterize the study population and examine the distribution of key variables. Cross-tabulations were employed to explore the relationship between HAP and cooking location within households. Bar charts and maps were used to visualize regional disparities in HAP prevalence across Nigeria's six geopolitical regions.

Bivariate logistic regression was conducted to assess the association between HAP and individual household characteristics. Multivariable logistic regression was used to identify household factors influencing HAP while controlling for other relevant variables. Odds ratios, confidence intervals, and p-values were calculated to determine the magnitude and statistical significance of these factors.

Data analysis was conducted using STATA version 15, incorporating sampling weights to account for the complex survey design of the NDHS.

RESULTS

Sociodemographic Characteristics of Households

Table 1 presents the sociodemographic characteristics of the households analysed in the study, which included a total of 39,735 households. A slightly higher proportion of these households reside in rural areas (52.95%) compared to urban areas (47.05%). The majority of household heads were male, accounting for 81.74%. In terms of wealth distribution, the richest households constituted 22.71%, while the poorest comprised 16.92%. Educational attainment among household heads varied, with 32.16% having completed secondary education and 16.85% having attained higher education.

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Table 1: Sociodemographic Characteristics of Household, N = 39,735.

Variable	Frequency	Percentage
Type of Residence		
Urban	18,694	47.05%
Rural	21,040	52.95%
Sex of Head of Household		
Male	32,478	81.74%
Female	7,256	18.26%
Wealth Index		
Poorest	6,723	16.92%
Poorer	7,306	18.39%
Middle	8,096	20.37%
Richer	8,586	21.61%
Richest	9,024	22.71%
Educational Level		
No Education, Preschool	12,078	30.40%
Primary	8,150	20.51%
Secondary	12,780	32.16%
Higher	6,694	16.85%
Region		
North Central	5,573	14.02%
North East	5,512	13.87%
North West	9,509	23.93%
South East	4,745	11.94%
South South	5,712	14.38%
South West	8,684	21.85%
Members of Household		
Mean (SD)	4.7 (3.18)	
95 % C.I.	4.62 - 4.68	
Age of Household Head		
Mean (SD)	45.7 (15.77)	
95 % C.I.	45.59 - 45.90	

Source: NDHS, 2018

Prevalence of Household Air Pollution across Nigerian Regions

HAP prevalence varied widely across Nigerian regions, with the North-West recording the highest prevalence at 23.93%, indicating a significant reliance on unclean cooking fuels (Figure 1). The South-East reported the lowest prevalence at 11.94%, suggesting better access to cleaner energy sources. The North-East and South-West regions showed intermediate levels of 19.88% and 15.67%, respectively (Figure 2). These variations underscore regional disparities in energy access and usage patterns, reflecting differences in socioeconomic conditions, infrastructure, and availability of clean energy options.

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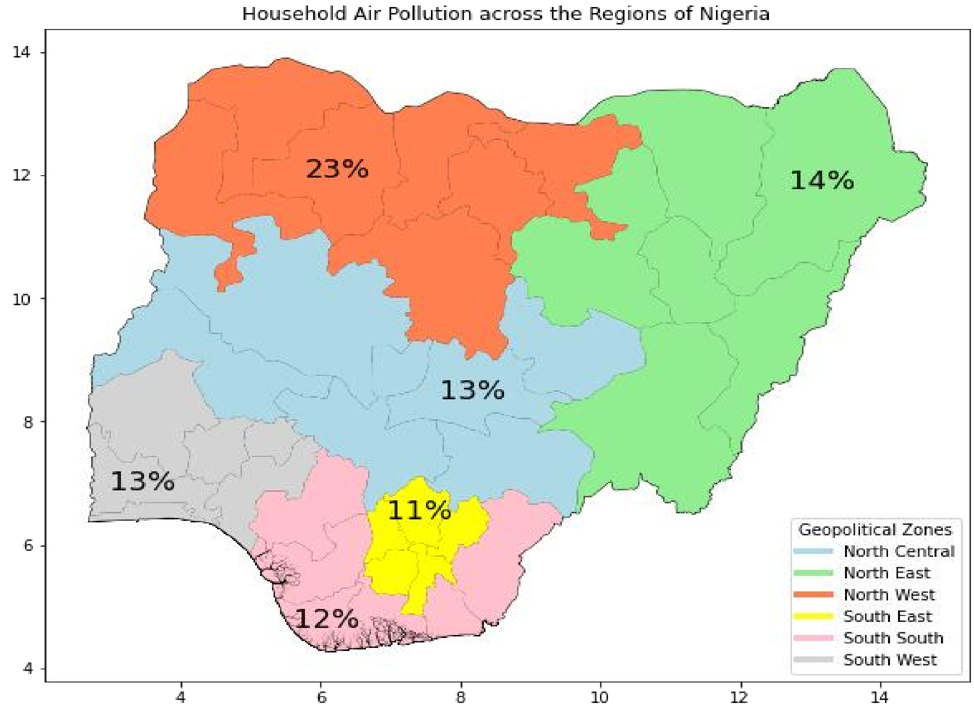

