FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 9 No. 8, August, 2025, pp 238 – 247
DOI: https://doi.org/10.33003/fjs-2025-0908-3759

WHAT DRIVES DRINKING WATER AND SANITATION CHOICES AMONG AGRICULTURAL HOUSEHOLDS? CASE STUDY FROM NIGERIA

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ABSTRACT

Access to clean drinking water and sanitation are fundamental human rights globally. This study aimed to determine the socio-demographic and location factors influencing the agricultural households' choices of drinking water sources (DWS) and sanitation facilities in Nigeria. Data was obtained from the fourth wave of the Nigerian Living Standard Measurement Study, Integrated Survey on Agriculture (LSMS-ISA), and analysed using descriptive statistics and a multinomial logistic model. Total number of rooms in a dwelling, proximity to water sources, electricity access, household education levels, household size, gender of the household head, age of the household head, marital status, residential location, wealth index, and regional variations are among the significant factors influencing access to drinking water sources and sanitation facilities. Rural households and those in the country's North-Central region are more exposed to open defecation than their counterparts in other locations. Based on the findings, we recommend that the stakeholders intensify efforts to provide access to electricity, introduce pro-poor policies and programmes, bridge the locational disparity, and introduce deliberate policy interventions, as these can improve access to drinking water and sanitation in Nigeria.

Keywords: Drinking Water, Households, Nigeria, SDG6, Smallholder, Toilet Facilities

INTRODUCTION

Water assumes a crucial role in the existence of humans and various organisms within the environment. Devoid of water, the possibility of life on Earth diminishes. The provision of safe drinking water is recognized as an essential human entitlement and is formally acknowledged in resolutions by the United Nations (United Nations, 2010). Nevertheless, ensuring sufficient access to safe drinking water remains a significant concern for governments worldwide. The Sustainable Development Goals (SDGs) 6.1 and 6.2, established by the United Nations, set forth the objectives of attaining comprehensive and impartial access to affordable and safe drinking water for all by 2030, as well as achieving access to suitable and equitable sanitation and hygiene for all while eradicating open defecation. These goals particularly emphasize addressing the requirements of women, girls, and those in vulnerable situations by 2030. According to UNICEF/WHO (2015), an improved drinking water source is described as one constructed in a manner that effectively shields the source from external contaminants, especially faecal matter. Examples of enhanced drinking water sources encompass piped water, boreholes or tube wells, safeguarded dug wells, shielded springs, rainwater, as well as packaged or delivered water (UNICEF/WHO, 2021).

According to available data, the period from 1990 to 2015 witnessed significant progress regarding global access to improved drinking water sources (DWS). During this timeframe, approximately 91% of the worldwide population gained access to improved drinking water sources. Notably, 96% of the urban and 84% of the rural populations worldwide also gained access to improved drinking water sources within this timeframe. This remarkable advancement can be attributed to the efforts linked with the Millennium Development Goals (MDGs) introduced by the United Nations in 2000. However, it is important to acknowledge that a considerable challenge persists despite these achievements. As of 2015, more than 663 million individuals utilised water from unimproved drinking water sources (UNICEF/WHO, 2015), and more than 1.2 billion depend on water sources contaminated by faeces (UNICEF/WHO, 2021). Unimproved drinking water sources encompass various unprotected sources such as dug wells, springs, rivers, dams, lakes, ponds, streams, and canals, including irrigation canals (UNICEF/WHO, 2021). The regions most affected by inadequate access to improved water, sanitation, and hygiene sources primarily lie in developing areas, particularly sub-Saharan Africa and Southern Asia (UNICEF/WHO, 2015). Despite the progress made, the disparities in water access remain a significant concern, requiring ongoing efforts to address this critical issue.

In Nigeria, the challenge of poor access to improved water, sanitation and hygiene (WASH)facilities is still very much predominant, particularly among the rural inhabitants characterised by poor socioeconomic conditions and inadequate access to basic infrastructure facilities required for a healthy and productive life. The consumption of unsafe or contaminated water, in addition to poor personal and environmental hygiene, results in high risks of water-borne diseases, severe infections and disease epidemics, which may become particularly dangerous for the health of under-five children (Abubakar, 2019; Adams et al., 2016). Abubakar (2019) reported that more than 2000 daily death cases in SSA are attributable to poor WASH. In particular, over 30% of under-five children's mortality in Nigeria is linked to unsafe drinking water and poor sanitation. In magnitude, UNICEF (2023) reported that an estimated 70,000 Nigerian under-five children die annually from diarrhoea.

The factors affecting access to water and sanitation in Nigeria and other developing countries have been documented in the literature (Abubakar, 2019; Adams et al., 2016; Aikowe & Mazancová, 2021; Andualem et al., 2021; Behera et al., 2020; Dey et al., 2019; Fotue & Sikod, 2012; Irianti et al., 2016;

Oskam et al., 2021). For instance, Abubakar (2019) utilised the 2013 Nigeria demographic health survey (DHS) dataset to examine factors contributing to household access to drinking water. Similarly, Aikowe & Mazancová (2021) used primary data to examine factors influencing the choice of water source and barriers to water access in rural Kogi State, Nigeria.

This work contributes to the existing literature on factors influencing access to improved drinking water sources and sanitation facilities on three fronts. This study utilizes the more recent and nationally representative 2019 Living Standards Measurement Survey dataset, ensuring the relevance and accuracy of the findings compared to previous studies that relied on older (Abubakar, 2019) or state-level data (Aikowe & Mazancová, 2021; Nketiah-Amponsah et al., 2009). Secondly, we utilized the WHO/UNICEF Joint Monitoring Programme classification of drinking water sources and sanitation facilities and analysed the factors influencing household choices using a multinomial logit model. This is a departure from the binary logit regression models used in previous research (Abubakar, 2019) and allows for a nuanced examination of the multi-faceted factors influencing access, yielding a more comprehensive understanding of the complex determinants at play. Thirdly, this study also concurrently investigates access to both improved water sources and sanitation facilities instead of the singular focus on either water or sanitation evident in earlier works (Abubakar, 2019; Andualem et al., 2021; Irianti et al., 2016; Oskam et al., 2021). This dual exploration underscores the interconnected nature of water and sanitation access, shedding light on potential synergies or disparities in influencing factors. Specifically, the study achieved the following objectives. Identify various sources of drinking water sources accessible by the households. Identify various types of sanitation facilities used by households. Determine factors influencing the agricultural households choice of drinking water sources and sanitation facilities in Nigeria.

