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# Access to Sanitation Facilities among Nigerian Households: Determinants and Sustainability Implications

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**Abstract:** Access to improved sanitation facilities is key to the socioeconomic wellbeing and sustainable development of any society. This study examines access to sanitation facilities in Nigeria and explores the socioeconomic and locational factors that influence the type of facility used by households. The study utilizes cross-sectional data from the 2013 Nigeria Demographic and Health Survey, and employs descriptive and inferential statistics for data analyses. The results indicated that 44.2% of households used various kinds of pit latrines, followed by toilets that flush to septic tanks (10.3%). While only 5.3% of the respondents used toilets that connect to sewer systems, about a third (31.5%) lacked sanitation facility and the remaining 8.7% used other types of sanitation facilities. Results from chi-square analysis and ANOVA revealed significant statistical differences between the type of sanitation facility households used and their place of residence, geopolitical zone, ethnicity, educational attainment and wealth. Multivariate regression results indicated that the type of household sanitation facility is significantly associated with the mentioned factors as well as household size, gender of the head of the household, type of water sources, number of rooms and access to electricity. Age of the head of the household and type of cooking fuel used were not significant. The study concludes by underscoring the implications of using unimproved sanitation facilities on human health and environmental sustainability.

**Keywords:** sanitation facility; toilets; households; access; environment; sustainability

## 1. Introduction

Improving public access to sanitation services in a rapidly urbanizing world is an increasingly important, yet challenging issue for governments, international development agencies, urban planners, and sanitation practitioners. Sanitation is here defined as a system that promotes proper disposal of human and animal waste for improving and protecting public and environmental health. An improved sanitation facility is that which hygienically separates excreta from human contact, and is used by only members of one household: toilets flushing to sewer systems or septic tanks, ventilated improved pit (VIP) latrines, pit latrines with a slab, and composting toilets [1]. However, about 32% of the global population, or about 2.4 billion people, do not have access to improved sanitation. Of these, about 1 billion people defecate in the open [2]. Indeed, most countries have not achieved Target 10 of the Millennium Development Goals (MDG), which involved halving the proportion of people lacking sustainable access to basic sanitation, by close to three-quarters of a billion people [2]. In 2015, 62% of the population in the least developed countries relied on unimproved sanitation facilities (pit latrines without a slab, flush to pit latrines or to somewhere else, and bucket and hanging toilets), shared facilities, or defecation in the open [1].

In sub-Saharan Africa, the picture is quite gloomy. Some 700 million people or about 63.6% of the population lacked access to improved sanitation in 2015 [1]. While the region's population has nearly doubled from 1990 to 2015, access to improved sanitation has increased by only six percentage points within the same period, making it the region with the lowest sanitation coverage (37%) on the planet [1]. Nigeria, a nation of about 186 million people as of 2016, forms Africa's largest economy, with a GDP valued at USD\$1.1 trillion in 2015 [3]. Here, access to improved sanitation declined from 38% of the population in 1990 to 29% in 2015. Within the same period, the proportion of the population defecating in the open has increased from 24% to 25% [1], despite increased oil revenues from 2005 to 2012. According to the 2013 Demographic and Health Surveys (DHS), 30.1% of Nigerian households used improved sanitation facilities that were not shared with other households (25.1% in rural areas and 36.6% in urban areas), while 39.9% and 15.5% of rural and urban households, respectively, lacked access to sanitation facilities and thereby defecated in the open ([4], p. 13).

The negative impact of poor sanitation on human and environmental health has been widely acknowledged and includes exposure to acute excreta-related illness such as diarrhea, cholera, dysentery, typhoid, and hepatitis A, contamination of drinking water sources, environmental degradation, and contributes to malnutrition and poor school attendance in children [5–9]. Whereas inadequate sanitation is estimated to cause 280,000 diarrheal deaths annually across the globe, about 2800 people die daily from illnesses related to inadequate sanitation, poor hygiene and unsafe water in Africa [8]. In Nigeria, children under 5 years old have a 38% higher risk of dying from lack of improved sanitation and water sources [9].

The importance of sanitation in improving the wellbeing of citizens and promoting sustainable development is also reflected in the United Nation's formal acknowledgement of access to safe sanitation as a human right in 2012 and the adoption of the Sustainable Development Agenda (SDA) in 2015, in which Goal 6.2 called for universal access to adequate and equitable sanitation and hygiene by 2030 [10]. However, achieving this noble Goal is not possible without a much sharper focus on disparities in access to sanitation between regions and groups—such as urban and rural groups, rich and poor, males and females, or disadvantaged groups such as minority ethnic groups and less educated people versus the general population. Identifying inequalities where they occur and understanding their determining factors allows targeted interventions towards achieving the Goal.

Many studies on household access to different types of sanitation facilities and factors that influence facility access have been conducted in some developing countries. These include nationwide studies in Indonesia [11], Yemen [12] and Ghana [13], in rural communities in China [14], southern Ethiopia [15], and Tanzania [16], and in urban settings in Kenya [17] and Uganda [18]. A review of the existing literature indicates a relationship between access to different types of sanitation facilities and educational attainment [13,15–17], income/wealth [12–16,19], age [16], gender [13,16], household size [13,14], access to electricity [12], housing condition [19] and geographical factors such as regions [13] and living in rural/urban areas [12].

However, in Nigeria, there are few national-level studies on access to sanitation facilities and factors that influence the types of facilities used by households, which include the Nigeria DHS (NDHS) and UNICEF/WHO Joint Monitoring Program (JMP) reports. However, while the JMP report does not go beyond providing breakdown of (un)improved sanitation data by rural/urban areas, the NDHS report assesses types of sanitation facilities by place of residence and regions, without exploring the influence of factors such as ethnicity, educational attainment, and wealth on access. On the other hand, the sub-national studies were based on sample sizes of 200–250, conducted in single communities, and have considered only few variables as determinants of sanitation facility usage [19,20]. Yet, examining socioeconomic and demographic factors that influence disparity in and determine access to household sanitation facilities could help identify and understand areas within the nation that need government intervention and assistance. A thorough search of available literature yielded only one unpublished national-level study on the subject, which analyzed access to improved sanitation facilities between urban and rural areas, but without exploring how socioeconomic,

demographic and locational factors influence access levels within different types of (un) improved facilities [21]. Similarly, wealth was used as dichotomous variable (poor or non-poor), without considering how poorer, richer and middle income groups differ from the two groups used. Thus, this paper, conceived to build upon these previous studies, has the following specific objectives:

- (1) To examine the trend in access to improved sanitation facilities in Nigeria;
- (2) To assess whether there is any significant difference in household access to sanitation facilities by place of residence, geopolitical zones, ethnicity, educational level, and wealth;
- (3) To explore which socioeconomic factors determine the types of sanitation facility used by households.

