

COMPARATIVE ASSESSMENT OF SANITATION FACILITIES AND HYGIENE PRACTICES DURING AND AFTER-PANDEMIC IN LAGOS, NIGERIA.

Olusegun Peter Akinpelu¹, Raphael Funsho Simon² and Mark Amarachi³

^{1,2, &3}Department of Urban and Regional Planning, College of Environmental Sciences,
Bells University of Technology, Ota, Nigeria

Correspondence: Olusegun Peter Akinpelu

Department of Urban and Regional Planning, College of Environmental Sciences,
Bells University of Technology, Ota, Nigeria

E-mail: opakinpelu@bellsuniversity.edu.ng

DOI: <https://doi.org/10.5281/zenodo.15697200>

Abstract

Inaccessibility to sanitation facilities and poor hygiene practices are major challenges faced by residents of cities in developing countries. Sanitation issue became critical during the COVID-19 pandemic due to current situation of facility and hygiene behaviour in most cities of developing nations. Improvement in sanitation facilities and hygiene practices were noticeable during the COVID-19. However, studies that explore the sanitation facility and hygiene behaviour during and after the COVID-19 are scanty in literature. This study compared the residents' sanitation facilities and hygiene practices during and after COVID-19 pandemic periods using residents' perceptual data according to residential densities. The study area was stratified into three residential densities, namely: low, medium, and high. Google Earth was utilized to determine the total number of buildings (3,233) in the selected neighborhoods. Using a systematic sampling technique, 195 buildings (6%) were selected for questionnaire administration. Data collected were analyzed using frequency distribution, percentage, ANOVA, and Likert scale. The residents' assessment of the adequacy of sanitation facilities was higher during the COVID-19 pandemic (mean Sanitation Facility Index (SFI) = 4.06) compared to the post-COVID-19 period (mean SFI = 2.93). Analysis of variance (ANOVA) results revealed a statistically significant difference in residents' sanitation practices during the COVID-19 period ($F(2,33) = 4.019, p = .027$). However, no statistically significant difference was observed in sanitation practices across residential densities in the post-COVID-19 period ($F(2,33) = 2.726, p = .080$). These findings indicated the decline in sanitation practices and the inadequacy of sanitation facilities in the post-pandemic context across urban residential densities in Nigeria.

Keywords: COVID-19 pandemic; residential density; sanitation facility; sanitation practice; urban sanitation.

INTRODUCTION

On March 11, 2020, the World Health Organization (WHO) formally declared the coronavirus disease 2019 (COVID-19) outbreak, three months after it was initially detected in Wuhan City, Hubei province, China, to be a pandemic because of its rapid rate of transmission and threat to public health (Meng, et al., 2020; Ojong 2020). Many government agencies and scientific organizations ventured into developing vaccination and medication in order to stop the disease. COVID-19 spreads through respiratory droplets and vomits; hygiene behaviour is unquestionably one of the most important non-pharmaceutical methods to contain the virus, in addition to the search for medications and the development of an effective

vaccine (Altun, et al., 2014; Ding, et al. 2021; Horby and Monto, 2006). As a result, the COVID-19 response has made the condition of the water supply, sanitation, and hygiene very important. This has been made possible, in part, by promoting correct hand washing practices and, in particular, frequent hand washing (Islam et al., 2021; World Health Organization and United Nations Children's Fund, 2020a). Hands are crucial in the spread of COVID-19, because they come into direct touch with the mouth, nose, and conjunctiva of the eyes, facilitating the virus's contraction (Cucinotta and Vanelli, 2020; Haston, 2020). As a result, practicing good hand hygiene by washing your hands often with soap and water or using hand sanitiser is advised (Haston, 2020). For proper and efficient

hand hygiene, Howard et al. (2020) stated that accessibility to hand-washing stations and enough water from reliable sources is essential. However, especially in low- and middle-income countries, there is a shortage of access to soap and water sources that encourage good hand hygiene (Howard et al., 2020; WHO, 2019; WHO, 2020).

A number of studies have reported condition of sanitation facilities and hygiene behaviour before COVID-19 pandemic in Nigeria and Lagos State in particular (Ordinioha and Owchondah, 2008; Abubakar, 2016; Bello, 2016). For example, findings of a study from a semi-urban community in River State, Nigeria found that only 68% of the households in the community had access to a sanitation facility (Ordinioha and Owchondah, 2008). Similarly, overwhelming majority of Nigerian urban areas remain unconnected to central sewer system and shortage of domestic water supply was experienced in several parts of Nigeria (Abubakar, 2016). Studies have shown that issues of poor environmental sanitation are not limited to a particular residential zone, it occurs in the traditional core areas, urban centres and peri-urban areas or suburbs (Adedibu and Okekunle, 1989; Afon, 2006). WHO (2015) reported that about 66 million people do not have access to portable water and more than 100 million people are without access to improved sanitation in Nigeria. The results of research conducted in Lagos, Nigeria revealed inadequate supply of sanitation facilities like public toilets, drainage, sewerage networks, waste water treatment and disposal facilities; and poor sanitation practices have contributed to various social and health problems in the country (Bello, 2016). Yussuf et al; (2014) found that waterborne diseases were significantly influenced by poor personal hygiene habits and open defecation in ditches, which were widely practiced in the urban slums in Lagos State.

To prevent the spread of disease that arises from coming into contact with dirty surfaces, public areas underwent thorough cleaning and disinfection (Yang, & Yu, 2023). A study found that inhabitants demonstrated improved hand washing and sanitation habits related to disinfection (e.g., using soap and alcohol to clean toilet seats) throughout the pandemic. Daily public lavatory disinfection was stepped up during the pandemic (Xu, et al., 2022). Long-standing differences in access to water and sanitation services among Indigenous

communities nationwide were highlighted by the COVID-19 pandemic (Hathaway, 2021; Kakol et al., 2021; van Dorn et al., 2020; Wilder, 2020). According to Rodriguez-Lonebear et al. (2020), there was a significant disparity in the incidence of COVID-19 cases between tribal communities in the contiguous United States and the general population as of July 2020. The lack of sanitary facilities is likely to blame for a considerable percentage of this gap. Unsafe water, poor sanitation, and poor hygiene were shown to be the cause of 829 000 annual diarrhoeal fatalities and 1.9% of the world's disease burden (Kumar et al., 2020). Study by Freeman et al. (2017) demonstrated that high frequency of infectious diseases in sub-Saharan Africa, Asia and part of Latin America are mostly attributable to the nations' inadequate sanitation standards. These include helminthic infections, cholera, typhoid, diarrhoea, Hepatitis A, acute respiratory infections, tuberculosis, and, in recent past, the COVID-19 outbreak, which is responsible for a sizable portion of morbidity and mortality.

