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Nigerian households' cooking energy use, determinants of choice, and some implications for human health and environmental sustainability

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A B S T R A C T

The aim of this study was to investigate the types of cooking fuels and factors that influence their choice by households in Nigeria. Cross national data used were extracted from the 2013 Nigeria Demographic and Health Survey (NDHS) on households' cooking energy and was subjected to descriptive and inferential statistics. The results indicated that 55% of sampled households have access to electricity, while about two-third (66.3%) of households depend on biomass as fuel for cooking. The Chi-square analysis revealed that a significant statistical relationship existed between geo-political regions, place of residence, access to electricity, educational level, and wealth index and type of cooking used. Results also showed significant statistical differences between rural and urban households' type of cooking fuel while analysis of variance found significant differences in the type of cooking fuel according to regions, educational level, and wealth index. Multiple regression results demonstrated that socio-economic factors such as household size, geographical region, place of residence, educational level and wealth index have a significant positive influence on the type of cooking fuel used by households in Nigeria. However, access to electricity showed no significant association with the household type of cooking fuel. These results have important implications for human health and environmental sustainability, and therefore it was recommended that government needs to intensify educational efforts towards enlightening people about the need for the sustainable utilization of energy resources.

1. Introduction

For decades, the issue of energy use and management has been a subject of global discourse not only because of its role in socio-economic and technology development but also in view of its negative impact on human health and the environment across countries and regions (Hall & Scrase, 1998; Fruergaard, Astrup, & Ekvall, 2009; Moldan, Janoušková, & Hák, 2012). This concern is more imperative in addressing some of the Millennium Development Goals MDGs), notably, goal 7 – which calls for ensuring environmental sustainability, especially for the poor and vulnerable people (World Energy Council (WEC), 2008). According to the International Energy Agency (IEA, 2014), more than 3 billion people worldwide use biomass in the form of fuelwood, animal dung, agricultural residues and charcoal to meet their cooking energy needs; of which 2.6 billion of this population were estimated to live in developing countries. Existing literature (Smith et al., 2007; World Bank, 2006; Adkins, Tyler, Wang, Siriri, & Modi, 2010) attests to the environmental and health effects of human dependence on traditional biomass. Women and children are reportedly exposed each day to pollution from indoor cooking smoke as they spend many hours near cooking fires. Such indoor exposures have been linked to acute respiratory illnesses, chronic obstructive lung diseases, low birth weights, lung cancer and eye problems, primarily, among women and children (World Health Organisation (WHO), 2007; 2014). Consequently, smoke from cooking fuels is estimated to account for nearly 2 million deaths, of which more than 99% occur in developing countries (WHO, 2007). According to the IEA (2014) Report, nearly 600,000 premature deaths occur in Africa from household use of solid biomass energy.

About 13% of the world's population lives in sub-Saharan Africa (IEA, 2014). However, the African continent is reported to account for only 4% of world energy consumption; the lowest per capita modern energy consumption in the world although it is richly endowed with various types of energy resources (solar, hydro, wind and geothermal). The continent also has 1.3 billion of world's

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people without access to electricity and one-quarter of the estimated 2.6 billion people in developing countries that depend on biomass for cooking and space heating (World Bank, 2012; IEA, 2014). More than 90% of the rural population relies on biomass, while well over half of all urban households also rely on fuelwood, charcoal or wood waste to meet their cooking fuel needs (WHO, 2006; WEC, 2008). This heavy reliance on traditional bioenergy is leading to increases in greenhouse gas emissions, low level of energy efficiency, deforestation, loss of biodiversity, health problems from indoor air pollution and reduction in capacity to mitigate climate change (Food and Agricultural Organisation (FAO), 2011; 2014).

Nigeria is sub-Saharan Africa's most populated country with an estimated population of 182 million people (United Nations, 2015) and it is estimated that 60% of them are not having access to electricity, while those with access often struggle with erratic, unstable power supply and continuous, arbitrary price increases by the power distribution companies (IEA, 2011; 2014). However, the country is richly endowed with abundant energy sources in the form of fossil fuels (oil, gas and coal), hydropower, uranium, biomass and other renewable energy sources - solar, wind, and geothermal power (IEA, 2011; 2014). Nigeria is the sixth largest producer of crude oil in the world and has the second largest crude oil reserves in Africa (United States Energy Information Administration (US EIA), 2015). The country's liquid natural gas (LNG) is estimated to be 187 trillion standard cubic meters, which is the largest in Africa and 9th largest in the world (IEA, 2011; 2014). Yet, Nigeria's current electricity generation is found to be less than 6000 MW (IEA, 2011; 2014). Moreover, over 80% of the country's population especially in the rural areas still rely on fuelwood for cooking and other domestic uses. Inevitably, the loss of forest resources such as trees and wildlife and accelerated deforestation and desertification as well as soil erosion, are some of the long term environmental problems associated with biomass consumption in Nigeria (Adelekan & Jerome, 2006). In fact, nearly 45,000 ha of woodland are lost annually due to illegal felling of trees and shrubs for domestic biomass and charcoal production. If these trends continue unabated, by the year 2020 all the forest resources would be lost (FAO, 2011; 2014).