Figure 1: **M**ap of Nigeria showing prevalence of HAP across regions.

Source: Adapted from Administrative Map of Nigeria

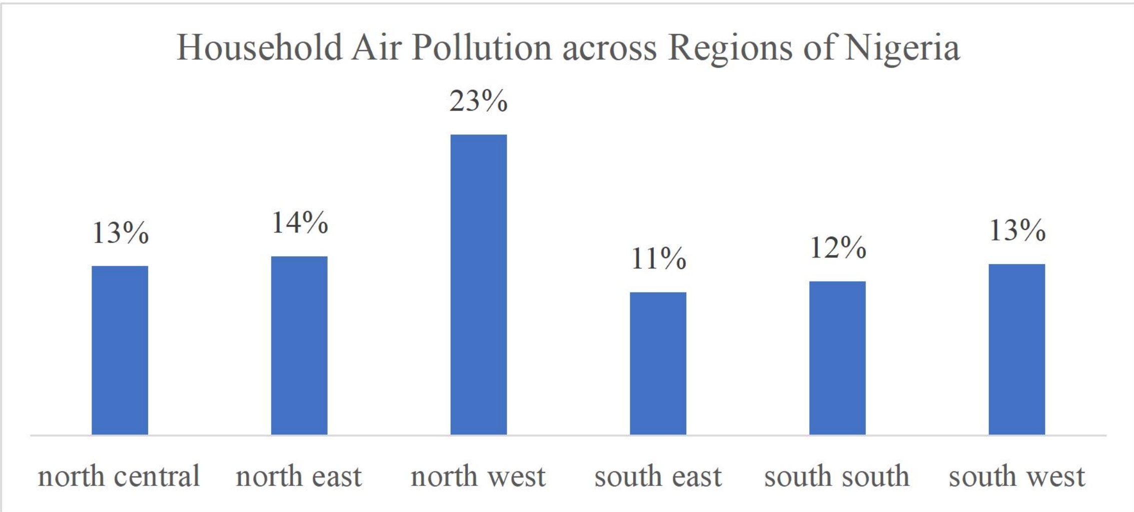

Figure: Prevalence of HAP across regions of Nigeria.

Source: NDHS, 2018

Household Air Pollution and Cooking Place

Cooking location significantly influenced HAP prevalence as shown in Table 2. The analysis showed that households cooking outdoors had the highest prevalence of HAP, with 96.24% using unclean fuels, compared to 74.93% of households cooking indoors and 93.77% cooking in a separate building. The presence of a separate kitchen also had a significant impact; households without a separate kitchen were more likely to use unclean fuels (89.65%) compared to those with a separate kitchen (69.50%).

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Table 2: Presence of HAP by Cooking Place.

Where Food is Cooked	Unclean Freq. (%)	Clean Freq. (%)	X^2	p-value
In the House	10,829 (74.93)	3,623 (25.07)		
In a Separate Building	11,694 (93.77)	777 (6.23)	3500	0.00
Outdoors	12,337 (96.24)	482 (3.76)		
Household Has Separate Kitchen				
No	3,430 (89.65)	396 (10.35)	605.69	0.00
Yes	7,321 (69.50)	3,213 (30.50)		