Basic hygiene practices, including washing of hands with soap and water, have been demonstrated by researchers to be the most straightforward and successful way to stop the spread of infectious diseases (Mushi and Shao, 2020; WHO, 2020). Additionally, millions of people are at greater risk of contracting infectious diseases like COVID-19 in many developing nations because of shortcomings in water, sanitation, and hygiene (WASH) organisations (Blake et al., 2020). Provision of drinkable water, enhanced sanitation, and a clean lifestyle are essential for maintaining public health during infectious disease outbreaks, including COVID-19 (Boisson et al., 2016; Wang et al., 2020). It is proper to continue using face masks, hand gloves, and hand washing among other common infection prevention and control measures, after COVID-19 outbreak (Desye, 2021). According to WHO/UNICEF (2015), sanitary services are scarce and difficult to access in low-income countries, particularly in areas with unplanned urban populations.

The COVID-19 pandemic, spread more quickly in unclean and unsanitary environments. It is therefore important for everyone to prioritise provision of sufficient sanitation facilities and good hygiene practices. Though there are studies on sanitation facilities and hygiene practices (COVID, 2020; Daramola, et al., 2019; Olanrewaju,

Ilemobade, 2009; Olowoporoku, 2017; Owoeye, and Adedeji, 2013; Pickering, et al., 2015; WHO, 2022), however, reliable data on sanitation facility and hygiene behaviour during and after COVID-19 pandemic in residential spatial structure of Nigerian cities are scarce in the literature. This study is an attempt to fill this gap. Against this background, the study seeks to explore whether there are significant variations in the socioeconomic characteristics of residents, assess their perceptions of the adequacy of available sanitary facilities, and examine the hygiene practices adopted during and after the

COVID-19 pandemic. It further aims to determine whether there are notable differences in hygiene behavior between the two periods.

MATERIALS AND METHODS

The study area is situated in Sub-Saharan Africa in Lagos State, Nigeria (see Fig. 1). Using historical characteristics determined by earlier research, the study region was stratified into three residential spatial structures (Faniran et al., 2017; Lawanson & Fadare, 2013).

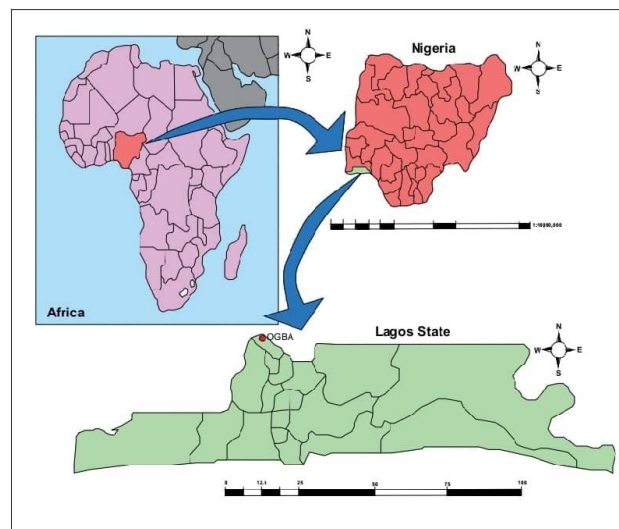


Figure 1: Locations of the study area

Source: Map Extract from Google Earth

There were 794, 852, and 1,587 residential buildings in low, medium, and high residential densities. There were 3,233 buildings in all (see Table 1). The total number of residential buildings

was determined using Google Earth in conjunction with a physical survey. A systematic sampling procedure was used to select 195 buildings (6%) for questionnaire administration.

Table 1: Residential densities and Neighbourhoods in Ogba Community, Lagos

Residential densities	Neighbourhoods	Number of houses	Sample size
Low	Guiness, Wemco and Adeniyi Jones	794	48
Medium	Aguda, Isheri, Oba Akran, Acme and Dideolu	852	52
High	Akilo, Iju, Haruna, Obawole, Collee, Anthony Enahoro and Pen-cinema	1,587	95
Total		3,233	195

Source: Author's Fieldwork

A questionnaire was used to collect required data from household heads. Households in the context of this study refer to male or female adult who makes key decisions for the household.

The survey was carried out in 2023 between March and April. The residents were asked to provide information on their socioeconomic attributes such as gender, age, marital status, and education, among

others, the availability of sanitary facilities both during and after the outbreak of the disease, and their hygiene practices both during and after. Descriptive statistics such as percentages and frequency distribution were used to analyse socioeconomic characteristics of the residents. ANOVA test was to establish if there is significance difference between in sanitation facilities and hygiene practices in residential areas during and after the pandemic.

Residents were asked to rate the level of perceived adequacy of sanitation facilities. They are required to assign a rating of "very adequate," "adequate," "just adequate," "inadequate," or "very inadequate" to each sanitary facility based on how adequate they believed it to be. Each rating was given a value of 5, 4, 3, 2, and 1 in order to create the indices. This approach was used in earlier research works (Adeniyi et al., 2022; Afon, 2007; Peter, 2019). The sanitation facility index (SFI) for each variable was calculated by dividing the total number of residents by the sum of the weight values (SWV), which are the product of the number of residents and every variable's weight value. The mathematical expression for SWV is as follows:

$$SWV = \sum_{i=1}^5 Qi Zi \text{ ----- } q. 1$$

Where: SWV = Summation of weight value attached to each rating

Qi = Number of residents rating sanitation facility i ; and

Zi = weight attached to attribute i (1, 2, 3, 4, 5)

The sanitation facility index (SFI) was arrived at by dividing SWV by the total number of responses. It is expressed with this mathematical equation:

$$SFSI = \frac{SWV}{\sum_{i=1}^5 Qi} \text{ ----- } eq. 2$$

Where SFI = Sanitation facility index

Qi = Number of residents rating sanitation facility i

The Sanitation Facility Index (SFI) has a range of values from 1 to 5. The index ranges from Very low (1), Low (2), Neither low/Nor high (3), High (4) and Very high (5). The perception of the adequacy of sanitation facilities was higher with higher SFI estimates.