2. Research objective and questions

A number of studies on the fuel type use and determinants of choice of fuel for cooking have been conducted in some developing countries such as China, Philippines, Pakistan, as well as India (Démurger & Fournier, 2010; Ekholm, Hrey, Pachauri & Riahi, 2010; Jan, Khan, & Hayat, 2012), and sub-Saharan Africa (Sudan, Malawi, Zimbabwe, Mozambique, Ghana and Nigeria) (Adkins, Oppelstrup, & Modi 2012; Mekonnen & Kohlin, 2008; Cuvias, Jirjis, & Lucas, 2010; Mwaura, Okoboi, & Ahaibe, 2014). However, a review of the available literature has shown that only a few surveys relating to Nigeria exist on household cooking fuel use. Moreover, in Nigeria, most of the studies conducted were in a few local government areas (Oyekale, 2012; Naibbi & Healey, 2013; Babalola & Opii, 2013). Thus, no previous studies have been conducted to provide a national level profile as well as an intra-national comparison in terms of types of cooking fuels and factors that influence their choice by households in Nigeria. Again, the only factors which were considered entailed income, sex and age of household heads as determinants of fuel choice. On the other hand, the examination of factors such as access to electricity, territorial aspects and type of residence may help in identifying and understanding areas within the country that are worthy of government intervention and assistance. It is against the foregoing background that this study was conceived to assess types of cooking fuel used and the determinants of the choice of cooking fuel amongst households at national level as well as their implications for environmental sustainability. To address this main goal, four research questions were formulated and they are specified as follows: (1) What is the pattern of access to electricity and fuel type used for cooking at households at national level? (2) Is there any significant statistical difference in household type of fuel used for cooking based on educational level, type of residence, number of household members, region and wealth? (3) Is there any significant statistical relationship between household socio-economic characteristics and types of fuel used for cooking? (4) Can socio-economic characteristics predict household types of fuel used for cooking?

3. Study area and research methodology

3.1. Study area

Nigeria lies roughly between latitudes 4° and 14° North and longitudes 3° and 15° East in West Africa. It is bordered by the elongated territory of Benin to the west, the semi-arid country of the Niger Republic to the north, the sub-equatorial Cameroon to the east and the Atlantic Ocean to the south. Her population is estimated at about 182 million with an average density of 200 people km^2 (United Nations, 2015). The total land area is nearly 923,773 km^2, which is about 14% of the land area in West Africa. The country is richly endowed with abundant natural resources, both renewable and non-renewable. Currently, Nigeria comprises 36 States and a Federal Capital Territory (FCT), grouped into six geopolitical zones: North Central, North East, North West, South East, South–South, and South-West (Fig. 1).

The country's population is predominantly rural. It is estimated that 70% of Nigerians live in rural areas and are directly or indirectly dependent on forest resources (Federal Ministry of Environment (FME, 2008). A major feature of Nigeria's coastal and marine environment is the Niger Delta, which covers an area of 70,000 km^2, and this makes it one of the largest wetlands in the world. The mangrove forests of Nigeria rank as the largest in Africa, and the third largest in the world.

3.2. Data analysis

The data for this study was extracted from the Nigerian Demographic and Health Survey (NDHS) conducted in 2013. This survey was nationally representative of 38495 households. Women's ages ranged from 15 to 49 whereas men's age was in the 15–59 brackets. With the aid of the SPSS 20 software, frequency, percentage, chi-square and logistic regression were used to address the research questions specified. A probability level of 0.05 was used for all tests of significance (National Population Commission (NPC) [Nigeria] and ICF International. (2014).

4. Results

From the data analysis, 55% of households have access to electricity, while 44% responded in the negative. The dominant type of fuel used for cooking is fuelwood, which is used by 66.3% of households. Kerosene is the country's second most preferred source of household energy with 23.6% of the respondents using it on a daily basis. Three percent (3%) of households used charcoal. Only 1.3% used natural gas while less than 1% of the respondents used each of the other sources of energy for cooking (electricity, LPG, biogas, agricultural residue and animal dung) (Table 1). The survey showed that 81% of households are using wood fuels (fuel wood and/or charcoal) as the main energy source for cooking.