MATERIALS AND METHODS

Data and sampling

Study Area

Nigeria is geographically located in the West African region of Africa, and its capital city is Abuja. It covers a total land mass of 923,768 km² between $4^0$16′ - $13^0$53′ N latitudes and $2^0$40′ - $14^0$40′ E longitudes. Nigeria is bordered by three countries Niger Republic (north), Benin Republic (west), Cameroun (east), and the Atlantic Ocean to the south. Like many other developing countries, agriculture is the mainstay of the Nigerian economy as it contributes more than 22% to the GDP (NBS, 2022) and provides means of livelihood for a greater share of the population. In 2021, Nigeria had an estimated population of 213,401,323 people, with an annual growth rate of 2.4% and more than half (52.75%) living in urban areas (World Bank, 2023). This makes Nigeria the largest country in Africa and the seventh globally. It is projected that Nigeria's population will be the third largest by 2050, with the highest population growth rate among the top ten countries in the world (UNDESA, 2015). Nigeria is populated primarily by three ethnic groups: Igbos in the Southeast, Yorubas in the Southwest, and Hausa-Fulani in the North. Regarding administrative division, Nigeria comprises 6 geopolitical zones, 36 states, 774 local government areas, and the Federal Capital Territory (Abuja).

Data

The dataset employed in this study was acquired from wave 4 of the Nigeria General Household Survey panel (GHS-Panel). The dataset was released in 2019 as part of the ongoing regional project in sub-Saharan Africa under the Integrated Surveys on Agriculture program to improve agricultural statistics. The data were collected by the Nigerian National Bureau of Statistics (NBS) in partnership with the World Bank Living Standard Measurement (LSMS) team and with the support of the Bill and Melinda Gates Foundation (BMGF). The survey used a two-stage sampling procedure to select the participating households. The first stage involves using probability proportionate to size (PPS) to select 500 Enumeration Areas (EAs) across the states and Federal Capital Tertiary. The second stage entails using systematic random sampling to select 10 households from each selected EAs. For a random start, the total number of households in each EA was divided by 10 to calculate the sampling interval (SI). After data manipulation and cleaning exercise, a total of 4427 households' information were subjected to descriptive and inferential statistical analysis.

Variables used in the study

Dependent variable

The explained variables used in this study are access to drinking water sources and access to sanitation sources. Access to improved drinking water sources was operationalised in the questionnaire by asking, "*What is the main source of drinking water for the household?*". The household head or the representative was asked to select from sixteen different predetermined drinking water sources with an option of mentioning other sources that were not listed in the options (see Table 1). Based on the Joint Monitoring Programme (JMP) classification (UNICEF/WHO, 2021), which categorised drinking water sources into three classifications (improved facilities, unimproved facilities and surface water), we recoded the responses about the household choices of drinking water sources. The drinking water sources and their classifications are presented in Table 1.

Table 1: Distribution of Drinking Water Sources Used by the Households

Drinking Water Sources	Frequency	Percentage
Piped into dwelling^{++}	141	3.19
Piped into yard/plot^{++}	46	1.04
Piped to neighbour^{++}	22	0.5
Public tap/standpipe^{++}	158	3.57
Tube well/borehole^{++}	1,697	38.33
Protected dug well^{++}	531	11.99
Unprotected dug well**	435	9.83
Protected spring^{++}	23	0.52
Unprotected spring**	93	2.1
Rainwater collection^{++}	395	8.92
Tanker truck/water vendor^{++}	48	1.08
With small tank/drum^{++}	8	0.18

Surface water (river, stream, pond, dam, canal) *	490	11.07
Bottled water++	13	0.29
Sachet water**	315	7.12
Water kiosk++	12	0.27
Total	4,427	100

Note: * = surface water; ** = unimproved; ++ = improved

In the case of access to sanitation services, the household head or the representative was asked, "*What kind of toilet facility do members of your household usually use?*". The responses were also recoded into open defecation, unimproved and improved (see Table 2) based on the JMP ladder for sanitation (UNICEF/WHO, 2021).

Table 2: Distribution of Types of Sanitation Used by the Households

Sanitation	Frequency	Percentage
Flush to piped sewage system++!	353	7.97
Flush to septic tank++!	662	14.95
Flush to pit latrine++!	360	8.13
Flush to open drain**	7	0.16
Flush to somewhere else**	6	0.14
Ventilated improved latrine (VIP) ++!	29	0.66
Pit latrine with slab++!	1193	26.95
Pit latrine without slab/open pit**	577	13.03
Composting toilet++!	2	0.05
Hanging toilet/ hanging latrine**	73	1.65
No facilities, bush, or field*	1157	26.14
Flush to unknown place/not sure/don't know**	8	0.19
Total	4427	100

Note: * = open defecation; ** = unimproved; ++ = improved; ! facilities classified as unimproved if shared with non-household members

Furthermore, in line with the DHS classification (see Table 3), we broadened the classification of facilities as unimproved by considering facilities (flush to piped sewage system, flush to septic tank, flush to pit latrine, ventilated improved latrine (VIP), Pit latrine with slab, composting toilet) if shared with other people living outside the family (DHS Program, 2017).