Source: NDHS, 2018

Household Factors Associated with Household Air Pollution

Multivariable logistic regression identified several significant household factors associated with HAP (Table 3). The odds of HAP were significantly lower in rural households (AOR: 0.60, 95% CI: 0.50-0.73, p<0.001) compared to urban households. Female-headed households were more likely to experience HAP (AOR: 1.36, 95% CI: 1.22-1.53, p<0.001) than male-headed households. Wealth was inversely associated with HAP, with the richest households having significantly lower odds (AOR: 258.90, 95% CI: 117.45-570.72, p<0.001) compared to the poorest households. Additionally, higher education levels were associated with reduced odds of HAP, with those having higher education showing the lowest likelihood of using unclean fuels (AOR: 4.21, 95% CI: 3.09-5.73, p<0.001). Regional disparities were also evident, with the North-East having significantly lower odds of HAP (AOR: 0.44, 95% CI: 0.28-0.68, p<0.001) compared to the North-Central region. In contrast, households in the South-West had significantly higher odds of HAP (AOR: 4.38, 95% CI: 3.38-5.68, p<0.001).

Table 3: Household factors associated with HAP.

Variable	COR (95% C.I)	p-value	AOR (95% C.I)	p-value
Age of Household Head	0.99 (0.98, 0.99)	0.00	0.99 (0.99, 1.00)	0.00
Household Members	0.84 (0.82, 0.92)	0.00	0.89 (0.87, 0.92)	0.00
Residence				
Urban	R.C		R.C	
Rural	0.12 (0.09, 0.15)	0.00	0.60 (0.50, 0.73)	0.00
Sex of Household Head				
Male	R.C		R.C	
Female	1.14 (1.03, 1.26)	0.01	1.36 (1.22, 1.53)	0.00
Wealth Index				
Poorest	R.C		R.C	
Poorer	2.25 (0.89, 5.68)	0.09	1.46 (0.57, 3.71)	0.43
Middle	14.01 (6.38, 30.77)	0.00	5.42 (2.42, 12.11)	0.00
Richer	135.49 (63.70, 288.19)	0.00	32.16 (14.70, 70.33)	0.00
Richest	1330.29 (627.72, 2819.16)	0.00	258.90 (117.45, 570.72)	0.00
Education Level				
no education/preschool	R.C		R.C	
Primary	4.44 (3.51, 5.61)	0.00	1.16 (0.88, 1.52)	0.29
Secondary	14.27 (11.18, 18.23)	0.00	1.66 (1.27, 2.19)	0.00

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Higher	47.44 (35.72, 63.01)	0.00	4.21 (3.09, 5.73)	0.00
Don't Know	8.56 (1.99, 36.82)	0.00	1.17 (0.21, 6.63)	0.86
Region				
North Central	R.C		R.C	
North East	0.20 (0.11, 0.36)	0.00	0.44 (0.28, 0.68)	0.00
North West	0.50 (0.31, 0.81)	0.01	1.04 (0.70, 1.52)	0.86
South East	1.06 (0.63, 1.80)	0.82	0.63 (0.44, 0.91)	0.01
South South	2.51 (1.76, 3.59)	0.00	1.61 (1.18, 2.19)	0.00
South West	7.53 (5.50, 10.31)	0.00	4.38 (3.38, 5.68)	0.00

Source: NDHS, 2018

DISCUSSION

The findings of this study provide valuable insights into the complex landscape of household air pollution (HAP) in Nigeria, highlighting significant regional and sociodemographic disparities. The high prevalence of HAP in the North-West region, where 23.93% of households are affected, underscores the urgent need for targeted interventions. This region's reliance on traditional biomass fuels, coupled with limited access to cleaner alternatives, likely contributes to the observed disparities. Studies indicate that solid biomass, particularly fuelwood, remains the dominant energy source for cooking in Nigeria, especially in rural areas, where over 85% of households utilize it (Bisu et al., 2016; Chikaire et al., 2011; Jekayinfa et al., 2020; Sani et al., 2024). The economic factors, such as poverty and low income levels, further exacerbate the reliance on these traditional fuels, making it difficult for households to transition to cleaner energy options (Chikaire et al., 2011; Emodi & Boo, 2015). In contrast, the South-East region, with a prevalence of 11.94%, may benefit from better infrastructure and access to cleaner cooking technologies, as well as more effective public health interventions (Ogwumike et al., 2014; Williams et al., 2019). These factors contribute to improved health outcomes and reduced exposure to household air pollution (HAP) in this area, highlighting the importance of targeted strategies to enhance energy access and public health initiatives.