Cross tabulations were conducted to show the relationship

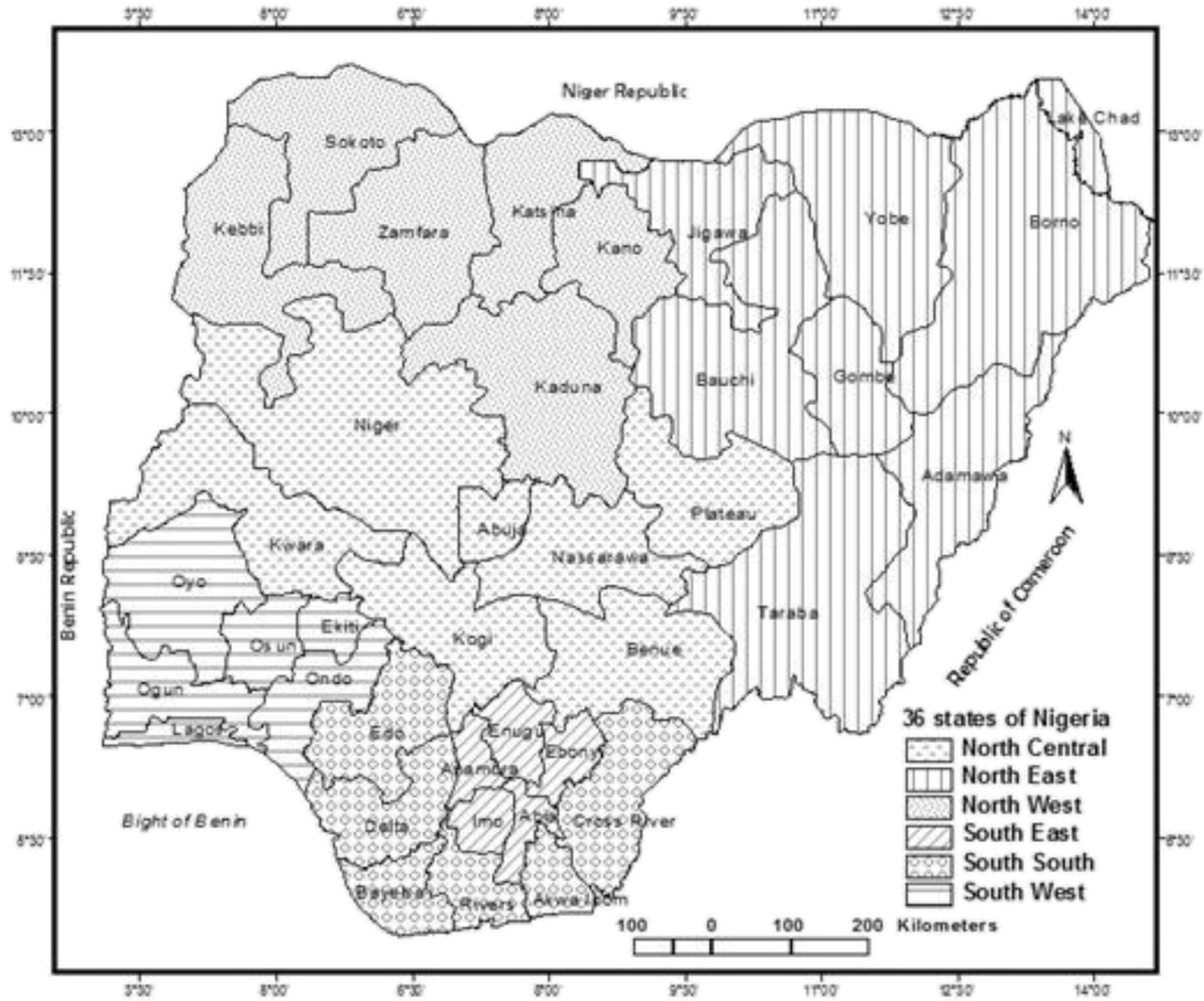

Fig. 1. Map of Nigeria showing the six geo-political zones and states.

Table 1
Distribution of households with access to electricity and type of cooking fuel.

	Frequency	Percentage
Access to electricity		
Yes	21162	55.0
No	17295	45.0
Total	**38457**	**100.0**
Type of cooking fuel		
Electricity	208	0.5
LPG	304	0.8
Natural gas	513	1.3
Biogas	100	0.3
Kerosene	9104	23.6
Coal, lignite	90	0.2
Charcoal	1147	3.0
Wood	25539	66.3
Straw/shrubs/grass	483	1.3
Agricultural crop	82	0.2
Animal dung	36	0.1
No food cooked in Household	887	2.3
Other	2	0.0
Total	**38495**	**99.9**

Table 2
Statistical relationship between households' place of residence and types of cooking fuel.