Table 3: Distribution of Sanitation Facilities Shared with non-Household Members

Toilet Facility used by Household Members	Do you Share this Facility with others who are not Members of your Household?		
	Yes	No	Total
Flush to piped sewage system	112 (3.42)	241 (7.35)	353 (10.77)
Flush to septic tank	233 (7.11)	429 (13.09)	662 (20.20)
Flush to pit latrine	173(5.28)	187(5.71)	360 (10.99)
Flush to open drain	2 (0.06)	5 (0.15)	7 (0.21)
Flush to somewhere else	2 (0.06)	4 (0.12)	6 (0.18)
Ventilated improved latrine	12 (0.37)	17 (0.52)	29 (0.88)
Pit latrine with slab	346 (10.56)	847 (25.85)	1193 (36.41)
Pit latrine w/o slab/open pit	116 (3.54)	461 (14.07)	577 (17.61)
Composting toilet	1 (0.03)	1 (0.03)	2(0.06)
Hanging toilet/ hanging latrine	72 (2.20)	1 (0.03)	73 (2.23)
No facilities, bush, or field	5(0.15)	2 (0.06)	7 (0.21)
Flush to unknown place/not sure/don't know where	6 (0.18)	2(0.06)	8 (0.24)
Total	1080 (32.96)	2197 (67.04)	3277 (100.00)

Note: Percentages in parentheses

Explanatory variables

The explanatory variables used in this study are based on a review of the literature and the availability of the dataset (Abubakar, 2019; Adams et al., 2016; Fotue & Sikod, 2012; Irianti et al., 2016). The variables included are the total number of rooms in a dwelling, water time, electricity, dependency ratio, household head education, average household years of education, household size, gender, age, marital status, region, wealth index and zone (see Table 4). These variables were operationalised differently. Variables such as number of rooms, water time, dependency ratio, household head education, average household years of education, household size, age and wealth index are continuous, while electricity gender, age, marital status, region, and zone are categorical. The household wealth index was calculated using characteristics relating to household asset ownership, such as radio, washing machine, guitar, and refrigerator ownership. The wealth index was computed using principal component analysis.

Table 4: Data Description for Selected Variables (N = 4427)

Variables	Description	Mean	S.D.	Min	Max
Water time	Number of minutes taken to travel to source of water	12.685	19.603	0	240
Electricity	Dummy for access to electricity by the household (1 if yes; 0 if otherwise)	0.548	0.498	0	1
Dependency ratio	A measure of the number of dependents aged 0 to 14 and over the age of 65 compared with the total population aged 15 to 64	0.986	0.853	0	8
Years of education	Number of years of schooling of household head (years)	7.857	5.594	0	20
Average household years of education	Average years of schooling of household (years)	5.959	3.852	0	20
Household size	Number of household members	6.118	3.555	1	31
Gender	Dummy for gender of household head (male = 1)	0.853	0.354	0	1
Age	Age of household head (years)	48.602	14.477	17	99
Marital Status	Marital status of household head, 1 if married and 0 otherwise	0.794	0.405	0	1
Rooms	Number of rooms in the house	3.579	2.323	1	25
Location	Location of the household, 1 if urban and 0 if otherwise	0.321	0.467	0	1
Household wealth index	A list of non-productive assets owned by the household, such as a television, radio, and lamp, among others (index)	0.125	0.147	0	1
Northcentral	Geopolitical zone of household, 1 if Northcentral and 0 otherwise	0.168	0.374	0	1
Northeast	Geopolitical zone of household, 1 if Northeast and 0 otherwise	0.174	0.379	0	1
Northwest	Geopolitical zone of household, 1 if Northwest and 0 otherwise	0.177	0.382	0	1
Southeast	Geopolitical zone of household, 1 if Southeast and 0 otherwise	0.159	0.365	0	1
South-south	Geopolitical zone of household, 1 if South-south and 0 otherwise	0.164	0.371	0	1
Southwest	Geopolitical zone of household, 1 if Southwest and 0 otherwise	0.158	0.365	0	1

Analytical Techniques

Descriptive statistics

To analyse the socio and demographic characteristics of the respondent and the various sources of drinking water and the type of sanitation accessible, we used descriptive statistics such as means, minimum, maximum, standard deviation, frequencies, and tables.

Econometric models

As discussed earlier, the three possible categories of water sources as classified by JMP are surface water ($j = 1$), unimproved facilities ($j = 2$) and improved facilities ($j = 3$). Similarly, the possible sanitation facilities are open defecation ($j = 1$), unimproved facilities ($j = 2$) and improved facilities ($j = 3$). We employed a multinomial logit model to analyse the factors influencing households' choice of water and sanitation facilities in Nigeria.

Following Greene (2012), the models for water and sanitation choices are expressed as follows:

For water

$$Prob(Y_i = j) = \frac{e^{\beta_j X_i}}{\sum_{k=1}^{3} e^{\beta_k X_i}} \; j = 1,2,3 \qquad (1)$$

For sanitation

$$Prob(Y_i = j) = \frac{e^{\beta_j X_i}}{\sum_{k=1}^{3} e^{\beta_k X_i}} \; j = 1,2,3 \qquad (2)$$

Where:

j is the observed water (equation 1) or sanitation (equation 2) choice of the ith household

e is the exponential function

β is the vector of coefficients

X_i is the vector of independent variables defined in Table 4

In estimating equations 1 and 2, we use $j = 1$ as the base category.

Given that the estimated coefficients (βs) can only be interpreted in terms of direction and not magnitude, we estimate the marginal effects of measuring how the probability of selecting a particular water or sanitation facility changes with changes in an explanatory variable, keeping all other independent variables fixed (Greene 2012; Adetoye, Adewuyi, and Akerele 2018).

RESULTS AND DISCUSSION

Result

Descriptive Statistics

In terms of the main drinking water sources accessible by the sampled households (Table 1), 38% of the sample households have access to tube wells/boreholes, 12% have access to protected dug well, while 11%, 10% and 9% have access to surface water, unprotected well, and rainwater collections respectively. The description of sanitation facilities used by households shows that 30% used pit latrines with slabs, 26% had no toilet facilities, and, thus, used bushes or open fields, while 15% used to flush septic tanks (Table 2).

Table 3 presents the summary statistics of explanatory variables hypothesised to affect households' accessibility to drinking water sources and types of sanitation facilities. Variables such as gender, marital status, access to electricity, location, and geopolitical zones are dummies. The result shows that the sampled households, on average, have 4 rooms in their dwellings and spent an average of 13.6 minutes travelling to the nearest drinking water sources. The average age of the household heads is 48.6 years, with an average household size of 6 people and a dependency ratio of 0.99.