## 2. Materials and Methods

### 2.1. Study Area

Nigeria, with a total land area of 923,768 km<sup>2</sup> is the 14th largest country in Africa and represents about one-seventh the size of West Africa. Its population density is about 197 persons per km<sup>2</sup>, which is five times the African average of 39 persons per km<sup>2</sup> [22]. The nation's climate varies: arid in the north, tropical in the central and equatorial in the south. There are two distinct seasons in Nigeria: the wet season which lasts from April to October and the dry season which lasts from November to March in most parts of the country [4]. The vegetation consists of mangrove swamp forest in the south, Guinea savanna in the central and Sahel grassland in the north.

With an estimated population of 182.2 million (with about 48% living in urban areas) in 2015, Nigeria is the most populous country in Africa and seventh most populous country in the world. By 2050 the population is projected to reach about 398.5 million, thus becoming the third largest country in the world after India and China [22]. Nigeria's current urbanization rate of around 4.66% per annum is almost twice the national population growth rate of 2.44% [3]. Nigeria, with an estimated GDP of USD\$1.1 trillion in 2015, is the largest economy in Africa, followed by South Africa and Egypt [3]. While there are over 200 ethnic groups in Nigeria, Hausa, Yoruba and Igbo are three main groups that constitute 68% of the country's total population [3]. There are currently 774 local government areas (LGAs) in the country, which are political administrative units under the state governments. As shown in Figure 1, there are 36 states plus the Federal Capital Territory (FCT) in the country that are grouped into six geopolitical zones: North West, North East, North Central, South West, South South and South East. In Nigeria, an urban area refers to a settlement with at least 20,000 people that earn their livelihood from mainly non-agricultural activities.

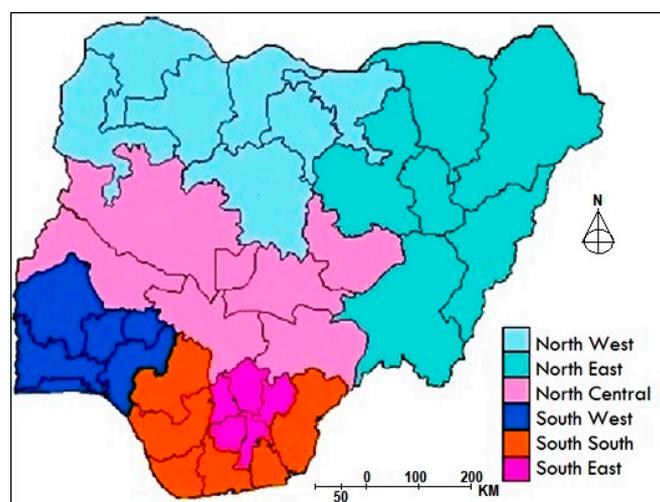


Figure 1. Nigeria's six geopolitical zones.

## 2.2. Data Sources and Analyses

The data utilized in the present study were obtained from two sources. First, the data used in Section 3.1 for meeting the first objective of the study were extracted from the 2016 World Development Indicators data [22]. Data from 1995 to 2015, which is the most current data point, were included in the analysis. To allow comparison of trend before and after the introduction of the MDGs, data from 1995 were used as the year represents the first data point before MDGs. The data in excel format can be downloaded from the World Bank website: [http://databank.worldbank.org/data/download/WDI\\_excel.zip](http://databank.worldbank.org/data/download/WDI_excel.zip) (accessed on 12 February 2017).

Second, to achieve the second and third objectives of the paper, the 2013 Nigeria Demographic and Health Surveys (NDHSs) household dataset was used, being the most current. The NDHSs were conducted from February to July 2013 by the National Population Commission, Nigeria and International Classification of Functions (ICF) International, USA, with financial and technical assistance from the Measure DHS Program [4]. While DHS reports can be obtained from the websites of NPC or the National Bureau of Statistics, the dataset in SPSS or Stata formats is available upon request from the DHS Program website: <https://dhsprogram.com/data/available-datasets.cfm/> (accessed on 12 February 2017). To obtain NDHS data, the author applied for permission on the agency's website indicating the country data requested and the reason. Access was later granted via email in the form of username and password which enabled the dataset to be downloaded.

The 2013 NDHS are nationally-representative cross-sectional surveys of 40,680 sampled households, selected based on a stratified multi-stage cluster sampling technique. In Nigeria, each LGA (sub-unit of a state) is divided into wards/localities and each ward is further subdivided into enumeration areas, based the 2006 national population census. These administrative divisions formed the strata used in the sampling procedure, with enumeration areas serving as sampling clusters. A total of 904 clusters were selected nationwide out of which 45 households were randomly selected from each cluster using a census list of households as a sampling frame. Appendix B of the 2013 NDHS report provides further details about the survey design and the sampling procedure ([4], pp. 377–383). The relevant question trained interviewers asked respondents was, “what kind of toilet facility do members of your household usually use?” and were given close-ended options to choose from types of facilities, ranked based on their hygienic nature, from toilets that flush to sewer systems, then those which flush to septic tanks, through to the last option, which is open defecation ([4], p. 423). The complete questionnaire used in the survey is available in Appendix F of NDHS report ([4], pp. 410–537).

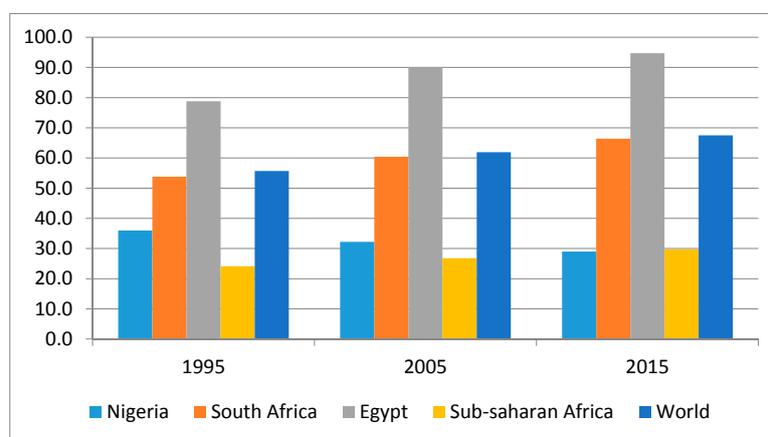
To meet the specified study objectives, the datasets were analyzed using descriptive (frequency and percentage) and inferential statistics (chi-square, ANOVA, *t*-test and multivariate regression) with the help of SPSS© 20 software (International Business Machines Corp: New York, NY, USA). A probability level of at least 0.05 was used for all tests of significance. Indicators of household access to sanitation facilities include household size, place of residence (rural/urban), geopolitical zone, housing condition, and socioeconomic and demographic variables such wealth index and ethnicity, as well as the age, gender, and highest level of education of the household head. According to NDHS, a household consists of persons living in the same dwelling and eating from the same pot.