	Types of place of residence		Total
Types of cooking fuel	Urban	Rural	
Electricity	157(75.5)	51 (24.5)	208
LPG	271 (89.1)	33 (10.9)	304
Natural gas	434 (84.6)	79 (1.4)	513
Biogas	85 (85.0)	15 (15.0)	100
Kerosene	6926 (76.1)	2178 (23.9)	9104
Coal, lignite	81 (90.0)	9 (10.0)	90
Charcoal	831 (72.4)	316 (27.6)	1147
Wood	6628 (26.0)	18911 (74.0)	25539
Straw/shrubs/grass	20 (4.1)	463 (95.9)	483
Agricultural crop	4 (4.9)	78 (95.1)	82
Animal dung	5 (13.9)	31 (86.1)	36
No food cooked in household	407 (45.9)	480 (54.1)	887
Other	1 (50.0)	1 (50.0)	2
Total	15850 (41.2)	22645 (58.8)	38495

Chi-square 8779.586 df 12 $p < 0.001$.

between place of residence, access to electricity, educational background, geo-political region, wealth index and type of cooking fuel. The results are presented in various tables (Tables 2–6). Table 2 presents fuel consumption patterns of urban and rural households. The majority of urban households used modern energy resources such as electricity, LPG, natural gas, biogas, and kerosene, while traditional energy sources such as firewood, straw/grass, agricultural crop, and animal dung were used by rural households (Table 2). Almost 76% used electricity for cooking in urban areas

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Table 3
Statistical relationship between access to electricity and types of cooking fuel.

	Urban			Rural			Overall total
	Has electricity		Total	Has electricity		Total	
	No	Yes		No	Yes		
Electricity	0 (0.0)	157(1.2)	157	0 (0.0)	51 (0.6)	51	208 (0.5)
LPG	4 (0.2)	267 (2.0)	271	2 (0.0)	31 (0.4)	33	304 (0.8)
Natural gas	5 (0.2)	429 (3.2)	434	4 (0.0)	75 (0.9)	79	513 (1.3)
Biogas	0 (0.0)	85 (0.6)	85 (0.5)	2 (0.0)	13 (0.2)	15 (0.1)	100 (0.3)
Kerosene	439 (16.7)	6481 (49.1)	6920 (43.7)	594 (4.1)	1579 (19.8)	2173 (9.6)	9093 (23.6)
Coal, lignite	3 (0.1)	77 (0.6)	80 (0.5)	5 (0.0)	4 (0.1)	9 (0.0)	89 (0.2)
Charcoal	85 (3.2)	745 (5.6)	830 (5.2)	113 (0.8)	202 (2.5)	315 (1.4)	1145 (3.0)
Wood	2012 (76.4)	4609 (34.9)	6621 (41.8)	13079 (89.2)	5808 (730)	18887 (83.5)	25508 (66.3)
Straw/shrubs/grass	14 (0.5)	6 (0.0)	20 (0.1)	405 (2.8)	58 (0.7)	463 (2.0)	483 (1.3)
Agricultural crop	0 (0.0)	4 (0.0)	4 (0.0)	57 (0.4)	21 (0.3)	78 (0.3)	82 (0.2)
Animal dung	5 (0.2)	0 (0.0)	5 (0.0)	31 (0.2)	0 (0.0)	31 (0.1)	36 (0.1)
No food cooked in household	66 (2.5)	341 (2.6)	407 (2.6)	366 (2.)	113 (1.4)	479 (2.1)	886 (2.3)
Other	0 (0.0)	1 (0.0)	1 (0.0)	1 (0.0)	0 (0.0)	1 (0.0)	2 (0.0)
Total	2633	13202	15835	14659	7955	22614	38449
	16.6%	83.4%	100.0%	64.8%	35.2%	100.0%	100.0

Chi-square 7896.183 df 12 $p < 0.001$.

Table 4
Statistical relationship between households' educational level and types of cooking fuel.

Types of cooking fuel	Highest educational level attained				Total
	No education	Primary	Secondary	Higher	
Electricity	5(2.4)	22 (10.7)	84 (40.8)	95 (46.1)	206
LPG	2 (0.7)	8 (2.6)	56 (18.5)	237 (78.2)	303
Natural gas	7 (1.4)	21 (4.1)	91 (17.8)	391 (76.6)	510
Biogas	2 (2.0)	6 (6.1)	20 (20.2)	71 (71.7)	99
Kerosene	723 (8.0)	1693 (18.7)	4273 (47.2)	2361 (26.1)	9050
Coal, lignite	33 (36.7)	15 (16.7)	30 (33.3)	12 (13.3)	90
Charcoal	289 (25.6)	221 (19.6)	382 (33.8)	237 (21.0)	1129
Wood	11486 (45.6)	6251 (24.8)	5431 (21.5)	2034 (8.1)	25202
Straw/shrubs/grass	372 (78.6)	74 (15.6)	23 (4.9)	4 (0.8)	473
Agricultural crop	67 (85.9)	6 (7.7)	4 (5.1)	1 (1.3)	78
Animal dung	32 (91.4)	2 (5.7)	1 (2.9_b)	0(0.0)	35
No food cooked in household	374 (42.5)	101 (11.5)	283 (32.2)	122 (13.9)	880
Other	1 (50.0)	0 (0.0)	0 (0.0)	1 (50.0)	2
Total	13393 (35.2)	8420 (22.1)	10678 (28.1)	5566 (14.6)	38057

Chi-square 9717.087 df 36 $p < 0.001$.

