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Household Water, Sanitation, and Hygiene (WASH) Conditions and Associated Public Health Risks in Omu-Aran, Kwara State

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ABSTRACT

Good water, sanitation, and hygiene (WASH) practices and adequate sanitation infrastructure are essential for promoting public health and safeguarding the environment. This study investigates sanitation infrastructure, WASH knowledge, attitude and practices, water quality and their public health implications in Omu Aran, Nigeria. 423 households were selected and surveyed using structured questionnaire to assess sanitation conditions and perceptions. Water samples from wells, boreholes, and streams were analysed for pH, dissolved oxygen, heavy metals, and nutrients across dry and rainy seasons. Findings reveal that sanitation infrastructure is inadequate, with 42.5% using pit latrines and 30.83% practicing open defecation, indicating poor water quality and high malaria (56.67%) and typhoid (17.5%) prevalence. The absence of adequate solid waste disposal services for 56.67% of respondents indicates high risks of environmental contamination. Well and borehole water exhibit alkaline pH levels above WHO guidelines, with high concentrations of cadmium and iron in all water sources posing health risks. The high phosphate concentration in streams increases eutrophication risks. The study concluded that sanitation infrastructure and water quality in Omu-Aran is in a critical state requiring urgent intervention. Government should invest in modern sanitation and water systems, community-led maintenance programs, and individual adoption of water treatment practices.

Keywords: WASH, Water, Sanitation, hygiene, Infrastructure, Water quality

INTRODUCTION

Water, sanitation, and hygiene (WASH) play vital roles in public health and environmental sustainability (Tahlil et al., 2025). WHO estimated that in 2022, 2.2 billion people still lacked access to safe drinking water (WHO, 2023). Rapid urban population growth creates unprecedented challenges, with the provision of water and sanitation being among the most pressing and painfully felt when lacking (Zyoud et al., 2023). Adequate clean water supply not only reduces water-related diseases but also positively impacts income by reducing working time lost to illness and lowering medical costs. WHO estimated that 88% of all cases of diarrhoea globally were attributable to WASH (WHO, 2019).

Several studies have been carried to evaluate WASH knowledge, attitude, and practices in order to identify the challenges to public health and sustainable development. Guo et al. (2017) examined 1,318 rural healthcare facilities in Ethiopia, Kenya, Mozambique, Rwanda, Uganda, and Zambia and found that less than half had improved water sources, sanitation, or reliable handwashing facilities, with fewer than a quarter consistently providing soap and drying materials. Similarly, the study on 2,270 rural schools in six Sub-Saharan African countries revealed that less than 23% of the schools attained the WHO's student-to-latrine standards (Morgan et al., 2017). The study of Tahlil et al. (2025) among 728 internally displaced persons in Somalia revealed poor WASH knowledge (71.2%), negative attitudes (70.3%), and poor practices (80.2%) which were influenced by education, employment, household size, and camp residency duration.

In Nigeria, Yaya et al. (2018) utilised the 2013 Nigeria Demographic and Health Survey to analyse data from 28,596 Nigerian mother-child pairs and found that 11.3% of children under five suffered from diarrhoea, 67.3% of the cases in rural areas. The study concluded that poor state of the toilets and water sources increased the risk of diarrhoea by 14% and 16% respectively. Similarly, High rates of stunting (44%), wasting (37.5%),

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and underweight (34%) of 200 under-five children were linked to poor WASH practices such as Access to unsafe water and poor hygiene, such as not washing hands before feeding in the study of Aleru et al. (2023).

Kucici et al. (2025) identified poor water governance and inadequate infrastructure are the major contributory factors to WASH challenges in Yobe State by using government publications, NGO reports, and media articles. Marhiagbe & Eghomwanre (2023) evaluated WASH conditions in Benin City markets evaluated through surveys and water analysis. The study showed that 77% had potable water access, 33% lacked it due to maintenance issues. About 79% had toilets, but 66% lacked handwashing facilities. The water analysis revealed that the water in the market borehole had low pH (4.6–5.7), below WHO standards. Wada et al. (2022) examined WASH knowledge, attitude, and practices on 400 students from five public and five private schools in Ibadan. The study revealed better WASH knowledge in the private schools, which the authors attributed to improved sanitation and hygiene service compared to the public schools. Similarly, Bosede et al. (2025) reported better WASH practices in private schools but higher knowledge among public schools in Imo State. Wada et al. (2022) and Bosede et al. (2025) pointed out that inadequate sanitation facilities increased open defecation in public schools.

In Asia, WASH studies carried out across hospitals in Cambodia, Lao People's Democratic Republic, Mongolia, Papua New Guinea, Philippines, Solomon Islands, and Viet Nam revealed that countries with local WASH standards had better WASH services and practices (Mannava et al., 2019). The study of Jitu et al. (2025) in Afghanistan, Bangladesh, Nepal, and Pakistan showed that higher income, education, and access to modern technology such as social media increased WASH practices. The reviewed studies collectively indicate that WASH is a global issue, which is influenced by several factors and plays an important role on people's health.