RESULTS AND DISCUSSION

Socioeconomic Characteristics

Issues of sanitation concern all and sundry, this is why analysis of residents' socioeconomic characteristics becomes necessary to ensure that the opinions and perceptions of residents with varying socioeconomic status are captured. The three distinct residential densities that are typically observed in cities were considered. This is done to make sure that socioeconomic bias was not present in the data that were gathered. The percentage of male and female residents sampled varied very marginally (1.6%). The data from the field survey reflected both genders' perspectives on post-COVID-19 sanitation practices and adequacy of facilities. Each residential density's sample percentage of the overall population was also proportionate to that density. The majority of residents that were interviewed were older than minors. This relates to the idea that adults should provide pertinent and thorough knowledge about domestic sanitation. Nonetheless, a sizeable fraction (13.8%) of residents who were younger than 18 was also included in the survey.

Sixty-seven percent of the residents were married. The percentages of residents who were single, divorced, and widowed or widower were 24.6%, 2.6%, and 6.7%, respectively. A small percentage (3.2%) of the residents lacked formal education, whereas the majority (96.8%) had some sort of education, with over 50% having completed postsecondary education. This is mostly because the study area is located in an urban environment with easily accessible and reasonably priced educational resources. Residents who work in the informal sector—that is, trading—make up a sizable portion of the workforce (55.4%). Thirty-one percent were employed in the official sector, and thirteen percent were students. The majority of residents (68.6%) were flat occupiers. Face-me-I-face-you housing has the lowest percentage (1.2%). The congested layout and lack of privacy of this kind of house deters city residents from occupying it. Large household sizes were common in the area, despite the survey being conducted in an urban setting. 34.9% of households are made up of less than five persons. Five-person households are represented by the remaining percentages (65.1%).

Table 2: Socioeconomic background

Variable	Residential density			Total n (%)
	Low n (%)	Medium n (%)	High n (%)	
Gender				
Female	26 (54.2)	24 (46.2)	49 (51.6)	99 (50.8)
Male	22 (45.8)	28 (53.8)	46 (48.4)	96 (49.2)
Total (%)	48 (100)	52 (100)	95 (100)	195 (100)
Age (years)				
< 18	5 (10.4)	9 (17.3)	13 (13.7)	27 (13.8)
18-28	15 (31.2)	17 (32.7)	32 (33.7)	64 (32.8)
29-39	13 (27.1)	14 (26.9)	28 (29.5)	55 (28.2)
40-49	9 (18.8)	5 (9.6)	12 (12.6)	26 (13.3)
Above 49	6 (12.5)	7 (13.5)	10 (10.5)	23 (11.8)
Total (%)	48 (100)	52 (100)	95 (100)	195 (100)
Marital status				
Single	10 (20.8)	13 (25.0)	25 (26.3)	48 (24.6)
Married	32 (66.7)	37 (71.2)	61 (31.3)	130 (66.7)
Divorced	2 (4.2)	0 (0.0)	3 (3.2)	5 (2.6)
Widow/widower	4 (8.3)	2 (3.8)	6 (6.3)	12 (6.7)
Total (%)	48 (100)	52 (100)	95 (100)	195 (100)
Education				
Illiterate	0 (0.0)	2 (4.2)	4 (4.2)	6 (3.2)
Primary	3 (6.3)	10 (19.2)	13 (13.7)	26 (13.3)
Secondary	8 (16.7)	11 (21.2)	15 (15.8)	34 (17.4)
Vocational	5 (10.4)	4 (7.7)	10 (10.5)	19 (9.7)
Tertiary	32 (66.7)	25 (48.1)	53 (55.8)	110 (56.4)
Total (%)	48 (100)	52 (100)	95 (100)	195 (100)
Occupation				
Student	6 (12.6)	8 (15.4)	15 (15.8)	29 (13.6)
Trading	25 (52.0)	26 (50.0)	57 (60.1)	108 (55.4)
Company-employment	12 (25.0)	9 (17.3)	14 (14.7)	35 (17.8)
Professional	5 (10.4)	7 (13.5)	8 (8.4)	20 (9.5)
Civil service	0 (0.0)	2 (3.8)	1 (1.1)	4 (2.4)
Total (%)	48 (100)	52 (100)	95 (100)	195 (100)
House type				
Face-me-I-face you	0 (0.0)	1 (1.3)	5 (2.0)	6 (1.2)
Self-contained	6 (12.5)	14 (25.0)	7 (34.0)	27 (14.8)
Flat	25 (71.8)	30 (71.3)	77 (62.0)	129 (68.6)
Duplex	17 (29.1)	7 (13.5)	6 (11.5)	30 (15.4)
Total (%)	48 (100)	52 (100)	95 (100)	195 (100)
Household size				
< 5 persons	14 (29.2)	32 (66.7)	13 (21.1)	59 (34.9)
5-9 persons	1 (2.1)	10 (19.2)	9 (36.8)	20 (11.8)
10-14 persons	18 (37.5)	4 (7.7)	21 (22.1)	67 (39.6)
>14 persons	4 (8.3)	6 (11.5)	12 (14.0)	23 (13.7)
Total (%)	48 (100)	52 (100)	95 (100)	195 (100)

Source: Author's Fieldwork

Adequacy perception of sanitation facilities during and after COVID-19

The residents' assessment of the sanitation facilities' adequacy, as measured by the Sanitation Facility Index (SFI), during and after the COVID-19 pandemic, is shown in Table 3. The table displays the Mean for every era indicated by \bar{y} . This is calculated by taking the total SFI of all the sanitary facilities and dividing it by the total number

of facilities (n=12). As a result, the average index of sanitation facilities during the COVID-19 pandemic, indicated by \bar{y}_a is 4.06, whereas the average value following the pandemic, indicated by \bar{y}_c is 2.93. Based on these data, it is evident that there were substantial differences in each of the two periods' sanitary facility adequacy. When compared to the post-COVID-19 period, the adequacy during the pandemic period was higher.