Also, the household head completed an average of 7.9 years of education with an average of 6 years within the household. Furthermore, the various options for drinking water sources were categorised into surface water, unimproved and improved categories, while the types of sanitation facilities were categorised as open defecation, unimproved and improved categories.

The result in Table 5 shows that nationally, 77% of the sampled households have access to improved drinking water sources (DWS), while 13% and 10% have access to unimproved DWS and surface water, respectively. The result further shows inequality in gender access to drinking water. About two-thirds (64%) of male-headed households have access to improved DWS, while only 12% of female-headed households have improved DWS. Most (95%) of the urban households had access to improved DWS, relative to 68% among rural households. However, only 38.9% of the households had access to improved sanitation facilities, and the distribution is similar among both male (39.6%) and female (34.8%) households.

Furthermore, the proportion of households using improved sanitation facilities in urban households (44.0%) was slightly higher than among rural households (36.5%). However, open defecation was much more prevalent among rural households (33.8%) than urban households (9.9%). Improved DWS are more common among households in the southwest (91.71%), southeast (90.60%) and south-south (83.91%) geopolitical zones. Although improved sanitation facilities are not as widely used as improved DWS, they are more used by households in the Northwest (49.4%), Northeast (49.6%) and Southeast (42.7%) geopolitical zones. This trend is similar to that reported by Abubakar (2018), who reported that open defecation is mostly practised in the Northcentral and southwest regions of Nigeria.

Table 5: Drinking Water Sources and Sanitation Facilities by Household Socio and Demographic Characteristics

Variables	Drinking Water Sources			Sanitation facilities		
	Surface water	**Unimproved**	**Improved**	**Open defecation**	**Unimproved**	**Improved**
National	461 (10.41)	557 (12.58)	3,409 (77.00)	1,157 (26.14)	1,548 (34.97)	1,722 (38.90)
Gender						
Female	63 (1.42)	28 (0.63)	561 (12.67)	182 (29.91)	243 (37.27)	227 (34.82)
Male	398 (8.99)	529 (11.95)	2848 (64.33)	975 (25.83)	1305 (34.57)	1495 (39.60)
Sector						
Rural	439 (14.60)	514 (17.09)	2,054 (68.31)	1016 (33.79)	895 (29.76)	1096 (36.45)
Urban	22 (1.55)	43 (3.03)	1355 (95.42)	141 (9.93)	653 (45.99)	626 (44.08)
Zone						
North Central	143 (19.19)	79 (10.60)	523 (70.20)	369 (49.53)	193 (25.91)	183 (24.56)
Northeast	92 (11.95)	172 (22.34)	506 (65.71)	135 (17.53)	253 (32.86)	382 (49.61)
Northwest	40 (5.11)	251 (32.06)	492 (62.84)	152 (19.41)	240 (30.65)	391 (49.94)
Southeast	47 (6.70)	19 (2.71)	636 (90.60)	172 (24.50)	230 (32.76)	300 (42.74)
South-south	93 (12.79)	24 (3.30)	610 (83.91)	132 (18.16)	294 (40.44)	301 (41.40)
Southwest	46 (6.57)	12 (1.71)	642 (91.71)	197 (28.14)	338 (48.29)	165 (23.57)

Note: Percentages in parentheses

Determinants of Household Access to Drinking Water Sources

The results of the multinomial logit model are presented in Tables 6 and 7. Water time, which represents the duration taken by households to complete the round trip to a water source, indicates that as the time taken for this journey increases, households are more likely to choose surface DWS rather than unimproved and improved sources. In particular, for every increase in the travel time to the water source, the probability of households selecting surface water rises by 0.1%, while the likelihood of using improved sources decreases by 0.2%. This supports assertions from previous literature (Cassivi et al., 2018; White et al., 2002) that the relationship between travel time and water use is negative and non-linear and aligns with the findings of similar studies in other African countries (Abubakar, 2019; Fotue & Sikod, 2012; Nketiah-Amponsah et al., 2009). In Cameroon, Fotue & Sikod (2012) discovered a significant inverse relationship between all types of DWS, except retailed water, and the distance to the water source. Similarly, Nketiah-Amponsah et al. (2009) concluded that the distance to the water source has a negative impact on the use of improved DWS in Ghana.

Moreover, households with access to electricity exhibit a higher inclination towards choosing improved and unimproved DWS over surface DWS. Specifically, households connected to the national grid in this study are 8.8% more likely to opt for improved DWS, while 3.2% and 5.7% are less likely to use unimproved and surface water DWS, respectively. In Nigeria, it is common for households to secure their own water supply, often through boreholes or tube wells, which are frequently powered by electric pumps. This finding is consistent with previous research conducted by Abubakar (2019) and Nketiah-Amponsah et al. (2009). Abubakar (2019) reported that 35.1% of Nigerian households use boreholes or tube wells and found that households with access to electricity are 1.5 times more likely to choose improved DWS. Similarly, Nketiah-Amponsah et al. (2009) observed a positive influence of access to electricity on various DWS options in Ghana.

This study highlights a significant disparity between urban and rural households regarding their DWS. Urban households are more likely to use unimproved and improved DWS over surface water when compared to their rural counterparts. Specifically, urban households are 10.7% more likely to use improved DWS and 6.1% less likely to rely on surface water DWS. One plausible reason for this disparity is that rural households often face limitations in both physical and economic access to improved water sources, given that most public and private water producers/suppliers are concentrated in urban areas. This finding aligns with previous studies (Abubakar, 2019; Adams et al., 2016; Irianti et al., 2016; Mulenga et al., 2017). For instance, Abubakar (2019) reported that rural households in Nigeria are 26% less likely to use improved DWS than their urban counterparts. In Ghana, Adams et al. (2016) found that urban dwellers have a 19% higher chance of accessing an improved water source than rural residents. Similarly, Irianti et al. (2016) and Mulenga et al. (2017) concluded that urban households in Indonesia and Zambia, respectively, are more likely to have access to improved DWS compared to their rural counterparts.