Table 5
Statistical relationship between geo-political region and types of cooking fuel.

Types of cooking fuel	Region						Total
	North central	North east	North west	South east	South South	South west	
Electricity	104 (50.)	6 (2.9)	5 (2.4)	15 (7.2)	43 (20.7)	35 (16.8)	208
LPG	79 (26.0)	4 (1.3)	1 (0.3)	26 (8.6)	75 (24.7)	119 (39.1)	304
Natural gas	152 (29.6)	12 (2.3)	21 (4.1)	58 (11.3)	168 (32.7)	102 (19.9)	513
Biogas	32 (32.0)	2 (2.0)	8 (8.0)	11 (11.0)	18 $(18.0)_c$	29 (29.0)	100
Kerosene	1208 (13.3)	181 (2.0)	426 (4.7)	1157 (12.7)	2276 (25.0)	3856 (42.4)	9104
Coal, lignite	9 (10.0)	2 (2.2)	57 (63.3)	3 (3.3)	2 (2.2)	17 (18.9)	90
Charcoal	430 (37.5)	163 (14.2)	94 (8.2)	27 (2.4)	32 (2.8)	401 (35.0)	1147
Wood	4594 (18.0)	4877 (19.1)	6618 (25.9)	3674 (14.4)	3482 (13.6)	2294 (9.0)	25539
Straw/shrubs/grass	9 (1.9)	78 (16.1)	392 (81.2)	4 (0.8)	0 (0.0)	0 (0.0)	483
Agricultural crop	3 (3.7)	8 (9.8)	71 (86.6)	0 (0.0)	0 (0.0)	0 (0.0)	82
Animal dung	1 (2.8)	15 (41.7)	20 (55.6)	0 (0.0)	0 (0.0)	0 (0.0)	36
No food cooked in household	168 (18.9)	350 (39.5)	237 (26.7)	6 (0.7)	26 (2.9)	100 (11.3)	887
Other	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	2
Total	6789 (17.6)	5699 (14.8)	7951 (20.7)	4981 (12.9)	6122 (15.9)	6953 (18.1)	38495

Chi-square 11204.032 df 60 $p < 0.001$.

while 24.5% used it in rural areas. LPG is used predominantly by urban households (89.1%), and to a much lesser (10.9%) extent in rural households. Furthermore, slightly more than two-third (76.1%) of urban households used kerosene for cooking while 23.9% of rural households do the same. About 90% of urban households reported that they used coal or lignite compared to 10% in rural households. The analysis also revealed that 74% of the rural households used firewood, while just a quarter (26%) of urban respondents used firewood. Thus, it is clear that firewood is the most popular source of energy in most rural households represented in

Table 6
Statistical relationship between wealth index and types of cooking fuel.

Types of cooking fuel	Wealth index					Total
	Poorest	Poorer	Middle	Richer	Richest	
Electricity	0 (0.0)	0 (0.0)	2 (1.0)	33 (15.9)	173 (83.2)	208
LPG	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	303 (99.7)	304
Natural gas	0 (0.0)	0 (0.0)	1 (0.2)	4 (0.8)	508 (99.0)	513
Biogas	0 (0.0)	0 (0.0)	2 (2.0)	5 (5.0)	93 (93.0)	100
Kerosene	2 (0.0)	19 (0.2)	485 (5.3)	2805 (30.8)	5793 (63.6)	9104
Coal, lignite	0 (0.0)	7 (7.8)	12 (13.3)	52 (57.8)	19 (21.1)	90
Charcoal	19 (1.7)	58 (5.1)	209 (18.2)	531 (46.3)	330 (28.8)	1147
Wood	5211 (20.4)	6806 (26.6)	7471 (29.3)	4966 (19.4)	1085 (4.2)	25539
Straw/shrubs/grass	321 (66.5)	141 (29.2)	13 (2.7)	8 (1.7)$_d$	0 (0.0)	483
Agricultural crop	37 (45.1)	32 (39.0)	11 (13.4)	2 (24)	0 (0.0)	82
Animal dung	35 (95.2)	1 (2.8)	0 (0.)	0 (0.0)	0 (0.0)	36
No food cooked in household	141 (15.9)	199 (22.4)	238 (26.8)	192 (21.6)	117 (13.2)	887
Other	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	2
	5767 (15.0)	7263 (18.9)	8444 (21.9)	8599 (22.3)	8422 (21.9)	38495

Chi-square 23190.215 df 48 $p < 0.001$.

the survey, while kerosene is commonly utilized among the urban dwellers. The reason for the use of LPG and natural gas largely among urban people is that they are relatively expensive and affordable by the few urban middle class households. Even though price subsidies are provided for kerosene, LPG and natural gas, their prices were still not affordable to the majority of the people even in urban areas where there is relatively more cash flow. Furthermore, Table 2 shows a chi-square value 8779.586 which is significant at 0.05, $p < 0.05$. Therefore, there is a significant relationship between types of cooking fuel and types of place of residence.