Table 3: Adequacy of sanitation facilities during and after COVID-19

Sanitation facility	During Covid-19 period				Post Covid-19 period			
	SWV	y_a	$(y_a - \bar{y}_a)$	$(y_a - \bar{y}_a)^2$	SWV	y_c	$(y_c - \bar{y}_c)$	$(y_c - \bar{y}_c)^2$
Nose cover	912	4.67	0.61	0.3721	207	1.06	-1.87	3.4969
Hand sanitizer/soap	908	4.66	0.60	0.3600	259	1.33	-1.60	3.3215
Wash-hand basin	900	4.62	0.56	0.3136	489	2.50	-0.43	0.1849
Hand glove	893	4.58	0.52	0.2704	297	1.52	-1.41	1.9881
Community waste storage container	769	3.94	-0.12	0.0144	894	4.58	1.65	2.7225
Private waste collection truck	765	3.92	-0.14	0.0196	737	3.78	0.79	0.6241
Government waste collection truck	742	3.81	-0.25	0.0625	759	3.89	0.96	0.9216
Community sewer system	711	3.65	-0.41	0.1681	693	3.55	0.62	0.3844
Public water supply	768	3.93	-0.13	0.0169	792	4.06	1.13	1.2769
Water supply from borehole	803	4.12	0.06	0.0036	873	4.48	1.55	2.4025
Water supply from well	764	3.92	-0.14	0.0196	742	3.81	0.88	0.7744
Public toilet	563	2.89	-1.17	1.3689	137	0.70	-2.30	5.2900
Total		48.72				35.26		
Mean		4.06				2.93		

\bar{y}_a represents Mean of SFI during Covid-19, while \bar{y}_c stands for Mean of SFI after Covid-19

Source: Author's Fieldwork

More investigation demonstrates that during the COVID-19 pandemic, five of the twelve sanitation facilities evaluated had a positive departure regarding the Mean (\bar{y}_a). The nose cover (0.61), hand sanitizer/soap (0.60), wash-hand basin (0.56), hand glove (0.52), and borehole water supply (0.06) are these sanitation facilities. It suggests that throughout the time, the facilities' level of adequacy is higher. The community waste storage containers (-0.12), private waste collection trucks (-0.14), government waste collection trucks (-0.25), community sewer system (-0.41), and public water supply (-0.13) are among the sanitation facilities that have a negative deviation from the Mean (\bar{y}_a). The well water supply (-0.14) and the public toilet (-1.17) are the other two. This implies that government rules requiring the use of sanitation facilities, which are essential to the prevention of

COVID-19, are being followed. In post-COVID-19 period, community waste storage containers (1.65), private waste collection trucks (0.79), government waste collection trucks (0.96), community sewer systems (0.62), and public water supply (1.13) are among the sanitation facilities with positive deviation about the Mean (\bar{y}_c). The others are wells (0.88) and boreholes (1.55). This shows that those sanitary facilities have improved to the point where, following the COVID-19 pandemic, their degree of adequacy is marginally above average. On the other hand, five sanitary facilities have negative deviations, meaning that their index is below average. These include a nose cover, hand soap/sanitizer, wash-hand basin, hand glove, and public lavatory, with relative variations from the mean of -1.87, -1.60, -0.43, -1.41, and -2.30. After COVID-19, the facilities were egregiously

deficient. This is related to the loosening of COVID-19 regulations, which led some individuals to believe that the sanitary materials are no longer required. Most residents assumed that the sanitation facilities are necessary to guard against the COVID-19 pandemic.

Sanitation practices during and after COVID-19 pandemic

Table 4 shows the sanitation habits of the inhabitants in each residential density both during and after the COVID-19 epidemic. For example, during the COVID-19 era, nose cover usage (100%) was perceived to be the most frequently observed sanitation practice in the low-density residential area. Other good habits include hand washing (95.8%), flushing the toilet after use (91.7%), using soap or sanitiser (89.6%), and properly disposing of garbage (87.5%), in that order of significance. The least was waste segregation (45.8%). Following the COVID-19 pandemic, residents' attention to cleanliness procedures severely decreased. During the COVID-19 pandemic, 100% of residents used nose covers; in the post-COVID-19 era, that number dropped to just 16.7%. Similarly, there was a significant decline in the proportion of inhabitants adhering to additional hygiene protocols. Hand washing dropped from 95.8% to 52.1%. After-use toilet flushing decreased to 83.3% from 91.7%. While appropriate waste disposal practices decreased from 87.5% to 79.2%, the use of sanitizer/soap decreased from 89.6% to 45.8%. From this analysis, it can be concluded that compared to the post-pandemic period, there was a higher level of engagement in sanitation activities during the pandemic.

Throughout COVID-19, the usage of nose covers was the most frequently observed (100%) sanitation practice in residential areas with a medium density. The residents also followed other good sanitary practices, such as cleaning their hands (96.2%), flushing the toilet after using it (90.4%), disposing of waste properly (86.5%), and weeding

(82.7%). After the pandemic, residents' attitudes towards cleanliness procedures significantly decreased, much like those of their counterparts in low-density neighbourhoods. While all people wore nose covers during the COVID-19 pandemic, just 13.5% of residents did so in the post-pandemic era. That was also the case with regard to basic hygiene, which includes weeding, cleaning your hands after using the toilet and disposing of waste properly. The proportions of inhabitants who took part after COVID-19 are 23.1%, 86.5%, 40.4%, and 44.2%. The proportionate difference in sanitation practices before and after the COVID-19 pandemic suggests that sanitation received more attention during the pandemic than it did after.