## 3. Results

This section presents the study findings per the three objectives of the study. It examines the trend in the proportion of Nigerians with access to improved sanitation. Next, it assesses the relationships between types of household sanitation facilities and socioeconomic and locational factors. Then, it explores whether these factors can predict the types of sanitation facilities households use.

### 3.1. Trend in the Proportion of Population with Accesses to Improved Sanitation in Nigeria

Figure 2 shows the percentage of populations with access to improved sanitation in Nigeria, in comparison with South Africa and Egypt (the second and third largest economies in Africa), and the sub-Saharan African and global averages, from 1995 to 2015. Within the two decades under review, access to improved sanitation facilities in Nigeria declined from 36.0% of the population in 1995 to 32.2% in 2005, while the global average jumped from 56% to 62% and the sub-Saharan African average increased from 24% to 27%. The proportion further declined to around 29.0% in 2015, when the global average reached 68% and that of Sub-Saharan Africa reached 30%. This was the time when the population of the country increased by more than a half; from 108.425 million to 182.202 million [22]. This is an issue of utmost concern with respect to sustainability that has been raised by international agencies such as the WHO.



**Figure 2.** Percentage of population with access to improved sanitation facilities, 1995–2015 [4].

Nigeria's performance in terms of the percentage of its population having access to improved sanitation is not encouraging, especially when compared with its regional economic rivals, South Africa and Egypt, who have made tremendous progress within the same time frame. From 1995 to 2015, while the percentage of Nigerians with access to improved sanitation declined by seven percentage points, the proportion improved by 12 percentage points from 54% to 66% in South Africa and by 16 percentage points in Egypt (79–95%) within the same time, thus close to achieving the Sustainable Development Goals (SDG) 6.2 target which is universal access.

The decline in access to improve sanitation in Nigeria is mainly a function of rapid population increase, as the proportion of households using improved sanitation facilities has been increasing within those two decades, although modestly (Table 1). From 1990 to 2013, the proportion of rural and urban households using improved sanitation facilities rose from about 2% to 25% and from 30% to 37%, respectively. This shows that more progress has been achieved in rural areas, where an increase of 23 percentage points was recorded, than in urban areas, which recorded an increase of 17 percentage points.

**Table 1.** Percentage of households with access to improved sanitation in Nigeria, 1990–2013 (Source: [https://dhsprogram.com/Publications/Publication-Search.cfm?ctry\\_id=30&c=Nigeria&Country=Nigeria&cn=Nigeria](https://dhsprogram.com/Publications/Publication-Search.cfm?ctry_id=30&c=Nigeria&Country=Nigeria&cn=Nigeria), accessed on 18 February 2017).

	1990	1999	2003	2008	2013
Urban households	29.9	29.6	34.2	31.4	36.6
Rural households	2.1	7.1	8.6	24.6	25.1
Total households	9.1	14.6	17.8	27.0	30.1

This analysis indicates that while the number of improved sanitation facilities per population has been declining in the last two decades, the number of facilities per households has been increasing, but at a lower rate. For Nigeria to tackle this issue, it is important to explore the socioeconomic and locational factors that influence disparities in access to sanitation facilities, as well as to explore the determinants of the disparities.

### 3.2. Relationships between Type of Household Sanitation Facility and Socioeconomic and Locational Factors

Given that the type of household sanitation facility is influenced by a variety of socioeconomic and locational factors, this subsection investigates whether significant relationships exist between type of household sanitation facility and place of residence (urban/rural), geopolitical zone, ethnicity, educational level and wealth.

#### 3.2.1. Place of Residence

The results indicate that close to a half of the total surveyed households (44.2%) used either ventilated improved pit (VIP) latrines, pit latrines with a slab or pit latrines without a slab/open pit. Unfortunately, close to one-third (31.3%) of the households have no access to any sanitation facility, thus defecating in the open (Table 2). To assess whether residing in urban or rural area influences the type of household sanitation facility, chi-square analysis was conducted. The result in Table 1 shows that there is a significant statistical difference between types of household sanitation facilities and living in rural or urban areas ( $\chi^2$  value of 7675.4, significant at 0.001). As expected, more urban households (12.6%) used the modern sanitation facilities (toilets that flush to sewer systems or septic tanks) than rural households (3.0%). Toilets that flush to septic tanks were used by 8.5% of urban and 1.8% of rural households, and toilets connected to sewer systems were used by 4.1% of urban households as compared to only 1.2% of their rural counterparts. Of those who used the modern facilities, 80% lived in urban areas. A likely reason is that the central sewer system is available only in Abuja and some parts of major cities. Other settlements have decentralized sewer systems, mainly in residential estates and large institutions.

**Table 2.** Relationship between type of sanitation facility and place of residence.

Sanitation Facility	Urban	Rural	Total	p-Value
Flush to piped sewer systems <sup>1</sup>	1578 (4.10)	461 (1.20)	2039 (5.30)	1104.0
Flush to septic tanks <sup>1</sup>	3260 (8.47)	708 (1.84)	3968 (10.31)	2751.3
Flush to pit latrines	1580 (4.11)	555 (1.44)	2135 (5.55)	950.0
Flush to somewhere else/do not know where	75 (0.19)	35 (0.09)	110 (0.29)	33.1
Ventilated improved pit (VIP) latrines <sup>1</sup>	2941 (7.64)	4384 (11.39)	7325 (19.04)	3.2
Pit latrines with a slab <sup>1</sup>	2323 (6.04)	2423 (6.30)	4746 (12.33)	118.3
Pit latrines without a slab/open pit	837 (2.18)	4094 (10.64)	4931 (12.81)	1192.4
No facility/bush/field	2894 (7.52)	9151 (23.78)	12,045 (31.30)	1462.6
Hanging toilets	327 (0.85)	774 (2.01)	1101 (2.86)	59.9
Composting toilets <sup>1</sup> , bucket toilets and others	30 (0.08)	51 (0.13)	81 (0.21)	0.6
TOTAL	15,845 (41.18)	22,636 (58.82)	38,481 (100)	7675.4

$\chi^2$  (9) = 7675.4,  $p < 0.001$ . <sup>1</sup> Improved sanitation facilities if not shared with other households [1].

The results also indicate that the VIP latrine was more favored among rural (11.4%) than urban households (7.6%), whereas the use of pit latrine with a slab was almost evenly distributed between rural and urban households. A notable result is the significant difference in open defecation between urban households (7.5%) and rural households (23.8%). A likely explanation is that there are more places for open defecation (such as bush, farms, and water bodies) and less awareness about the health risks of the practice in rural than in urban areas. Other types of sanitation facilities which in this study are referred to as 'crude' due to their unhygienic nature—toilets that flush to somewhere else and hanging, bucket, and other toilets—were used by less than 6% of all households, mostly in rural areas. Out of the total households that used hanging toilets, the majority (70.3%) lived in rural areas.