However, the result reveals certain associations between household size and different water sources (DWS). Specifically, the findings indicate that larger household sizes positively correlate with choosing surface water as the primary DWS option and negatively correlate with opting for unimproved and improved DWS categories. In other words, as the number of household members increases, there is a 0.2% higher likelihood of selecting surface water over other DWS options. One potential explanation for this outcome is that larger households can deploy their members to fetch water freely from open sources without incurring any associated costs. This may make surface water more appealing and accessible for them compared to other potentially improved DWS alternatives. This position is corroborated by Adams et al. (2016), who also observed a negative relationship between household size in Ghana and the use of improved DWS. Conversely, the result contradicts other findings from the literature, such as those presented by Irianti et al. (2016) in Indonesia. According to their study, an additional household member in Indonesia increased the odds of using improved DWS. The differences between these findings may be attributed to variations in cultural practices, geographical contexts, and water resource availability between the regions studied.

The result indicates that education and household wealth significantly influence households' drinking water choices. An increase in the average household education positively impacts the likelihood of using improved DWS over surface DWS. Specifically, for every additional year of education, there is a corresponding 0.8% increase in the probability of utilising improved DWS, while there is a decrease of 0.4% in using unimproved and surface water. Similarly, wealthier households demonstrate a preference for improved DWS over surface water. The result reveals that wealthy households have a 34.0% likelihood of using improved DWS, with 20.9% and 13.1% chances of using unimproved and surface DWS, respectively. Educated households are more informed about the potential risks associated with surface water or unimproved DWS, leading them to prefer improved DWS. Additionally, their access to well-paid jobs in the public or private sectors may enhance their ability to afford improved DWS for personal use. This finding aligns with the previous studies conducted in Nigeria (Abubakar, 2019), Ghana (Adams et al., 2016; Nketiah-Amponsah et al., 2009), Cameroon (Fotue & Sikod, 2012), Indonesia (Irianti et al., 2016), Uganda (Tumwebaze et al., 2023) and South Africa (Oskam et al., 2021).

The analysis further reveals that households in the northeast, northwest, and southeast regions exhibit a higher tendency to select improved and unimproved DWS over surface water relative to households in the southwest region (which serves as the reference category). On the other hand, households in the northcentral region are more likely to opt for unimproved DWS and less likely to use improved DWS over surface water when compared to households in the southwestern region.

Table 6: Multinomial Logit Estimation Result for the Factors Influencing the Household Choice of Drinking Water Sources

Variables	Unimproved		Improved	
Rooms	0.031	(0.037)	0.053*	(0.030)
Water time	-0.025***	(0.003)	-0.031***	(0.003)
Access to electricity	0.644***	(0.199)	1.224***	(0.159)
Dependency ratio	0.113	(0.093)	0.039	(0.078)
Household head education	0.005	(0.021)	0.015	(0.017)
Average household education	0.028	(0.037)	0.102***	(0.029)
Household size	-0.043*	(0.023)	-0.043**	(0.019)
Gender	0.322	(0.355)	-0.398	(0.254)
Age	-0.008	(0.005)	-0.007	(0.004)
Marital status	-0.128	(0.298)	0.037	(0.233)
Location	0.821***	(0.297)	1.749***	(0.246)
Wealth index	-0.363	(1.295)	3.251***	(0.983)
Northeast	2.531***	(0.374)	0.894***	(0.235)
Northcentral	1.008***	(0.370)	-0.468**	(0.222)
Northwest	3.519***	(0.388)	1.343***	(0.263)
Southeast	0.727*	(0.440)	0.712***	(0.253)
South-south	0.185	(0.415)	-0.383	(0.234)
Constant	-1.240**	(0.512)	1.323***	(0.345)
LR chi2(34)	1603.36			
Prob > chi2	0.0000			
Pseudo R2	0.2596			
Log-likelihood	-2286.5338			
Observations	4427			

Note: In the model, dependent variable: drinking water sources (surface water = 1 (base category); unimproved = 2; improved = 3). Excluded category: Southwest. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7: Results of the Marginal Effects on the Factors Influencing the Household Choice of Drinking Water Sources

Variables	Surface water		Unimproved		Improved	
Rooms	-0.002*	(0.001)	-0.001	(0.002)	0.003	(0.002)
Water time	0.001***	(0.000)	0.000	(0.000)	-0.002***	(0.000)
Access to electricity	-0.057***	(0.009)	-0.032***	(0.009)	0.088***	(0.013)
Dependency ratio	-0.002	(0.003)	0.005	(0.004)	-0.003	(0.006)
Household head education	-0.001	(0.001)	-0.001	(0.001)	0.001	(0.001)
Average household education	-0.004***	(0.001)	-0.004**	(0.002)	0.008***	(0.002)
Household size	0.002**	(0.001)	-0.000	(0.001)	-0.002	(0.001)
Gender	0.014	(0.009)	0.035***	(0.011)	-0.049***	(0.015)
Age	0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)
Marital status	-0.001	(0.010)	-0.010	(0.015)	0.011	(0.019)
Location	-0.061***	(0.007)	-0.046***	(0.009)	0.107***	(0.011)
Wealth index	-0.131***	(0.041)	-0.209***	(0.053)	0.340***	(0.067)
Northeast	-0.035***	(0.006)	0.166***	(0.045)	-0.131***	(0.045)
Northcentral	0.014	(0.012)	0.136***	(0.042)	-0.150***	(0.042)
Northwest	-0.047***	(0.006)	0.255***	(0.054)	-0.209***	(0.054)
Southeast	-0.025***	(0.008)	0.003	(0.024)	0.023	(0.025)
South-south	0.016	(0.012)	0.039	(0.030)	-0.055*	(0.032)
Observations	4,427					

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Determinants of Household Access to Sanitation Facilities

The outcomes of the multinomial logit regression model concerning household access to sanitation facilities in Nigeria are presented in Tables 8 and 9. The findings indicate socioeconomic and demographic factors influence household access to sanitation facilities. Access to electricity exhibits a significant and positive association with unimproved and improved sanitation practices. This suggests that households with electricity access are more inclined to utilise unimproved and improved sanitation facilities instead of resorting to open defecation. The outcomes of the marginal effect analysis reveal that being connected to the national electricity grid raises the likelihood of employing unimproved sanitation facilities and improved sanitation facilities by 7.7% and 9.1%, respectively, while concurrently reducing the likelihood of engaging in open defecation by 16.7%. This outcome underscores the advantage households with electricity access possess in adopting improved sanitation amenities like flush-to-piped sewage systems, flush-to-septic tanks, flush-to-pit latrines, ventilated improved latrines (VIP), and others. These facilities require a consistent water supply, often sourced from boreholes that rely on electricity for pumping. This finding aligns with the conclusions drawn by Abubakar (2018), who reported that households with electricity access in Nigeria are less likely to practice open defecation when compared to those without such access.