Even though 94.7% of residents in high-density residential areas adhered to the sanitary practice of covering their noses, it is still the most common one. Comparing the percentage of residents in low- and medium-density residential areas who utilised nasal covers during the COVID-19 pandemic, there is a 5.3% difference. During the COVID-19 pandemic, residents participated in hand washing (89.5%), using soap or sanitiser (84.2%), cleaning the drains (82.1%), and weeding (79.0%) at higher rates than other sanitation activities. Residents in high-density residential areas showed a similar reduction in attitude towards sanitation measures following the pandemic as did those in the other two residential densities. The percentage of those who followed sanitation guidelines during the COVID-19 pandemic and those who participated in post-pandemic activities differs significantly. The percentage changes in the residents' use of nose covers, hand washing, sanitizer/soap use, drainage cleaning, and weeding during and after the COVID-19 pandemic are 93.6%, 80.0%, 76.8%, 36.8%, and 21.1%, respectively. Low income and low levels of education among the residents may be the cause of the significant difference in the percentage of sanitation practices between the two periods.

Table 4: Residents' sanitation practice during and after COVID-19 periods

Sanitation practice	Low Density				Medium Density				High Density				The Two Periods			
	During Covid-19 (%)	Ranking	Post Covid-19 (%)	Ranking	During Covid-19 (%)	Ranking	Post Covid-19 (%)	Ranking	During Covid-19 (%)	Ranking	Post Covid-19 (%)	Ranking	During Covid-19	Ranking	Post Covid-19	Ranking
Washing of hands	95.8	2	52.1	6	96.2	2	23.1	6	89.5	2	9.5	6	92.8	2	23.6	6
Using sanitizer/soap	89.6	4	45.8	7	80.8	6	21.2	7	84.2	3	7.4	7	84.6	3	20.5	7
Sneezing into elbow	85.4	6	10.4	10	73.1	9	8.9	11	45.3	8	2.1	10	62.6	8	4.6	10
Nose cover usage	100	1	16.7	8	100	1	13.5	8	94.7	1	1.1	11	97.4	1	8.2	9
Hand glove usage	72.9	11	4.2	12	51.9	11	1.9	12	34.7	9	0.0	12	48.7	10	1.5	12
Drainage cleaning	83.3	7	62.5	5	78.9	7	55.8	2	82.1	4	45.3	2	81.5	5	52.3	3
Weeding	81.1	8	70.8	3	82.7	5	44.2	3	79.0	5	57.9	1	80.5	6	57.4	2
Proper waste disposal	87.5	5	79.2	2	86.5	4	40.4	4	76.8	6	41.1	3	82.1	4	50.3	4
Flushing of toilet after use	91.7	3	83.3	1	90.4	3	86.5	1	51.6	7	34.7	4	71.8	7	60.5	1
Cleaning & disinfection of surfaces	77.1	10	14.6	9	75.0	8	9.6	9	29.5	10	5.3	8	53.3	9	8.7	8
Waste segregation	45.8	12	6.3	11	38.5	12	5.8	10	15.8	12	3.2	9	29.2	12	4.6	10
Water treatment	79.2	9	64.6	4	57.7	10	36.5	5	19.0	11	11.6	5	44.1	11	31.3	5

Source: Author's Fieldwork

This is because maintaining and replacing sanitation facilities requires funding as well as access to up-to-date knowledge on the fundamentals of good sanitation practice.

Overall, using a nose cover (97.4%), washing hands (92.8%), using soap or sanitiser (84.6%), properly disposing of waste (82.1%), clearing the drains (81.5%), and weeding (80.5%) were the most often observed sanitation measures during the COVID-19 pandemic. Nonetheless, it was believed that throughout the pandemic, hand glove use (48.7%), water treatment (44.1%), and waste segregation (29.2%) were the least followed practices. After the COVID-19 outbreak, inhabitants' hygiene habits generally drastically worsened. During COVID-19, 97.4% of residents reported using a nose cover; this rate dropped to 8.2% after the outbreak. The percentage of residents wearing nose covers dropped by nearly 80.0%; in the post-pandemic period. The following sanitation behaviours have declined by 64.1%, 31.8%, 29.2%, and 23.1%, respectively: hand washing, using soap or sanitiser, disposing of waste properly, cleaning drainage systems, and weeding. This might be a reflection of the fact that the residents lack sufficient knowledge of good sanitation procedures. The finding on better sanitation practices during the pandemic has been reported earlier. The study of Xu et al. (2022) revealed that better cleanliness practices were embraced by the people during COVID-19. It is possible to characterise the residents' reaction to the COVID-19's sanitation

efforts as reactive. This is because, following the COVID-19 pandemic, the majority of these practices that had been adopted during the pandemic were significantly reduced or abandoned by the residents. This is contrary to Desye (2021) recommendation that, in addition to other measures for infection prevention and control, the usage of face masks, hand gloves, and hand washing should continue following the COVID-19 pandemic.

Comparative Test of Significance of Residents' Sanitation Practices during the COVID-19 Pandemic

There is a variation in the mean scores of the inhabitants' cleanliness habits in the three residential densities, as indicated by the descriptive ANOVA table generated (refer to Appendix I). The data analysis specifically shows that, with a mean score of 82.45, people living in low-density residential areas were more dedicated to good sanitation practices during the COVID-19 pandemic. This could be because they have higher average monthly incomes, occupations, and educational levels than people who live in medium- and high-density residential areas. Research by authors like Hathaway (2021); Kakol et al. (2021); van Dorn et al. (2020); and Wilder (2020) supports this conclusion. They claimed that during the COVID-19 pandemic, residential neighbourhoods differed in terms of sanitary standards and infrastructure.

Table 5: ANOVA Results of Sanitation Practices during the COVID-19

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3678.094	2	1839.047	4.019	.027
Within Groups	15099.469	33	457.560		
Total	18777.563	35			

Source: Author's Fieldwork

Based on a one-way ANOVA, there is a statistically significant difference ($F(2,33) = 4.019$, $p = .027$) in the sanitation practices of the residents during the COVID-19 pandemic among the three residential densities. According to a Turkey post hoc test, residents in low-density residential areas have statistically substantially better sanitation behaviours than those in medium- and high-density residential areas ($p = .026$) (see Appendix II).