A hanging toilet is a toilet built over a water body so that human waste is disposed inside the water. A likely reason that riverine communities largely use this facility is that they live predominantly in rural areas.

Aggregating responses for (un)improved sanitation facilities indicates another rural–urban divide; 37% of urban households have access to improved facilities as opposed to 25% of rural households. When a further analysis was carried out using *t*-test (Table A1 in the Appendix A), a significant difference in the type of sanitation facilities used by urban and rural households was found ( $t = -77.4420, p < 0.01$ ).

### 3.2.2. The Geopolitical Zones

In Nigeria, the 36 states and the FCT have been categorized into six geopolitical zones, as mentioned in Section 2.1. In the present study, a significant difference was found between the type of household sanitation facility and the zones ( $\chi^2 = 14,236.6$ , significant at  $p < 0.01$ ) (Table 3). Cross-tabulation indicates that the proportion of households using the sewer system was the highest in North Central zone (1.5), followed by the South West (1.4%). A possible reason is because of Abuja, the only city with substantially developed centralized sewer system in Nigeria, located in the North Central zone could have skewed the result for the zone. The use of the VIP latrine was higher in the North West (7.9%) and North East (4.2%) when compared with North Central (2.5%), and southern zones where households using the system represented less than 2% in each zone. About 73% of all households who used the hanging toilet were from the South South and about 17% were from the South East, indicating that the practice is largely a regional issue. The dominance of hanging toilet in South South is likely due to the riverine nature of their communities.

**Table 3.** Relationship between type of sanitation facility and geopolitical zone.

Sanitation Facility	North West	North East	North Central	South West	South East	South South	Total
Flush to piped sewer systems	89 (0.23)	111 (0.29)	590 (1.53)	291 (0.76)	429 (1.11)	529 (1.37)	2039 (5.30)
Flush to septic tanks	107 (0.28)	75 (0.19)	530 (1.38)	1694 (4.40)	930 (2.42)	632 (1.64)	3968(10.31)
Flush to pit latrines	177 (0.46)	169 (0.44)	486 (1.26)	607 (1.58)	146 (0.38)	550 (1.43)	2135 (5.55)
Flush to somewhere else/do not know where	10 (0.03)	21 (0.05)	24 (0.06)	18 (0.02)	0 (0.00)	37 (0.10)	110 (0.29)
VIP latrines	3032 (7.88)	1606 (4.17)	967 (2.51)	445 (1.16)	629 (1.68)	646 (1.68)	7325 (19.04)
Pit latrines with a slab	1059 (2.75)	649 (1.69)	468 (1.22)	1126 (2.93)	805 (2.09)	639 (1.66)	4746 (12.33)
Pit latrines without a slab	2047 (5.32)	1385 (3.60)	324 (0.84)	188 (0.49)	358 (0.93)	629 (1.63)	4931 (12.81)
No facility/bush/field	1381 (3.56)	1655 (4.30)	3386 (8.80)	2508 (6.52)	1479 (3.84)	1636 (4.25)	12,045 (31.3)
Hanging toilets	27 (0.07)	5 (0.01)	10 (0.03)	63 (0.16)	189 (0.49)	807 (2.10)	1101 (2.86)
Composting toilets, bucket toilets and others	11 (0.03)	22 (0.06)	3 (0.01)	12 (0.03)	17 (0.04)	16 (0.04)	81 (0.21)
<b>TOTAL</b>	<b>7940 (20.63)</b>	<b>5698 (14.81)</b>	<b>6788 (17.64)</b>	<b>6952 (18.07)</b>	<b>4982 (12.95)</b>	<b>6121 (15.91)</b>	<b>38,481 (100)</b>

$$\chi^2 (45) = 14,236.6, p < 0.001.$$

Regarding open defecation, the highest proportion (8.8%) was found in the North Central zone, followed by the South West (6.5%) and then North East (4.3%) zones. By contrast, a lower percentage was recorded in the South East (3.8%) and the lowest in the North West (3.6%). The likely reason for higher prevalence of open defecation in the North Central and South West zones is that their forest vegetation provides more room for the practice, unlike the grassland vegetation in the North West where the practice is the least used. Although, South East zone has more dense vegetation but has lower prevalence of open defecation than the North East, suggesting an influence of other factors such as education and wealth.

In addition, multiple comparison analyses conducted using ANOVA indicated that there is a statistically significant mean difference between the different geopolitical zones and the types of household sanitation facility ( $F = 121.6, p < 0.01$ ).

### 3.2.3. Household Ethnicity

Household ethnicity (native language used as proxy) was found to be one of the significant factors that influences the type of household sanitation facility ( $\chi^2 = 9676.1$ ,  $p < 0.001$ ) (Table 4). While the VIP latrine was the most utilized facility among the Hausas (7.9%), open defecation was the number one means of household sanitation among the Yorubas (6.1%), Igbos (4.2%) and other ethnicities (18.2%). Of those households who defecated in the open, more than half (58%) were from the minority ethnic groups. About 2.3% of minority ethnic groups were connected to the sewer system, compared to 1.6% of Yorubas, 1.1% of Igbos and few Hausas (0.3%). Toilets that flush to septic tanks were used predominantly by Yorubas (3.6), followed closely by Igbos (3.5%), other ethnic groups (2.3) and by few Hausas (0.4%). Pit latrines with a slab was mostly utilized by other ethnic groups (~4.0%), followed in descending order by Hausas (3.2%), Yorubas (2.9%) and Igbos (2.4%). The highest level of using pit latrines without a slab, an unimproved facility, was found among the Hausas (5.8%).

**Table 4.** Relationship between type of sanitation facility and ethnicity.

Sanitation Facility	Hausa	Yoruba	Igbo	Other <sup>1</sup>	Total
Flush to piped sewer systems	113 (0.29)	408 (1.06)	623 (1.63)	888 (2.32)	2032 (5.30)
Flush to septic tanks	153 (0.40)	1370 (3.57)	1340 (3.50)	1088 (2.84)	3951 (10.31)
Flush to pit latrines	179 (0.47)	648 (1.69)	311 (0.81)	987 (2.58)	2125 (5.54)
Flush to somewhere else/ do not know where	12 (0.03)	16 (0.04)	6 (0.02)	76 (0.20)	110 (0.29)
VIP latrines	3039 (7.93)	570 (1.49)	731 (1.91)	2948 (7.69)	7288 (19.02)
Pit latrines with a slab	1210 (3.16)	1103 (2.88)	902 (2.35)	1514 (3.95)	4729 (12.34)
Pit latrines without a slab	2218 (5.79)	158 (0.41)	418 (1.09)	2117 (5.52)	4911 (12.81)
No facility /bush/field	1080 (2.82)	2321 (6.06)	1616 (4.22)	6982 (18.22)	11,999(31.31)
Hanging toilets	24 (0.06)	18 (0.05)	215 (0.56)	842 (2.20)	1099 (2.87)
Composting toilets, bucket toilets and others	14 (0.04)	9 (0.02)	20 (0.05)	38 (0.10)	81 (0.21)
<b>TOTAL</b>	<b>8042 (20.98)</b>	<b>6621 (17.28)</b>	<b>6182 (16.13)</b>	<b>17,480 (45.61)</b>	<b>38,325 (100)</b>

$\chi^2 (27) = 9676.1$ ,  $p < 0.001$  <sup>1</sup> other ethnicities are referred to 'minority ethnic groups'.