Education positively and significantly affects households' choice of sanitation facility. The results show that households with more educated household heads are more likely to use improved and unimproved sanitation facilities instead of open defecation. Each additional year of education attained by the household head contributes to a 0.6% increase in the likelihood of using improved sanitation facilities and a corresponding 0.6% decrease in the likelihood of resorting to open defecation. Furthermore, the cumulative years of education within the household also hold a substantial and positive influence on the likelihood of selecting improved sanitation options over open defecation. This implies that as the members of a household complete more years of education, the likelihood of choosing improved and unimproved sanitation facilities over open defecation rises by 2.4% and 1.4%, respectively. These findings underscore the pivotal role of education in shaping the preference for sanitation facilities within households. Households with higher levels of education tend to be more cognizant of the health risks associated with inadequate sanitation and the environmental benefits of utilising improved sanitation facilities. This is consistent with the conclusions drawn from prior research conducted in Nigeria (Abubakar, 2018) and other countries, including Ghana (Adams et al., 2016), Ethiopia (Andualem et al., 2021) and Nepal (Behera et al., 2020).

Moreover, the household wealth index variable, which gauges household affluence through a composite assessment of possessions such as radio ownership, washing machines, guitars, refrigerators, and more, exerts a significant and positive influence on the household choice of sanitation methods in Nigeria. Wealthier households are more likely to opt for improved and unimproved sanitation facilities, favouring them over open defecation. This is unsurprising given that wealthier households have the financial capacity to bear the initial costs associated with installing improved sanitation facilities, as well as recurrent costs of maintaining them (such as water costs) — a financial challenge that could be more daunting for poor households. Furthermore, adopting improved sanitation can be regarded as a marker of affluence or elevated social status within society, especially in rural areas. This finding aligns concordantly with the conclusions drawn by Adams et al. (2016), Behera et al. (2020), and Andualem et al. (2021).

The "location" variable captures whether a household resides in an urban or rural setting and exhibits a positive and significant correlation with unimproved and improved sanitation practices. The results suggest that urban households possess a 1.43% higher likelihood of adopting improved sanitation facilities, a 0.13% higher likelihood of using unimproved sanitation facilities and a reduced probability of 1.56% for practising open defecation relative to their rural counterparts. This outcome aligns with prior research findings in the existing literature (Abubakar, 2018; Adams et al., 2016; Andualem et al., 2021). The plausible rationales behind this disparity can be attributed to the predominant engagement of the sampled households in agriculture as their primary livelihood source. This context is particularly pertinent in rural areas where economic returns are typically lower, potentially limiting the financial capacity to afford improved sanitation facilities. Additionally, the multidimensional poverty prevalent in rural households, stemming from low living standards and multiple deprivations, contrasts with the relatively higher living standards of urban counterparts (Aminu et al., 2022). This disparity in living standards can further contribute to the inclination of urban households to adopt improved sanitation practices compared to their rural counterparts.

Furthermore, households with a higher number of economically dependent members are more likely to use improved sanitation relative to open defecation, plausibly because working-age members may tend to prioritise the health and well-being of their economically dependent members (children and old members). In this vein, such households might opt to invest in improved sanitation facilities to safeguard their members against the risks of communicable diseases arising from the utilisation of unimproved facilities or open defecation. In addition, female-headed households are more likely to use improved sanitation facilities than male-headed households, supporting the hypothesis that women tend to prioritise domestic hygiene more than men. This position is well supported in the literature as reported in studies conducted in Ghana (Adams et al., 2016), Ethiopia (Andualem et al., 2021), Nepal (Behera et al., 2020) and Pakistan (Akter et al., 2022).

Other variables such as age, marital status and number of rooms also significantly influence household choice of sanitation facilities. The results show that an increase in the age of the household head is associated with a higher likelihood of opting for improved sanitation compared to open defecation. This could be because as household heads advance in age, there is an observable inclination towards heightened concern for health status, thereby favouring the adoption of improved sanitation facilities over unimproved options and open defecation practices. This pattern resonates with the findings of Akter et al. (2022), who established that age significantly influenced the preference for improved sanitation in both Bangladesh and Pakistan. Also, consistent with previous research, the household head's marital status is positively associated with the use of improved sanitation facilities relative to open defecation. For example, Akpakli et al. (2018) found that married households in Ghana are more likely to use improved toilet facilities, while Koskei et al. (2013) also found a similar result in Kenya. A possible explanation for this is that married people are able to pool resources which could enable them to afford to install improved sanitation facilities compared to single people.

The results also suggest that as the number of rooms increases, households are likely to opt for improved sanitation options. For each additional room added to a household dwelling, the probability of utilising improved sanitation increases by 5%, while the probabilities of using unimproved sanitation and engaging in open defecation decrease by 4% and 1%, respectively. These findings align with the conclusions drawn by Abubakar (2018), which indicated that an increased total room count within a household dwelling significantly correlates with a reduced likelihood of practising open defecation. Lastly, across the regions, households in the northeast, northwest, southeast, and south-south regions have a greater likelihood of using improved and unimproved sanitation facilities relative to open defecation. These findings closely align with earlier research studies documented within the existing literature (Abubakar, 2018; Adams et al., 2016; Andualem et al., 2021; Behera et al., 2020).