Table 3 shows the cross-tabulation results of households' access to electricity and type of cooking fuel. The results clearly shows that the overall chi-square value of $\chi^2 = 7896.183$, $p < 0.05$ is statistically significant. This indicates that the type of cooking fuel used by households is a function of access to electricity. The data analyses also reveals that only 1.2% of urban households with electricity used it for cooking. Similarly, natural gas and liquefied gas were used by only 3.2% and 2.0% respectively of urban households with access to electricity. Forty-nine percent (49%) of urban households that have access to electricity used kerosene. The results also show that wood is used by majority of households in urban and rural areas irrespective of whether or not they have access. Overall, 66.3% of the households in the study use fuelwood for cooking. Invariably, its availability and cheaper cost account for the high dependence on wood resources. Factors such as poverty, lack of access, and the erratic nature of power supply can be advanced as possible explanations for the non-usage of electricity and other modern energy fuels for cooking.

As shown in Table 4, electricity is used by only 2.4% of households with no education, 10.7% with primary school background, 40.8% with secondary and 46.1% with higher education. The results also show that there is heavy (49.0%) reliance on fuelwood by households with no education. On the other hand, about 21.6% of households with primary education and 26.6% with secondary education use fuelwood. Only 2.8% of households with higher education used fuelwood. Kerosene was found to be the most commonly used fuel type for cooking by households with secondary education 57.8% and higher education 24.5%, respectively. Almost 36% of households with secondary education and 59.6% with higher education used LPG. Natural gas was used by 65.5% and 30.1% of those with higher and secondary education, respectively. Only 4.6% and 2.7% of households with primary education used LPG and natural gas. Two percent (2%) of households with no education used biogas and the proportion for those with primary education was 6.1%. However, as the level of educational status improved, the proportions of biogas usage also increased (Table 4). Further analysis also revealed a chi-square value of 9717.087 which is significant at 0.05, $p < 0.05$. This implies that there is significant statistical relationship between households' educational background and the type of cooking fuel used.

Table 5 shows the breakdown of the type of cooking fuel used by household across the six geo-political regions in Nigeria. From the results obtained, the proportion of households that uses firewood was fairly high amongst most regions, ranging from 25.9% in the Northwest to 13.6% in the South–South. However, the South west geopolitical region displayed only 9.0%. On the whole, these trends may be attributed to the low cost of fuelwood and lack of available alternatives. Regarding access to modern electricity, the highest proportion (50%) was found in the North Central region and this was followed in descending order by the South South (20.7%) and South West (16.8%) regions. By contrast, regions such as the North East, North West and South East had low levels of access to electricity. Furthermore, the highest (39.1%) proportion of access to LPG was found in the South West. Meanwhile, the North Central (26.0%) and South South (24.7%) exhibited nearly the same proportions. However, regions such as the North East (1.3%) and North West (0.3%) had lower degrees of access to LPG. The greatest proportion of access to natural gas was found in the South South (32.7%), the North Central (29.6%), and South West (19.9%) regions; although it was low in other states. Kerosene is used by 13.3% in North Central, 2.0% in North East, 4.7% by household in North West, 12.7% South East, 25.0% in South South and 42.4% in South West. Although the use of bioenergy sources such as straw, agricultural crops as well as animal dung was recorded for three regions located in the north of the country, almost no access to these energy resources were found in regions located the south. A statistically significant relationship was found between type of cooking fuel and region with a chi-square value (11204.032) which is significant at 0.05, $p < 0.05$.

Table 6 illustrates the distribution of household wealth and type of cooking fuel used. The result shows that a significant relationship exists between types of cooking fuel and household wealth index grades, with a chi-square value (23190.215) which is significant at 0.05, $p < 0.05$. The result also shows that only the richer (15.9%) and the richest (83.2%) households use electricity for cooking. The same trend was observed in the use of LPG (99.7%), natural gas (90.0%) and biogas (93.0%) - that they are all fuels of the richest households. Therefore, modern energy (electricity, natural gas, biogas and solar) resources are accessible mostly among the affluent households. Kerosene is used by 0.2% of the poorer households, 5.3% of middle and 30.8% and 63.6% of the richer and richest households, respectively. The results further show that 20.4% and 26.6% of the poorest and poorer households respectively rely on wood, while 29.3% of the middle class used wood. Thus, the level of income or wealth influences the type of cooking fuel used by households. It also implies that extreme poverty makes households to rely on biomass to meeting their fuel needs.