Further analysis using one-way ANOVA in Appendix A (Table A1) revealed a statistically significant mean difference between ethnicity and the type of sanitation facility used by households ( $F = 536.14$ ,  $p < 0.01$ ). This finding underscores the importance of differences in ethnicity in understanding access to sanitation in Nigeria.

### 3.2.4. Highest Educational Level

Level of education is one of the factors that influence the type of household sanitation facility. As Table 5 shows, there is statistically significant relationship between facility type and educational attainment of household heads, chi-square value of 7177.1 with significant at  $p < 0.01$ . Sewer system was used by only 0.4% of households whose heads had no education, 0.7% with primary school education, and 1.8% and 2.5% with secondary and higher education, respectively. Toilets that flush to septic tanks were used by 4% of households with a secondary education, slightly more than those with a higher education (3.7%), and twice that of those with primary education (1.9%).

A quite remarkable finding is that households without education used VIP latrines (an improved facility) the most (8.7%), followed in decreasing order by those with secondary (4.5%), primary (3.8%) and higher education (2%). More households without education used pit latrines with a slab, which is an improved facility (3.6%), than those with primary education (3.3%). Thus, the results imply that a high education level is directly related to the use of modern sanitation facilities (flush to sewer or septic tanks), while a lower education level is related to the use of pit latrines and crude facilities. The findings also indicate heavy (13.9%) reliance on open defecation by households without education, followed in almost equal proportion by those with secondary (7.8%) and primary education (7.6%). This pattern indicates that households with primary and secondary education constituted nearly the same proportions in the use of unimproved sanitation facilities and in practicing open defecation.

When extra analysis was conducted using ANOVA, a statistically significant mean difference existed between each of the four educational levels and using a specific type of household sanitation facility ( $F = 1380.46$ ,  $p < 0.01$ ).

**Table 5.** Relationship between type of sanitation facility and highest educational level of household head.

Sanitation Facility	No Education	Primary	Secondary	Higher	Total
Flush to piped sewer systems	151 (0.40)	264 (0.69)	669 (1.76)	937 (2.46)	2021 (5.31)
Flush to septic tanks	316 (0.83)	720 (1.89)	1503 (3.95)	1408 (3.70)	3947 (10.38)
Flush to pit latrines	229 (0.6)	387 (1.02)	898 (2.36)	600 (1.58)	2114 (5.56)
Flush to somewhere else/do not know where	18 (0.05)	17 (0.04)	32 (0.08)	43 (0.11)	110 (0.29)
VIP latrines	3302 (8.68)	1459 (3.84)	1716 (4.51)	762 (2.00)	7239 (19.03)
Pit latrines with a slab	1368 (3.60)	1262 (3.32)	1433 (3.77)	615 (1.62)	4678 (12.30)
Pit latrines without a slab	2451 (6.44)	1075 (2.83)	986 (2.59)	306 (0.80)	4818 (12.66)
No facility/bush/field	5286 (13.89)	2886 (7.59)	2976 (7.82)	796 (2.09)	11,944 (31.40)
Hanging toilets	230 (0.60)	331 (0.87)	444 (1.17)	87 (0.23)	1092 (2.87)
Composting toilets, bucket toilets and others	34 (0.09)	19 (0.05)	18 (0.05)	9 (0.02)	80 (0.21)
<b>TOTAL</b>	<b>13,385 (35.18)</b>	<b>8420 (22.13)</b>	<b>10,675 (28.06)</b>	<b>5563 (14.62)</b>	<b>38,043 (100)</b>

$$\chi^2 (27) = 7177.1, p < 0.001.$$

### 3.2.5. Household Wealth

Household wealth index, categorized into five categories (Table 6), is a measure of household economic status based on ownership of assets such as bank accounts, farmland, livestock, vehicles, radio, TVs, air conditioners, computers, or cell phones ([4], p. 15). This study found a significant relationship between the type of sanitation facility and household wealth. The poorest households had no access to VIP latrines and modern sanitation facilities (flush to septic tanks or sewer systems), except only one household, and 4.2% of them relied on pit latrine without slab. Whereas 4% of the poorer households used pit latrines without a slab, 1.42% used pit latrines with a slab and a tiny proportion (0.01–0.07%) used the remaining types of facilities. The results further show that 3.4% and 2.7% of middle class households relied on pit latrines with and without a slab, respectively.

**Table 6.** Relationship between type of sanitation facility and household wealth index.

Sanitation Facility	Poorest	Poorer	Middle	Richer	Richest	Total
Flush to piped sewer systems	1 (0.00)	2 (0.01)	44 (0.11)	364 (0.95)	1628 (4.23)	2039 (5.30)
Flush to septic tanks	0 (0.00)	4 (0.01)	79 (0.21)	615 (1.60)	3270 (8.50)	3968 (10.31)
Flush to pit latrines	6 (0.02)	26 (0.07)	155 (0.40)	654 (1.70)	1294 (3.36)	2135 (5.55)
Flush to somewhere else/do not know where	0 (0.00)	2 (0.01)	14 (0.04)	30 (0.08)	64 (0.16)	110 (0.29)
VIP latrines	0 (0.00)	2 (0.01)	14 (0.04)	30 (0.08)	64 (0.16)	7325 (19.04)
Pit latrines with a slab	214 (0.56)	548 (1.42)	1325 (3.44)	1906 (4.95)	753 (1.96)	4746 (12.33)
Pit latrines without a slab	1632 (4.24)	1556 (4.04)	1018 (2.65)	583 (1.52)	142 (0.37)	4931 (12.81)
No facility/bush/field	2625 (6.82)	3248 (8.44)	3620 (9.41)	2170 (5.64)	382 (0.99)	12,045 (31.3)
Hanging toilets	29 (0.08)	171 (0.44)	355 (0.92)	376 (0.98)	170 (0.44)	1101 (2.86)
Composting toilets, bucket toilets and others	15 (0.04)	13 (0.03)	18 (0.05)	15 (0.04)	20 (0.05)	81 (0.21)
<b>TOTAL</b>	<b>5762 (14.97)</b>	<b>7261 (18.87)</b>	<b>8443 (21.94)</b>	<b>8595 (22.34)</b>	<b>8420 (21.88)</b>	<b>38,481 (100)</b>

$$\chi^2 (36) = 23,467.4, p < 0.001.$$

Quite surprisingly, there were more middle-income households which defecated in the open (9.4%) when compared with the poorer (8.4%) and poorest (6.8%) households. When the poorest, poorer and middle class groups were combined, they constituted more than three quarters (78.8%) of those who defecated in the open. As expected, modern sanitation facilities were used by more affluent households as they were more likely to have the means to build these facilities. Of those

households who used toilets that flush to sewer system, 79.8% of them were of the richest households. A noteworthy finding is that, while the use of improved sanitation facilities decreases with decreasing household wealth and vice-versa across the groups, the use of hanging toilets and open defecation does not decrease with decreasing wealth index when moving from medium class to poorest households.