Between medium and low residential densities ($p = .128$) or between medium and high residential densities ($p = .741$), there is no statistically significant difference in the sanitary practices of the people. This implies that there were residents that exhibited better sanitation behaviour in medium density residential area, while sizeable proportion displayed poor sanitation behaviour like residents in high residential density during the pandemic.

Comparative Test of Significance of Residents' Sanitation Practices in the post-COVID-19 Pandemic

A variance in the mean scores of the sanitation practices of the residents in the three residential densities during the post-COVID-19 pandemic era is revealed by the descriptive ANOVA findings (see Appendix III). Nonetheless, with a mean score of 42.54, more people living in low residential density than in the other two

residential densities practiced good sanitation. Their socioeconomic traits, including their occupation, average monthly income, level of schooling, and others, may be to blame for this. It is assumed that residents in low residential density areas have the means to participate in proper sanitation practices since they have better occupations, greater levels of education, and higher average monthly incomes.

Table 6: ANOVA Results of Sanitation Practices in Post-COVID-19

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3552.571	2	1776.285	2.726	.080
Within Groups	21503.546	33	651.623		
Total	25056.116	35			

Source: Author's Fieldwork

One-way ANOVA ($F(2,33) = 2.726, p = .080$) indicates that there is no statistically significant variation in the sanitation habits among the people in the three residential densities. With p -values of .567, .567, and .066 for high, medium, and low residential densities, respectively, a Turkey post hoc test showed that resident engagement in sanitation activities is not statistically significant in any of the three residential densities (see Appendix IV). The implication of this is that there is no noticeable difference in sanitation behaviour of the residents in the three residential densities after the COVID-19 pandemic.

CONCLUSION

This study has provided valuable insights into residents' perception of sanitation facilities and practices both during and after the COVID-19 pandemic. It is established that, in comparison to the post-pandemic period, sanitary facilities were more adequate during the COVID-19 pandemic. Nonetheless, it is important to note that the three residential densities were found to have sufficient sanitation services, which are required by law during COVID-19 pandemic. Conversely, during the post-pandemic period, the majority of these amenities were perceived to be insufficient. It is possible to blame this on carelessness and a low maintenance culture. The investigation also revealed that there were differences in the three residential densities' sanitation practices. For example, sanitation practices, were shown to differ

significantly between low-density residential areas and high-density residential areas, but no significant difference between low and medium or high and medium residential densities. There was no statistically significant variation in the sanitation practices of the residents across the three residential densities in the post-COVID-19 period, though; appreciable level of better sanitation was demonstrated in the low-density residential area. The current situation of sanitation facilities and practices pose danger in the event of public health emergency.

It is important that urban authorities prioritise provision of adequate sanitary infrastructure, particularly in neighbourhoods that are disadvantaged and vulnerable. Collaborations among government and community-based organisations in providing sanitary facilities or financial assistance to household heads for the purpose of procuring of the sanitation facilities to make it more accessible. Furthermore, public education and orientation regarding the importance of adopting a proper sanitation culture at all times—rather than waiting until there is a public health emergency—must receive more attention. This could be done through religious organizations, trade associations, cultural societies and community development associations, among others, using local dialect. Environmental sanitary officers must be alive to their responsibilities, especially enforcement of sanitation laws and routine environmental monitoring to detect and prosecute offenders, in order to serve as a deterrent to others.

References

- Abubakar, I.R. (2016). Quality dimensions of public water services in Abuja, Nigeria. *Util. Policy*, 38, 43–51
- Adedibu, A.A and Okekunle, A.A, (1989). Environmental sanitation in Lagos mainland: Problems and possible solution. *International Journal of Environmental Studies*, 33:99-109.
- Adeniyi, L., Akinpelu, O., Fatoke, M., & Adeniji, M. (2022). Evaluation of urban solid-waste generation and safety consciousness of waste collectors amidst COVID-19 pandemic. *Journal of Material Cycles and Waste Management*, 24(5), 1948-1957 <https://doi.org/10.1007/s10163-022-01449-y>
- Afon, A.O, (2006). Informal sector initiative in the primary sub-system of urban solid waste management in Lagos, Nigeria. *Habitat International*, 31(2):193–204
- Afon A. (2007). An analysis of solid waste generation in a traditional African city: the example of Ogbomoso, Nigeria. *Environment and Urbanisation*, 19(2), 527–537 <https://doi.org/10.1177/0956247807082834>
- Altun, İ., Erkek, Y., Demirhan, Y., Peker, A., & Çetinarslan, B (2014). Hygiene behavior in persons with type 2 diabetes. *American Journal of Infection Control*, 42(7), 817-818 <http://dx.doi.org/10.1016/j.ajic.2014.03.013>
- Bell, D., Nicoll, A., Fukuda, K., Horby, P., Monto, A., Hayden, F., & Van Tam, J. (2006). Non-pharmaceutical interventions for pandemic influenza, national and community measures. *Emerging Infectious Diseases*, 12(1), 88-94 <https://doi.org/10.3201/eid1201.051371>
- Blake, M., Glaeser, A., Kriticos, S., & Mutizwa-Mangiza, N. (2020). Water, sanitation, and hygiene policy in the time of COVID-19. *International Growth Centre Policy Brief*. <http://www.theigc.org/covid-19>
- Boisson, S., Engels, D., Gordon, B., Medlicott, K., Neira, M., Montresor, A., & Velleman, Y. (2016). Water, sanitation, and hygiene for accelerating and sustaining progress on neglected tropical diseases: a new Global Strategy 2015–20. *International Health*, 8(suppl_1), i19-i21 <https://doi.org/10.1093/inthealth/ihv073>
- Bello, H.O. (2016). Assessment of behavioural responses to environmental sanitation facilities in the core areas of developing countries: Case study of Ikorodu, Nigeria, *International Journal of Ecology and Ecosolution* 3(2), pp. 12-20, ISSN: 2437 - 1327
- COVID, N.; (2020). outbreak in Nigeria situation report—Abuja: Nigeria centre for disease control. 2020b. Available on <https://ncdc.gov.ng/themes/common/files/sitreps/0daa083aeed110eddba8937c1f90a6d9.pdf> On 27th November.
- Cucinotta, D., & Vanelli, M. (2020). WHO declares COVID-19 a pandemic. *Acta Bio Medica: Atenei Parmensis*, 91(1), 157-160 <https://doi.org/10.23750%2Fabm.v91i1.9397>
- Daramola, O., Olowoporoku, O., & Popoola, A. (2017). Worse than a tiger's grip: The case of household water supply and sanitation practices in Osogbo Nigeria. *Advances in Environmental Research*, 55, 153-170
- Desye, B. (2021). COVID-19 pandemic and water, sanitation, and hygiene: impacts, challenges, and mitigation strategies. *Environmental Health Insights*, 15, 11786302211029447 <https://doi.org/10.1177/11786302211029447>
- Ding, Z., Qian, H., Xu, B., Huang, Y., Miao, T., Yen, H., & Li, Y. (2021). Toilets dominate environmental detection of severe acute respiratory syndrome coronavirus 2 in a hospital. *Science of the Total Environment*, 753: 141710 <https://doi.org/10.1016/j.scitotenv.2020.141710>
- Faniran, G., Afon, A., & Dada, O. (2017). Solid waste management during monthly environmental sanitation exercise in Ibadan municipality Nigeria. *Management of Environmental Quality* 28(6), 868-878 <https://doi.org/10.1108/MEQ-03-2016-0030>
- Freeman, M., Garn, J., Sclar, G., Boisson, S., Medlicott, K., Alexander, K. & Clasen, T. (2017). The impact of sanitation on infectious disease and nutritional status: A systematic review and meta-analysis. *International Journal of Hygiene Environmental Health*, 220(6), 928-949 <https://doi.org/10.1016/j.ijheh.2017.05.007>