Table 8: Multinomial Logit Estimation Result for the Factors Influencing Household Access to Sanitation Facilities

Variables	Unimproved		Improved	
Rooms	-0.043	(0.027)	0.180***	(0.025)
Water time	-0.001	(0.002)	-0.001	(0.002)
Access to electricity	1.107***	(0.113)	1.084***	(0.123)
Dependency ratio	-0.007	(0.064)	0.162**	(0.067)
Household head education	0.035**	(0.014)	0.049***	(0.015)
Average household education	0.024	(0.022)	0.117***	(0.024)
Household size	0.005	(0.017)	-0.013	(0.017)
Gender	-0.185	(0.181)	-0.943***	(0.208)
Age	-0.001	(0.004)	0.012***	(0.004)
Marital status	-0.128	(0.165)	0.613***	(0.192)
Location	1.349***	(0.135)	1.055***	(0.147)
Wealth index	4.461***	(0.727)	8.817***	(0.749)
Northeast	2.155***	(0.189)	3.996***	(0.218)
Northcentral	-0.194	(0.165)	0.408**	(0.198)
Northwest	1.925***	(0.189)	3.842***	(0.217)
Southeast	0.752***	(0.173)	1.873***	(0.198)
South-south	1.129***	(0.175)	1.796***	(0.202)
Constant	-1.682***	(0.274)	-5.311***	(0.320)
LR chi2(34)	2157.20			
Prob > chi2	0.0000			
Pseudo R2	0.2245			
Log-likelihood	-3726.5149			
Observations	4,427			

Note: In the model, dependent variable: sanitation facilities (open defecation = 1 (baseline group); unimproved = 2; improved = 3). Excluded category: Southwest. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 9: Results of the Marginal Effects on the Factors Influencing Household Sanitation Choices

Variables	Open defecation		Unimproved		Improved	
Rooms	-0.010***	(0.003)	-0.041***	(0.005)	0.050***	(0.005)
Water time	0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)
Access to electricity	-0.167***	(0.018)	0.091***	(0.021)	0.077***	(0.022)
Dependency ratio	-0.011	(0.009)	-0.029**	(0.013)	0.040***	(0.013)
Household head education	-0.006***	(0.002)	0.000	(0.003)	0.006**	(0.003)
Average household education	-0.010***	(0.003)	-0.014***	(0.004)	0.024***	(0.004)
Household size	0.000	(0.002)	0.003	(0.003)	-0.004	(0.003)
Gender	0.077***	(0.020)	0.122***	(0.033)	-0.199***	(0.039)
Age	-0.001	(0.000)	-0.002***	(0.001)	0.003***	(0.001)
Marital status	-0.029	(0.025)	-0.130***	(0.032)	0.159***	(0.031)
Location	-0.156***	(0.015)	0.143***	(0.022)	0.013	(0.023)
Wealth index	-0.969***	(0.094)	-0.395***	(0.099)	1.364***	(0.104)
Northeast	-0.255***	(0.011)	-0.249***	(0.027)	0.504***	(0.028)
Northcentral	-0.018	(0.023)	-0.114***	(0.032)	0.133***	(0.039)
Northwest	-0.248***	(0.011)	-0.264***	(0.026)	0.512***	(0.027)
Southeast	-0.149***	(0.014)	-0.167***	(0.029)	0.316***	(0.033)
South-south	-0.158***	(0.014)	-0.069**	(0.032)	0.227***	(0.035)
Observations	4,427					

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

CONCLUSION

Access to clean drinking water and sanitation are fundamental global human rights. However, the lack of household access to basic amenities could lead to grave health and environmental risks. This study aimed to decipher the socio-demographic factors influencing the households' choices of drinking water sources (DWS) and sanitation facilities in Nigeria. The study shows that a substantial proportion of Nigerian households have access to improved drinking water sources and sanitation facilities. However, gender, regional and urban-rural disparity in accessing DWS and sanitation facilities which could exacerbate the burden of diseases linked to inadequate water and sanitation, were observed. Key variables influencing access to drinking water and sanitation facilities include household education level, electricity access, household wealth, urban-rural and regional location.

RECOMMENDATIONS

Based on the findings from this study, several recommendations are proposed. Firstly, stakeholders should intensify efforts to extend electricity access to off-grid populations, mitigating environmental and health risks by ensuring improved access to drinking water and sanitation facilities. Secondly, pro-poor policies and initiatives should be introduced to aid impoverished households in constructing toilets and accessing enhanced drinking water sources, thereby curbing open defecation. Thirdly, urgent attention should be directed towards reducing regional disparities in the availability of improved water sources and sanitation amenities, focusing on enhancing infrastructure in rural areas to achieve equitable access. Furthermore, the study's data highlights the influence of household size on water source preferences, revealing that larger households tend to opt for surface water over other DWS alternatives. The implications of these findings warrant deeper exploration and contextual analysis to better comprehend the underlying rationales. Finally, considering the study's reaffirmation of the significance of education and economic status in households' choices of drinking water sources, deliberate policy interventions should be pursued to uplift living standards in Nigeria.

REFERENCES

Abubakar, I. R. (2018). Exploring the determinants of open defecation in Nigeria using demographic and health survey data. *Science of the Total Environment*, *637–638*, 1455–1465. https://doi.org/10.1016/j.scitotenv.2018.05.104

Abubakar, I. R. (2019). Factors influencing household access to drinking water in Nigeria. *Utilities Policy*, *58*(April), 40–51. https://doi.org/10.1016/j.jup.2019.03.005

Adams, E. A., Boateng, G. O., & Amoyaw, J. A. (2016). Socioeconomic and Demographic Predictors of Potable Water and Sanitation Access in Ghana. *Social Indicators Research*, *126*(2), 673–687. https://doi.org/10.1007/s11205-015-0912-y

Adetoye, A. M., Adewuyi, S. A., & Akerele, D. (2018). Determinants of forest land use decisions among rural farm households in south-western Nigeria. *Agricultura Tropica et Subtropica*, *51*(2), 83–91. https://doi.org/doi:10.2478/ats-2018-0009

Aikowe, J. O., & Mazancová, J. (2021). Barriers to water access in rural communities: Examining the factors influencing water source choice. *Water (Switzerland)*, *13*(19). https://doi.org/10.3390/w13192755