Additional analysis using ANOVA indicated that statistically significant mean difference existed between the richest, richer, middle class, poorer and poorest households in the types of sanitation facilities they used ( $F = 4634.97$ ,  $p < 0.01$ ).

### 3.3. Predictors of the Types of Sanitation Facilities Used by Households

In order to meet the last objective of this study, determining whether socioeconomic and other factors can predict the type of household sanitation facility, a multiple regression analysis was conducted. The result in Table 7 shows the relative influence of each predictor variable (Beta weights) on the types of household sanitation facilities with the direction of the relationship (positive/negative) and whether they are statistically significant. The combined effects of the predictors (adjusted  $R^2$  value of 0.346) means that 34.5% of the variance in the type of sanitation facility used by Nigerian households (outcome variable) is accounted for by the independent variables. The results also indicate that the  $F$ -value (525.9) is statistically significant at 0.001, indicating that the type of sanitation facility is significantly associated with the predictor variables collectively.

**Table 7.** Multiple regression of factors predicting the type of sanitation facility households used.

	Coef.	Std. Error	Beta	$t$	Sig.
Constant	23.4099	0.3024		77.41	0.000
Age of household head	−0.0054	0.0023	−0.0113	−2.37	0.018 <sup>1</sup>
Gender of household head	0.4467	0.0885	0.0232	5.05	0.000
Household size	0.0453	0.0117	0.0182	3.87	0.000
Total number of rooms	−0.0724	0.0099	−0.0331	−7.34	0.000
Highest educational level	−0.2227	0.0410	−0.0313	−5.44	0.000
Ethnicity	0.3792	0.0180	0.1047	21.10	0.000
Wealth index	−2.7323	0.0599	−0.4839	−45.65	0.000
Type of cooking fuel	0.0049	0.0025	0.0085	1.99	0.047 <sup>1</sup>
Type of water source	0.0188	0.0021	0.0380	8.91	0.000
Access to electricity	−0.7901	0.0725	−0.0594	−10.90	0.000
Place of residence	1.3809	0.0836	0.0884	16.52	0.000
Geopolitical zone	0.1695	0.0281	0.0383	6.04	0.000
State	0.0102	0.0005	0.1432	19.57	0.000
Local government area	−0.0062	0.0004	−0.0610	−14.13	0.000

Note:  $R^2 = 0.3458$ ; Adj.  $R^2 = 0.3451$ ;  $F = 525.90$  ( $p < 0.001$ ); degree of freedom (14, 37,829);  $n = 37,846$ ; <sup>1</sup> not significant.

With regards to the relative contribution of each independent variable to the variance in the type of sanitation facility used by households, Table 7 shows that household wealth has the largest influence, in absolute value, on the type of sanitation facility used (Beta value of  $-0.484$ ). Other significant predictors after wealth index arranged in decreasing order of magnitude are state (0.143), ethnicity (0.105), place of residence (0.088), local government area ( $-0.061$ ), access to electricity ( $-0.059$ ), geopolitical zone (0.038), and type of water sources (0.038). Lower beta values signify weaker association between the factors and type of household sanitation facilities, while higher values indicate a stronger association. For example, for a one standard deviation unit increase in household wealth, it is predicted that the rank of the type of sanitation facility will increase by 0.0484 standard deviation units. Similarly, for a one standard deviation unit increase in household size, it is predicted that the rank of type of sanitation facility will lower by 0.045 standard deviation units. It is important to note that in the NDHS the toilet that flushes to the piped sewer system is ranked as first (lowest numeral) as the best form of sanitation facility while open defecation is ranked the last (highest numeral) as the worst. As such the negative value of beta means increasing rank and vice-versa.

Access to electricity and the type of water sources such as piped water and boreholes are important to sanitation type as they facilitate using the flush systems toilets. The table also shows that the age of household head and type of cooking fuel have no significant effect on household type of sanitation facility. This implies that how old the household head is and the kind of cooking fuel used by households (e.g., wood, kerosine, natural gas, electricity) are not important factors in predicting the type of sanitation facility used by Nigerian households.

## 4. Discussion and Implications

### 4.1. Discussion of the Findings

Within the last two decades, the proportion of Nigerians with access to improved sanitation has declined, while the practice of open defecation has risen. However, other countries in sub-Saharan Africa have on average made substantial progress. In Nigeria, VIP latrines, pit latrines with a slab and pit latrines without a slab collectively constituted the dominant types of sanitation facilities (44%) in 2013. Since they are cheaper to construct and maintain compared to modern facilities, these facilities are more preferred by the poor, who constituted more than two-thirds of Nigerians (70% below poverty line) in 2010 [3]. Considering that pit latrines without a slab are an unimproved type of facility that exposes people to health risks and can cause injuries when people accidentally fall inside (especially children), there is the need for more efforts to assist households in upgrading to improved latrines. It is also important to educate households on how to maintain hygienic conditions in their improved latrines. This is because a study found that satisfaction with and use of sanitation facilities depend on whether facilities are improved (40%), cleaned (37%) and not shared (16%) [18].

Similarly, as far as the overwhelming majority of Nigerian urban areas remain unconnected to central sewer system, substantial progress cannot be made in improving access to the system. Similarly, a shortage of domestic water supply being experienced in several parts of Nigeria [23] grossly undermines the use of modern sanitation facilities. While the use of crude sanitation facilities is fizzling out (3%), close to one-third (31%) of Nigerian households defecate in the open, which is higher than sub-Saharan African average of 23% and much higher than that of Ghana (19%), Kenya (12%) and South Africa (4%) in 2015 [1]. The sub-Saharan African countries with higher prevalence of open defecation in 2015 include Liberia (48%), Togo (52%) and Burkina Faso (55%) [1]. Main reasons for open defecation include unhygienic conditions of existing facilities, high cost of building a toilet, shortage of space at home and vegetation type [19,24–26].

Pertaining to the second objective of the study, the results indicated significant relationships between types of household sanitation facilities and socioeconomic and locational factors. Like previous studies, living in urban areas increases the possibility of using improved sanitation facilities and rural living increases the possibility of open defecation and using unimproved facilities. For example, two-thirds (66.8%) of surveyed households with access to improved facilities lived in urban areas in Indonesia, [11]. Also, households in Ghana country side were 0.58 times less likely to have improved facilities than urban households [13]. Globally, the proportion of rural population using unimproved facilities is about thrice (50%) the urban one (18%) [2]. A likely reason for the disparity includes agrarian life where rural populations stay away from built areas where sanitation facilities are available, concentration of poverty in rural areas and less appreciation of the health risks of open defecation among rural households.