- Haston, J. (2020). Characteristics associated with adults remembering to wash hands in multiple situations before and during the COVID-19 pandemic—United States, October 2019 and June 2020. *MMWR. Morbidity and mortality weekly report*, 69. <https://www.cdc.gov/handwashing/when-how-handwashing.html>
- Hathaway, E. (2021). American Indian and Alaska Native people: Social vulnerability and COVID-19. *The Journal of Rural Health*, 37(1), 256-259. <https://doi.org/10.1111%2Fjrh.12505>
- Howard, G., Bartram, J., Brocklehurst, C., Colford Jr, J., Costa, F., Cunliffe, D., & Wright, C. (2020). COVID-19: urgent actions, critical reflections and future relevance of ‘WaSH’: lessons for the current and future pandemics. *Journal of Water and Health*, 18(5), 613-630. <https://doi.org/10.2166/wh.2020.162>.
- Islam, A., Kalam, M., Sayeed, M., Shano, S., Rahman, M., Islam, S., & Hassan, M. (2021). Escalating SARS-CoV-2 circulation in the environment and tracking waste management in South Asia. *Environmental Science Pollution Research*, 1-18. <https://doi.org/10.1007/s11356-021-16396-8>
- Jiwani, S., & Antiporta, D. (2020). Inequalities in access to water and soap matter for the COVID-19 response in sub-Saharan Africa. *International Journal for Equity in Health*, 19(1), 82. <https://doi.org/10.1186/s12939-020-01199-z>
- Kakol, M., Upson, D., & Sood, A. (2021). Susceptibility of southwestern American Indian tribes to coronavirus disease 2019 (COVID-19). *The Journal of Rural Health*, 37(1), 197-199. <https://doi.org/10.1111%2Fjrh.12451>
- Kumar, S., Maurya, V., & Saxena, S. (2020). Emerging and Re-emerging Water-Associated Infectious Diseases. *Water-Associated Infectious Diseases*, 27-51. https://doi.org/10.1007/978-981-13-9197-2_5
- Lawanson, T., & Fadare, S. (2013). Neighbourhood differentials and environmental health interface in Lagos metropolis, Nigeria. *Habitat International*, 39, 240-245. <https://doi.org/10.1016/j.habitatint.2012.12.001>
- Meng, L., Hua, F., & Bian, Z. (2020). Coronavirus disease 2019 (COVID-19): emerging and future challenges for dental and oral medicine. *J. Dent. Res.*, 99: 481-487. <https://doi.org/10.1177/0022034520914246>
- Mushi, V., & Shao, M. (2020). Tailoring of the ongoing water, sanitation and hygiene interventions for prevention and control of COVID-19. *Tropical Medicine and Health*, 48(1), 47. <https://doi.org/10.1186/s41182-020-00236-5>
- Ojong, N. (2020). The COVID-19 pandemic and the pathology of the economic and political architecture in Cameroon. *Healthcare*, 8(2), 176. <https://doi.org/10.3390/healthcare8020176>
- Olanrewaju, O., & Ilemobade, A. (2009). Waste to wealth: A case study of the Ondo State integrated wastes recycling and treatment project, Nigeria. *European Journal of Social Sciences*, 8(1), 7-16. https://core.ac.uk/display/188776196?utm_source=pdf&utm_medium=banner&utm_campaign=pdf-decoration-v1
- Olowoporoku, O. (2017). A recipe for disaster: An assessment of environmental sanitation situation in Nigeria. *MAYFEB Journal of Environmental Science*, 1, 1-5
- Ordinoha, B and Owmondah, G. (2008). Sanitation facilities and hygiene practices in a semi-urban community in Rivers State, south-south Nigeria *The Nigerian Health Journal*, 8, 1 -2,
- Owoeye, J., & Adedeji, Y. (2013). Poverty, sanitation and public health nexus—implications on core residential neighbourhood of Akure, Nigeria. *International Journal of Developing Societies*, 2(3), 96-104. <https://doi.org/10.11634/216817831504448>
- Peter, A. (2019). Cleaners Perception of Solid Waste Generation in the University College Hospital, Ibadan, Nigeria. *Covenant Journal of Research in the Built Environment*. 7(2), 9-19. <https://journals.covenantuniversity.edu.ng/index.php/cjrbe/article/view/1837>
- Pickering, A., Djebbari, H., Lopez, C., Coulibaly, M., & Alzua, M. (2015). Effect of a community-