Table 7 reports the results of a t-test analysis to determine whether significant difference existed in type of cooking fuel by place of residence. Significant statistical differences were found in the type of cooking fuel used by rural and urban households.

Table 8 depicts a comparison between type of cooking fuel per region, age, type of residence, educational level and wealth index. One-way ANOVA was employed to determine if mean differences were statistically significant. The ANOVA summary revealed that there were statistically significant mean differences in the type of cooking fuel of households across a number of households, regions, age ranges, educational levels, as well as wealth indices.

When the results were further subjected to post hoc analysis using Scheffé multiple comparison analysis, it was found that significant differences existed within and between the groups in the choice of their specific cooking fuel. For instance, significant statistical differences were found between each of the regions in terms of the use of wood as cooking fuel. In terms of wealth, significant differences also occurred equally between the poorest, poorer and richer and richest households regarding cooking fuel.

In order to address the research question on whether socio-economic characteristics predict household choice on the type of fuel being used for cooking, a multiple regression analysis was conducted. Table 9 shows the composite effects and the relative contributions of each independent variable on the types of cooking fuel. The Table shows the regression value for the combined effects (0.242) and the adjusted R^2 (0.058). This implies that 58% of the variance in the type of cooking fuel of households is accounted for by the predictor variables. The analysis also shows that the F-value (236.822) is statistically significant at 0.001, a level that is less than 0.05. This shows that the predictor variables have significant influence on the type of cooking fuel of households.

Furthermore, Table 9 shows the relative contribution of each predictor variable to the variance in cooking fuel of households. The number of household members has the highest beta value (−0.193), followed by state (−0.109), wealth index (−0.058), region (−0.041), highest education (−0.034), type of residence (−0.027). As shown in Table 9, with the exception of access to electricity and local government area the predictor variables have significant effect on cooking fuel of households. It implies that having access to electricity determines its use as cooking fuel by Nigerian households.

5. Discussion of results

In this study, it was found that 55% of households sampled have access to electricity while 45% did not have such access. In addition, fuelwood appears to be the fuel type commonly used for cooking by almost two-thirds of Nigerian households represented in the survey. This pattern is not surprising because fuelwood is cheaper, affordable and easily available. In some instances, fuelwood also comes almost free for those households that have farmland where they can collect it. On the other hand, many households could not afford to buy kerosene and cooking gas as these are not easily available and, where they are available, their price is relatively unaffordable for most rural households. These findings are in line with previous studies (Ikurekong, Esin, and Mba (2009); Babanyara & Saleh, 2010; Adepoju, Oyekale, & Aromolaran, 2012; Baiyegunhi & Hassan, 2014) that the predominant fuel type used for domestic and commercial cooking in Nigeria is fuelwood.

Furthermore, findings from the study indicate that a statistically significant relationship exists between socio-economic variables such as geographical regions, place of residence, access to electricity, educational level, and wealth index and the type of cooking used in Nigeria. These findings are consistent with the results emanating from some of the Nigerian studies (Oyekale, 2012; Desalu, Ojo, Ariyibi, Kolawole, and Ogunleye (2012); Nlom & Karimov, 2014) as well as in Tanzania and Uganda (Menendez & Curt, 2013; Mwaura et al., 2014), which have indicated that there is a significant statistical association between households cooking fuel type and socio-economic status. More specifically, Adepoju et al. (2012) have attributed fuelwood choice to gender influences. Meanwhile, the likelihood of using charcoal was highly probable in households headed by illiterate individuals.

The regression analyses also revealed that Nigerian households' choices of types of cooking fuel are determined by various factors. These results agree with the findings of Babanyara and Saleh (2010) who concluded that the factors causing fuel wood demand in urban areas include rural-urban migration, urbanization, lack of income, increases in prices of kerosene and cooking gas, amongst others. Other studies that corroborate these findings include those of Akpan, Wakili, and Akosim (2007); Ogunniyi, Adepoju, and Olapade-Ogunwole (2012); Oyekale (2012); Desalu et al. (2012); and Ajah (2013). That the more socio-economically privileged households had better access to electricity and other modern types (natural gas, biogas and solar) of cooking energy resources was also found in the existing literature. For instance, Heltberg (2005) confirmed in a multi-country study that households with a higher education status tended to use modern fuels. In tandem with Brazilian and Indian studies, Mekonnen and Kohlin (2008) also reported similar evidence in Ethiopia where households with more educated members were more likely to use modern fuels. The overall implication from all these findings is that there is a need for policy makers to seriously consider socioeconomic factors in addressing issues and challenges associated with household energy consumption.

6. Conclusion and implications

Access to energy is one of the basic requirements for achieving sustainable human settlements. In this study, we have assessed and determined the factors which influenced Nigerian households' type of fuel used for cooking by analyzing the 2013 Nigerian DHS Data. Based on these findings, we can conclude that firewood is the primary energy of choice for a majority of households in Nigeria especially in the rural areas. It is also concluded that various factors determine the type of cooking fuel used by Nigerian households. Most importantly, the choice of cooking fuel in both rural and urban areas was found to be influenced by socio-economic factors such as age, education, wealth, as well as income. These results have far-

Table 7
Test of statistically significant difference between type of place of residence and types of cooking fuel.