The association between cooking location and HAP prevalence revealed in this study is particularly noteworthy. Households that cook outdoors or in separate buildings are often assumed to be less exposed to harmful pollutants due to better ventilation. However, the high prevalence of HAP in these settings suggests that the type of fuel used and the frequency of exposure remain significant risk factors, regardless of the cooking environment. Specifically, cooking in a separate building was associated with higher HAP prevalence, while having a separate kitchen within the house was protective (aOR = 0.74, 95% CI: 0.67-0.81) (Gordon et al., 2014). This finding aligns with previous research indicating that while outdoor cooking can reduce the concentration of indoor pollutants, it does not eliminate exposure, especially in areas with high ambient air pollution (Myers & Maynard, 2005; Vardoulakis et al., 2020). The protective effect of having a separate kitchen suggests that structural modifications to households could be a viable strategy to reduce HAP exposure. Interventions that promote the construction of separate, well-ventilated cooking spaces, particularly in rural and low-income communities, could significantly mitigate the health risks associated with HAP (Ahmed et al., 2019; Das et al., 2018).

The multivariable analysis highlights several sociodemographic factors that influence

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HAP exposure. Urban households were found to have higher odds of HAP compared to rural households (aOR = 1.52, 95% CI: 1.35-1.70). This counterintuitive finding may be explained by the complex interplay of factors in urban settings, including higher population density, limited space for cooking, and higher fuel costs, which may drive households to use cheaper, unclean fuels (Das et al., 2018). Additionally, urbanization in Nigeria is often accompanied by informal settlements where access to clean energy sources is limited, further exacerbating HAP exposure. This underscores the need for urban planning and housing policies that prioritize access to clean cooking technologies in rapidly growing urban areas (Emodi & Boo, 2015).

The higher likelihood of HAP in female-headed households (aOR = 1.38, 95% CI: 1.24-1.54) highlights the intersection of gender and energy poverty. Female-headed households in Nigeria are often economically disadvantaged, with limited access to financial resources and social support systems (Pachauri & Rao, 2013). This economic vulnerability likely contributes to their reliance on cheaper, unclean fuels, despite the known health risks. This finding is consistent with other studies that have shown that gender plays a critical role in energy access, with women bearing a disproportionate burden of energy poverty (Clancy et al., 2002; Ogwumike & Ozughalu, 2014; Pachauri & Rao, 2013). Addressing HAP in female-headed households will require targeted interventions, such as microfinance programs that enable women to purchase clean cooking technologies or subsidies that reduce the cost of clean fuels (Ogwumike & Ozughalu, 2014).

The role of wealth and education as protective factors against HAP is well-documented in the literature, and our study reaffirms these associations. Households in the lowest wealth quintile had significantly higher odds of HAP (aOR = 2.15, 95% CI: 1.87-2.47) compared to those in the highest quintile. Similarly, education was a protective factor, with households where the head had a secondary or higher education being less likely to experience HAP. These findings suggest that policies aimed at reducing HAP should include educational campaigns that raise awareness about the dangers of unclean cooking fuels and the benefits of cleaner alternatives (Behera & Ali, 2016; Ozughalu, 2023). Additionally, financial incentives or subsidies could help lower-income households transition to cleaner energy sources.

Regional disparities in HAP odds were also notable, with the South-West having the highest odds (aOR = 1.61, 95% CI: 1.42-1.82) and the North-East the lowest (aOR = 0.79, 95% CI: 0.67-0.93). These disparities reflect the diverse energy landscapes within Nigeria, influenced by factors such as urbanization, population density, and regional economic development (Eweka et al., 2022). The South-West's higher odds may be linked to its rapid urbanization and associated challenges, such as housing shortages and inadequate infrastructure, which can exacerbate exposure to indoor air pollution (Ogwumike et al., 2014; Sani et al., 2024). In contrast, the North-East, despite its economic challenges, may benefit from lower population density and more traditional lifestyles that reduce HAP risk (Akeh et al., 2023).

CONCLUSION

This study highlights significant regional and sociodemographic disparities in household air pollution across Nigeria, emphasizing the need for targeted interventions. The findings reveal that cooking location, urban residence, female-headed households, and socioeconomic status are critical factors influencing HAP exposure. Addressing these disparities through tailored policies and programs, particularly in high-risk regions and among vulnerable populations, is essential to reducing the health burden of

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HAP. Future research should continue to explore these dynamics to inform effective strategies for improving indoor air quality and public health in Nigeria.

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