With regards to regional disparity, the use of sewer systems and VIP latrines was highest in North Central and North West respectively. Over two-thirds of all households that used the hanging toilet were from the South South zone. This result concurs well with a few earlier studies. In Ghana for instance, the Greater Accra region has the highest proportion of access to improved sanitation facilities as opposed to the northern region [13]. The unique characteristics of each region, its people and their socioeconomic challenges, and differences in vegetation, climate and topography are the possible reasons for the variation in the type of facilities household used across regions. In terms of ethnicity,

the significant relationship between ethnicity and household type of sanitation facility and open defecation practice found in the present study suggests that the ethnic groups in Nigeria have varied preferences for different sanitation facilities and attitudes towards the practice of open defecation.

Furthermore, while more educated households used modern sanitation facilities, less educated ones used pit latrines and practiced open defecation the most, as reported in previous studies [11,13,19,24]. A likely reason is that educated households are more aware about the risks of unimproved sanitation and poor hygiene associated with pit latrines. Awareness of the benefits of safe sanitation were found to increase the likelihood of having improved sanitation facility nine-fold among households in rural Tanzania [16]. Similarly, households headed by persons with at least secondary education in Indonesia and those headed by persons with higher education in Ghana, were respectively 3.0 and 2.5 times more likely to use improved sanitation facility compared to households with lower educational levels [11,13]. Educational attainment is thus key towards understanding inequity in access to sanitation facilities.

This study also found that the poorest, poorer and middle class combined constituted about four out of five of those who defecate in the open. A likely reason is that the relative costs of different sanitation facilities make the likelihood of using unimproved facility and practicing open defecation increase with decreasing wealth [13,19,24]. For example, the likelihoods of using improved sanitation facilities and VIP latrines were more than twice higher in higher-income households than in lower-income households in rural Ethiopia (odds ratio (OR): 2.3) [15] and Tanzania (OR: 2.1) [16] respectively. Although poverty is significantly related to using unimproved facilities or open defecation, as mentioned earlier, the present study found that their magnitudes did not simply increase by decreasing wealth. For example, open defecation was higher in middle income households than in poorer and poorest households and the use of hanging toilets was higher in middle class and richer households than in poor and poorer ones. This suggests that the relationship between the type of household sanitation facility and wealth is not linear when moving from the poorest to the richest.

Regarding the last objective of the study, the regression model indicated that among the factors that influenced the type of sanitation facility households used, wealth index has the largest effect followed in decreasing order by state, ethnicity, place of residence, local government area, access to electricity and type of water source. This finding is in line with that of earlier studies. For example, in Yemen the probability of access to improved sanitation facilities is 20% higher for people living in urban than rural areas and 18% higher for those connected with public electricity than those not connected [12]. In Ghana, households who used improved drinking water source were 1.36 times more likely to use improved sanitation facilities than those with unimproved water sources. Unlike in the present study, no statistically significant association was found between educational status and access to improved sanitation facilities in a rural community in Ethiopia [15] and in the Bomet municipality in Kenya [17]. Similarly, household size was not significantly associated with the type of toilet facility used by surveyed households in Kenya [17]. The likely reason for these contrary findings is that both studies were conducted at rural or urban level based on smaller samples of 150–515 households, unlike the national-level studies that used secondary data from substantially large samples.

On the other hand, the present study found that the age of household head and type of household cooking fuel have no significant association with the type of household sanitation facility. However, the gender of household head in both the multivariate regression and *t*-test (Table A1 in the Appendix A) is one of the significant predictors of household's type of sanitation facility. Mixed results have been reported in the literature concerning the relationship between gender and access to sanitation facilities. In Ghana, households headed by females were 2.54 times more likely to have improved sanitation facilities than those headed by males [13]. Conversely, male-headed households in a municipality in Kenya were more likely to have improved sanitation facilities than female-headed households [17]. Similarly, female-headed households were 60% less likely to own VIP latrines than male-headed households in rural Tanzania [16]. These conflicting findings could be due to the different emphasis on sanitation placed by male or female respondents in those different studies.

#### 4.2. Sustainability Implications

There is increasing appreciation of the linkages between sanitation and environmental, social, and economic pillars of sustainability. The use of unimproved sanitation facilities by over two-thirds of Nigerians is really a sanitation crisis that has serious environmental sustainability implications. Although the use of crude sanitation facilities (hanging toilet, flush to nowhere, bucket toilets and others) is fizzling out, open defecation is on the rise, which can cause several environmental problems, including contamination of surface water through runoff, which can render water bodies uninhabitable for many organisms, and expose people to diseases when they drink or swim in the water. As close to one-third of Nigerians still defecate in the open, achieving the SDG 6.2 in the country is not possible without eliminating the practice altogether. Open defecation is the worst form of sanitation as it pollutes public open spaces, water bodies, railway lines, building construction sites, and includes the use of flying toilets (which is a form of open defecation inside polythene bags and throwing it away) [19,27]. Human behavior has been reported to contribute to the prevalence of open defecation in sub-Saharan Africa [25]. For example, parents were reported to allow their children to defecate in the open for the fear of the children falling into pit latrines or dirtying flush toilets [19]. Some studies also reported that even with the availability of latrines, certain people do defecate on the ground rather than inside the pit [18,24]. Similarly, high incidence of pit latrines is associated with underground water contamination that could pose threats to households that use local wells located in proximity to the latrines. Even flush toilets, as the best form of sanitation facilities, can only transport excreta but cannot render it harmless, as sewage treatment in developing countries is not fully effective because untreated sewage is often discharged into water bodies [24]. There are also reports of some households and trucks that empty sewage they evacuated from septic tanks into running storm water and water bodies respectively [27].

From a health perspective, use of unimproved sanitation facilities and unsustainable disposal of human waste is a leading cause of diseases transmitted via human excrement, such as diarrhea, hepatitis and typhoid fever [28]. Open defecation and the use of unimproved sanitation facilities, highly prevalent among Nigerian population, have dangerous effects on human health, particularly with respect to diarrhea. The percentage of children under the age of five who had diarrhea two weeks prior to the survey was higher among rural (10.8%) than urban households (9.2%), and highest in North East zone (21.1%), followed by South East (10.3%) and North West (9.2%), areas that the NDHS found to have higher utilization of unimproved sanitation facilities and practice of open defecation [4] (p. 166). Nigeria is the second largest contributor to the under-five mortality rate in the world (after India) with about 2300 deaths daily, of which 10% is from diarrhea [1]. The implications of this include increasing demand on the already overwhelmed healthcare systems of the country. Globally, about 88% of diarrheal diseases can be ascribed to poor sanitation and hygiene and unclean water [7]. Certainly, facilitating access to improved sanitation facilities have great health benefits, including reduction in diarrhea risk by up to 37%, and schistosomiasis by up to 77% [7].