	Type of place of residence	N	Mean	Std. D	t	Sig.
Has electricity	Urban	15839	0.83	0.372	106.331	**.001s**
	Rural	22618	0.35	0.478		
Type of cooking fuel	Urban	15850	8.54	14.158	−7.220	**.001s**
	Rural	22645	9.53	12.634		

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Table 8
Test of statistically significant difference between household demographic variables and types of cooking fuel.

		Sum of squares	df	Mean square	F	p.
No of household members	Between Groups	32722.516	12	2726.876	309.377	**.000**
	Within Groups	339183.514	38482	8.814		
	Total	371906.030	38494			
Region	Between Groups	15966.848	12	1330.571	513.335	**.000**
	Within Groups	99745.861	38482	2.592		
	Total	115712.709	38494			
Wealth index	Between Groups	32452.476	12	2704.373	2667.214	**.000**
	Within Groups	39018.120	38482	1.014		
	Total	71470.596	38494			
Highest educational level	Between Groups	9494.160	12	791.180	860.500	**.000**
	Within Groups	34979.267	38044	0.919		
	Total	44473.427	38056			

Table 9
Multiple regression of factors influencing households' types of cooking fuel.

	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	23.661	0.528		44.807	0.000
State	-0.013	0.001	-0.109	−14.024	0.000
Local Government Area	-0.001	0.001	-0.004	-0.751	.453ns
Region	-0.311	0.053	-0.041	−5.909	0.000
Type of place of residence	-0.727	0.167	-0.027	−4.357	0.000
Has electricity	0.166	0.187	0.006	0.885	.376ns
Sex of head of household	−2.236	0.179	-0.067	−12.493	0.000
Age of head of household	-0.020	0.005	-0.024	−4.341	0.000
Household members	-0.827	0.023	-0.193	−36.220	0.000
Highest educational level	-0.415	0.083	-0.034	−4.989	0.000
Wealth index	-0.566	0.090	-0.058	−6.276	0.000
R = 0.242					
R Square = 0.059					
Adjusted R Square = 0.058					
F value = 236.822					

Dependent Variable: Type of cooking fuel ns-not significant.

reaching policy implications for sustainable development in the energy supply sector of Nigeria.

Firstly, the attainment of the United Nations Millennium Goals that involve promoting gender equality and women empowerment, reducing child mortality, improving maternal health, combatting diseases and ensuring environmental sustainability and halving the number of households that use traditional biomass for cooking by 2015 in Nigeria appear unrealisable. Fuelwood exploitation in the six geo-political zones is markedly unsustainable as most fuelwood collectors do not replant trees to replace those removed from the forest for fuelwood. People must, therefore, be environmentally educated and encouraged to replant trees whenever they remove them in order to enhance the sustainable use of such natural resources. To this end, the introduction and cultivation of fast growing tree species should be prioritized in order to accelerate the regeneration of forests, thus avoiding large-scale deforestation, which could eventually lead to desertification and ubiquitous soil erosion. To implement these interventions successfully, the Nigerian government needs to intensify educational efforts towards environmental awareness by enlightening people on the sustainable use of energy resources, thus raising public consciousness about the challenges and benefits of biomass energy. Community-based environmental education should not only be directed at influencing the choice of household fuel, but also on the importance of cleaner cooking spaces and improved ventilation in households.

Secondly, the human health and safety implications of the results stemming from this study raise concerns around increased exposure of vulnerable people to indoor air pollutants (IAPs) due to biomass burning for energy generation purposes. The health consequences of IAPs include chronic obstructive lung disease in adults, prenatal mortality, low birth weights, asthma, and cataracts. It has been estimated that globally, 1.5 million deaths in 2002 were ascribable to air pollution and associated diseases (WHO, 2007).

Thirdly, the adoption of more efficient improved wood stoves should be promoted especially in rural areas where access to modern household energy sources like electricity, kerosene and liquefied natural gas is inadequate. The provision of low-cost energy efficient woodfuel stoves will assist in reducing excessive exploitation of wood. As a matter of fact, development work in countries such as Sudan, Kenya, Côte d'Ivoire, Malawi, Mozambique and Tanzania, has shown that the utilization of such stoves can save up to 50% of wood and charcoal. Moreover, these wood stoves have an improved combustion efficiency of 40% and have been reported to emit less particulate matter, thus reducing the risk of burns, respiratory diseases and eye irritations (Smith et al., 2007; World Bank, 2006; Malinski, 2008; Adkins et al., 2010; Kuunibe, Issahaku, & Nkegbe, 2013).

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