Akpakli, D. E., Manyeh, A. K., Akpakli, J. K., Kukula, V., & Gyapong, M. (2018). Determinants of access to improved sanitation facilities in rural districts of southern Ghana: Evidence from Dodowa Health and Demographic Surveillance Site. *BMC Research Notes*, *11*(1), 1–7. https://doi.org/10.1186/s13104-018-3572-6

Akter, M., Khan, M., Beg, T. H., & Sarker, M. M. R. (2022). Determinants of Adapted Improved Sanitation in Rural and Urban of Bangladesh and Pakistan. *Asian Journal of Agricultural Extension, Economics & Sociology*, *40*(9), 398–410. https://doi.org/10.9734/ajaees/2022/v40i931020

Aminu, R. O., Si, W., Ibrahim, S. B., Arowolo, A. O., & Ayinde, A. F. O. (2022). Impact of socio and demographic factors on multidimensional poverty profile of smallholder arable crop farmers – evidence from Nigeria. *International Journal of Social Economics*, *49*(1), 107–123.

https://doi.org/10.1108/IJSE-12-2020-0834

Andualem, Z., Dagne, H., Azene, Z. N., Taddese, A. A., Dagnew, B., Fisseha, R., Muluneh, A. G., & Yeshaw, Y. (2021). Households access to improved drinking water sources and toilet facilities in Ethiopia: A multilevel analysis based on 2016 Ethiopian Demographic and Health Survey. *BMJ Open*, *11*(3). https://doi.org/10.1136/bmjopen-2020-042071

Behera, B., Rahut, D. B., & Sethi, N. (2020). Analysis of household access to drinking water, sanitation, and waste disposal services in urban areas of Nepal. *Utilities Policy*, *62*(May 2019), 100996. https://doi.org/10.1016/j.jup.2019.100996

Cassivi, A., Dorea, C. C., Johnston, R., & Waygood, E. O. D. (2018). Access to drinking water: Time matters. *Journal of Water and Health*, *16*(4), 661–666. https://doi.org/10.2166/wh.2018.009

Dey, N. C., Parvez, M., Islam, M. R., Mistry, S. K., & Levine, D. I. (2019). Effectiveness of a community-based water, sanitation, and hygiene (WASH) intervention in reduction of diarrhoea among under-five children: Evidence from a repeated cross-sectional study (2007–2015) in rural Bangladesh. *International Journal of Hygiene and Environmental Health*, *222*(8), 1098–1108. https://doi.org/10.1016/j.ijheh.2019.08.006

DHS Program. (2017). *New data available from DHS-7 Questionnaire: WASH Indicators*. The DHS Program Blog. https://blog.dhsprogram.com/dhs7-wash/

Fotue, L. A. T., & Sikod, F. (2012). Determinants of the households' choice of drinking water source in Cameroon. *Journal of Sustainable Development in Africa*, *14*(3), 86–97.

Greene, W. H. . (2012). Econometric Analysis. In *Prentice Hall* (7th Editio, Vol. 97). Prentice Hall. www.pearsoned.co.uk

Irianti, S., Prasetyoputra, P., & Sasimartoyo, T. P. (2016). Determinants of household drinking-water source in Indonesia: An analysis of the 2007 Indonesian family life survey. *Cogent Medicine*, *3*(1), 1151143. https://doi.org/10.1080/2331205x.2016.1151143

Koskei, E. C., Koskei, R. C., Koske, M. C., & Koech, H. K. (2013). Effect of Socio-economic Factors on Access to Improved Water Sources and Basic Sanitation in Bomet Municipality, Kenya. *Research Journal of Environmental and Earth Sciences*, *5*(12), 714–719. https://doi.org/10.19026/rjees.5.5727

Mulenga, J. N., Bwalya, B. B., & Kaliba-Chishimba, K. (2017). Determinants and inequalities in access to improved water sources and sanitation among the Zambian households. *International Journal of Development and Sustainability*, *6*(8), 746–762. www.isdsnet.com/ijds

NBS. (2022). *Nigerian Gross Domestic Product Report (Q1 2022)* (Vol. Q1, Issue 2). https://nigerianstat.gov.ng/download/1241175

Nketiah-Amponsah, E., Aidam, P. W., & Senadza, B. (2009). Socio-economic Determinants of Sources of Drinking Water: Some Insight from Ghana. *Conference on International Research on Food Security, Natural Resource Management and Rural Development Held at University of Hamburg, October 6-8, 2009*, 1–4. https://www.tropentag.de/2009/abstracts/full/185.pdf

Oskam, M. J., Pavlova, M., Hongoro, C., & Groot, W. (2021). Socio-economic inequalities in access to drinking water among inhabitants of informal settlements in south africa. *International Journal of Environmental Research and Public Health*, *18*(19). https://doi.org/10.3390/ijerph181910528

Tumwebaze, I. K., Sseviiri, H., Bateganya, F. H., Twesige, J., Scott, R., Kayaga, S., Kulabako, R., & Howard, G. (2023). Access to and factors influencing drinking water and sanitation service levels in informal settlements: Evidence from Kampala, Uganda. *Habitat International*, *136*(January), 102829. https://doi.org/10.1016/j.habitatint.2023.102829

UNDESA. (2015). *The World Population Prospects: 2015 Revision*. The World Population Prospects. https://www.un.org/en/development/desa/publications/world-population-prospects-2015-revision.html

UNICEF/WHO. (2015). *Progress on Sanitation and Drinking Water - 2015 Update and MDG Assessment*.

UNICEF/WHO. (2021). *Progress on Household Drinking Water, Sanitation And Hygiene 2000 - 2020: Five Years into the SDGs WHO/UNICEF*.

United Nations. (2010). UN General Assembly Resolution - The human right to water and sanitation The. In *Resolution adopted by the General Assembly A/RES/64/2*. United Nations. https://doi.org/10.1007/978-90-6704-569-8_33

White, G. F., Bradley, D. J., & White, A. U. (2002). Drawers of water: domestic water use in East Africa. 1972. *Bulletin of the World Health Organization*, *80*(1), 62–63. https://apps.who.int/iris/handle/10665/268615

World Bank. (2023). *Nigeria*. Data. https://data.worldbank.org/country/nigeria