From the equity perspective, improving access to adequate sanitation is necessary for protecting human dignity and privacy. Lack of access to adequate sanitation is among the principal factors hindering progress towards the poor meeting their basic needs and it is a misery for women and children who are often physically attacked when using facilities outside their homes [28,29]. Adequate sanitation encourages children to attend schools, particularly girls: an increase in girls' enrolment have been credited to providing separate sanitary facilities for girls [1]. Also, as shown in this study ethnicity as a sub-culture and regional variations have significant influence on the facilities household used and the practice of open defecation. As such, even the improved sanitation facilities would not achieve the aim of hygienic separation of waste from human contact without behavior change. As such, efforts to increase access to improved sanitation should be coupled with schemes to promote appropriate utilization of sanitation facilities [16].

From the economic point of view, poor sanitation leads to poor health status, which in turn leads to lower productivity [1,8]. Lack of proper sanitation and hygiene cost developing countries a

substantial proportion of their GDP, which includes costs of healthcare, loss of income due to illness, and time spent seeking for places to defecate. Sanitation improvement contributes to poor household economies through reduced costs and losses of time.

## 5. Conclusions

This paper underscores the importance of ethnicity, wealth, educational attainment and regional variations in access to different types of household sanitation facilities, and that 14 socioeconomic, demographic and locational factors can predict over a third of the variance in the type of sanitation facility used by Nigerian households. Significant findings include that households without education used VIP latrines more than those with secondary, primary and higher education. Also, middle class households defecate in the open more than the poorer and poorest households, and open defecation is the number one means of sanitation by Igbos and Yorubas, with minority ethnic groups constituting more than half of households who practiced open defecation.

Key lessons of this study findings include the need for formulating and implementing sanitation policies with more focus on tackling the internal socioeconomic and regional variations in access to improved sanitation facilities, as a significant step towards sustainable sanitation delivery in Nigeria. The poor levels of access to improved sanitation recorded in the northwest and northeast zones calls for policy attention towards deprived areas where citizens are barely able to afford the cost of improved sanitation. There is also the need to draft sanitation policies with greater emphasis on educating communities to recognize the adverse effect of poor sanitation, as well as assisting poorer people to afford improved sanitation. As such, government investment in sanitation should be accompanied by more initiatives in hygiene education and poverty reduction as wealthier and more educated households have better access to improved sanitation facilities and are less likely to defecate in the open. More targeted interventions that include providing technical and financial assistance could help poor households upgrade their unimproved toilets to latrines with slabs or VIP latrines, and stop the practice of open defecation. Improving access to sanitation could ultimately help the poor to channel their income and time savings into other productive activities. Sanitation programs need to also recognize that lack of access to adequate sanitation is also linked to the limited access to water supply being experienced in many Nigerian settlements [29–31].

For Nigeria to address the challenges of improving access to sanitation, it is essential for major stakeholders in Nigeria's sanitation sector, such as the National/State Task Force on Sanitation and National Economic Empowerment and Development Strategy, the local water supply and sanitation departments, donor agencies, and non-governmental organizations, to work in tandem with the affected households themselves towards implementing the mentioned suggestions. This is important because improved sanitation facilities are mainly the responsibility of individual households, except the centralized sewer system, which is the responsibility of both the public and individuals. Unfortunately, the sanitation sector is being neglected by governments in many developing countries. Unlike water supply, human waste and its removal are considered distasteful issues, so the resources needed to tackle the existing sanitation crisis have not been forthcoming [32]. Nigerian governments and other sanitation stakeholders must move the sanitation crisis to the top of national development agenda. Efforts to reach the SDG 6.2 target should focus more on improving and sustaining existing sanitation services in addition to constructing new facilities at public places and institutions [28,32–34]. Through the ongoing community-based total sanitation program, the federal governments and donor agencies need to empower local governments and communities with the required resources, authority, and professional capability necessary for the provision and management of sanitation services, in addition to efforts towards behavior change.

This paper is not without some limitations. Certainly, housing tenure (homeownership or tenancy) is an important factor in determining the type of household sanitation facility or the extent of facility improvement. For example, more tenants were reported to use unimproved facilities and defecate in the open than owner occupiers [18,24]. Similarly, living in informal settlements has been reported

to influence the type of household sanitation facilities and open defecation, due largely to lack of tenure and location in peri-urban and topographically challenging sites (hilly, sloping or waterfront areas) [13,31,33]. Given that the 2013 NDHS dataset does not contain variables on tenancy type and living in informal or slum settlements to allow their inclusion in this study, future studies should investigate the influence of both factors on household access to sanitation. Also, in-depth qualitative study is recommended to contextualize policy and programming approaches per the significant demographic differences, such as the geopolitical zones and ethnic groups.

The present study is important as it analyzed household access to different types of sanitation facilities, beyond just ‘improved’ and ‘unimproved’ types, thus providing “a more complete characterization of access” [24]. The present study has also investigated several socioeconomic and locational determinants of different access levels, and suggested sharper policy and program focus on deprived households and regional variations, as well as hygiene education and behavior change towards more sustainable sanitation delivery in Nigeria. Placing adequate attention to sanitation sector is key towards improving human health and environmental sustainability.

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## Appendix A

**Table A1.** Test of significant difference between type of sanitation facility and gender and place residence.

	N	Mean	Std. Dev	Std. Error	t	Sig.
Urban	15,845	19.8921	7.8347	0.0622	−77.4420	0.001
Rural	22,636	25.6166	6.6039	0.0439		
Male	30,816	23.1455	7.4315	0.0423	−5.8155	0.001
Female	7665	23.7178	8.5578	0.0977		

**Table A2.** ANOVA between type of sanitation facility and socioeconomic variables.

		Sum of Squares	df	Mean Square	F	p
Household size	Between groups	10,199.13	32	318.72	5.43	0.000
	Within groups	2,254,933.46	38,448	58.64		
	Total	2,265,132.59	38,480			
Wealth	Between groups	736,553.73	4	184,138.43	4634.97	0.000
	Within groups	1,528,578.85	38,476	39.73		
	Total	2,265,132.59	38,480			
Ethnicity	Between groups	90,920.59	3	30,306.86	536.14	0.000
	Within groups	2,166,199.23	38,321	56.53		
	Total	2,257,119.82	38,324			
Highest educational level	Between groups	220,628.96	3	73,542.99	1380.46	0.000
	Within groups	2,026,497.70	38,039	53.27		
	Total	2,247,126.66	38,042			
Geopolitical zone	Between groups	35,237.61	5	7047.52	121.60	0.000
	Within groups	2,229,894.97	38,475	57.96		
	Total	2,265,132.59	38,480			

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