- led sanitation intervention on child diarrhoea and child growth in rural Mali: a cluster-randomised controlled trial. *The Lancet Global Health*, 3(11), e701-e711
<http://www.thelancet.com/lancetgh/content?id=KFA0DgAAQBAJ&pg=PA1963&img=1&zoom=3&hl=en&sig=ACfU3U3ceUH9vMWhgGOc0AXO3e33LAVHgw&w=1280>
- Rodriguez-Lonebear, D., Barceló, N., Akee, R., & Carroll, S. (2020). American Indian reservations and COVID-19: correlates of early infection rates in the pandemic. *Journal of Public Health Management and Practice*, 26(4), 371-377
<https://doi.org/10.1097/PHH.0000000000001206>
- Van Dorn, A., Cooney, R., & Sabin, M. (2020). COVID-19 exacerbating inequalities in the US, *Lancet* (London, England), 395: 1243-1244
[https://doi.org/10.1016%2FS0140-6736\(20\)30893-X](https://doi.org/10.1016%2FS0140-6736(20)30893-X)
- Wang, C., Horby, P., Hayden, F., & Gao, G. (2020). A novel coronavirus outbreak of global health concern. *The Lancet*, 395: 470-473
[https://doi.org/10.1016/S0140-6736\(20\)30185-9](https://doi.org/10.1016/S0140-6736(20)30185-9)
- Wilder, J. (2021). The disproportionate impact of COVID-19 on racial and ethnic minorities in the United States. *Clinical Infectious Diseases*, 72: 707-709
<https://doi.org/10.1093/cid/ciaa959>
- World Health Organization, (2011). Guidelines for drinking-water quality: Fourth edition incorporating the first and second addenda (4th ed +1st add +2nd add). *WHO chronicle*, 38: 104-108
https://apps.who.int/iris/handle/10665/35253_2
- World Health Organization/Water, Sanitation and Hygiene., (2015). Water sanitation and hygiene for accelerating and sustaining progress on neglected tropical diseases. Global Strategy. Geneva: WHO; 2015.
- WHO/UNICEF Joint Water Supply; Sanitation Monitoring Programme. (2015). *Progress on sanitation and drinking water: 2015 update and MDG assessment*. World Health Organization.
<https://books.google.com.ng/books/publisher>
- World Health Organization, (2019). *Progress on household drinking water, sanitation, and hygiene 2000-2017: special focus on inequalities*. World Health Organization Report.
- World Health Organization, (2019). nCoV outbreak is an emergency of international concern. <http://www.euro.who.int/en/healthtopics/healthemergencies/internationalhealthregulations/ews/news/2020/2/2019-ncovoutbreak-is-an-emergency-of-international-concern> (accessed 27 April 2020)
- World Health Organization, (2020). Hygiene Baselines Pre-COVID-19 Global Snapshot Source: WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene. Geneva, Switzerland: WHO.[Google Scholar].
- World Health Organization, (2020). *Water, sanitation, hygiene, and waste management for the COVID-19 virus: interim guidance, 23 April 2020* (No. WHO/2019-nCoV/IPC_WASH/2020.3). World Health Organization
<https://www.who.int/gpsc/5may/tools/ru/>
- Xu, J., Xu, X., Sun, K., Wu, D., Lam, T., & Zhou, X. (2022). Changes in residents' hygiene awareness and behaviors in public toilets before and during the COVID-19 pandemic in Hangzhou, China: a two-round cross-sectional study. *BMC Public Health*, 22: 1690
<https://doi.org/10.1186/s12889-022-14114-8>
- Yang, Y., & Yu, M. (2023). Response to global public health emergency: overview and lessons from Chinese experience against COVID-19. *Journal of Global Health*, 13: <https://doi.10.7189/jogh.13.03016>
- Yussuf L, Bako, A.I, Omole, F.K, Nwokoro, I.I.C, Olajuyigbe, A.E, (2014). Survival in the midst of challenges tale from Ijora-Badia slum dwellers of Lagos State, Nigeria, *Energy and Environment Research*, 4(3): 119-125.

Appendix I: Descriptive ANOVA Results of Sanitation Practices during the COVID-19

Residential Density	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
High	12	58.5167	29.00918	8.37423	40.0851	76.9482	15.80	94.70
Medium	12	75.9750	18.36336	5.30105	64.3075	87.6425	38.50	100.00
Low	12	82.4500	13.92601	4.02009	73.6018	91.2982	45.80	100.00
Total	36	72.3139	23.16251	3.86042	64.4768	80.1510	15.80	100.00

Appendix II: A Turkey Post Hoc Test of Sanitation Practices during the COVID-19

(I) Residential	(J) Residential	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Medium	6.47500	8.73269	.741	-14.9532	27.9032
	Low	23.93333*	8.73269	.026	2.5051	45.3616
Medium	High	-6.47500	8.73269	.741	-27.9032	14.9532
	Low	17.45833	8.73269	.128	-3.9699	38.8866
Low	High	-23.93333*	8.73269	.026	-45.3616	-2.5051
	Medium	-17.45833	8.73269	.128	-38.8866	3.9699

Appendix III: Descriptive ANOVA Results of Sanitation Practices in Post-COVID-19

Residential Density	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
High	12	18.2667	20.48784	5.91433	5.2493	31.2840	.00	57.90
Medium	12	28.9500	24.91920	7.19355	13.1171	44.7829	1.90	86.50
Low	12	42.5417	30.23491	8.72807	23.3313	61.7520	4.20	83.30
Total	36	29.9194	26.75610	4.45935	20.8665	38.9724	.00	86.50

Appendix IV: A Turkey Post Hoc Test of Sanitation Practices in Post-COVID-19

(I) Residential	(J) Residential	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Medium	-10.68333	10.42131	.567	-36.2551	14.8884
	Low	-24.27500	10.42131	.066	-49.8468	1.2968
Medium	High	10.68333	10.42131	.567	-14.8884	36.2551
	Low	-13.59167	10.42131	.403	-39.1634	11.9801
Low	High	24.27500	10.42131	.066	-1.2968	49.8468
	Medium	13.59167	10.42131	.403	-11.9801	39.1634