Despite the implementation of various water supply and sanitation projects in Nigeria, their impacts on the well-being of residents is still unknown (Abdus-Salam et al., 2016). This is primarily because assessments or evaluations of these projects have rarely been conducted due to the cost, time, technical complexity involved, and the sensitivity if the findings are negative (Bhatkal et al., 2024). Furthermore, if such evaluations are carried out, they are censured for not addressing the right questions, or not comprehensive, and sometimes at a late period.

As a result, there is no comprehensive study documenting the implications of water and sanitation projects in Nigeria as a whole. This justifies this study which focuses on Omu-Aran. The study will assess the quality of water from different sources, sanitation infrastructure, and identify potential health risks in Omu-Aran, in Kwara State. The findings will inform evidence-based interventions to improve water quality and sanitation infrastructure, ultimately enhancing the health and well-being of urban dwellers.

MATERIALS AND METHODS

Both quantitative and qualitative approaches were employed to achieve the aim of this study. The quantitative approach involved water sample collection through experimental design while the qualitative approach involved the use of a descriptive cross-sectional design using a questionnaire. Figure 1 depicts the methodology employed in this paper.

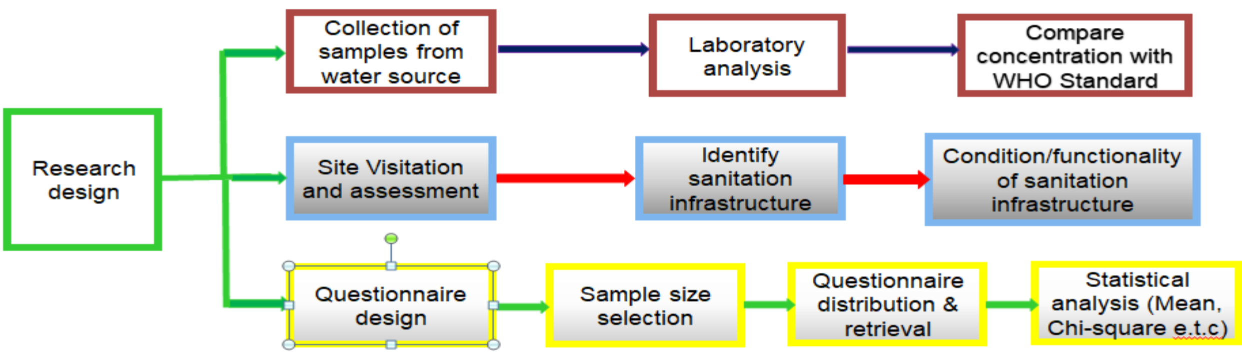

Figure 1: Research Methodology

Instrument for Data Collection

A well-structured questionnaire was used to gather information from respondents. The questionnaire included information on demographics, water quality, sanitation infrastructure, and associated health risks. The population of Omu-Aran in 2006 was 14,477 Geonames Data. The data collected were coded and analysed using frequency table and Statistical Package for Social Sciences (SPSS). The sample size for the study was calculated using Cochran's formula for estimating proportions (Cochran, 1977). Cochran's formula (for 95% confidence level and proportion, $p = 0.5$) is given by equation (1).

$$n_o = \frac{Z^2 \cdot p(1-p)}{e^2} \quad (1)$$

Where:

- $Z =$ Z-score for confidence level (e.g., 1.96 for 95%)
- $p =$ estimated proportion of population (0.5 for maximum variability)
- $e =$ margin of error (e.g., 0.05)

For this study,

$$n_o = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} = 384.16$$

Israel (1992) explains that when the sample comprises more than 5% of the population (i.e. $\frac{n_o}{N} > 0.05$), the Finite Population Correction (FPC) should be applied to adjust the sample size for better accuracy using equation 3.

$$n = \frac{n_o}{1+(\frac{n_o-1}{N})} \quad (2)$$

For this study, $n_o = 384.16, N = 40586$

$$\therefore \frac{n_o}{N} = \frac{384.16}{40586} = 0.0095 = 0.95\%$$

$0.95\% < 5\%$, hence, the FPC is not applied. To account for potential non-response or incomplete questionnaire, the sample size was increased by 10%.

$$384.16 \times 1.1 = 422.576 \approx 423$$

Hence, total sample size for this study is 423 participants.

Water Sampling and Laboratory Analysis

Water samples from borehole, stream, and well were collected for water quality tests. The sampling points and the coordinates are presented in Figure 2 and Table 1 respectively. Water was collected at six (6) different locations. Water samples were collected in 500ml water bottles. Procedure for water sample collection and laboratory analyses for the selected parameters were carried out according to Standard Methods and Procedures (APHA, 2005). The parameters selected for water quality determination are pH, dissolved oxygen (DO), iron, copper, and cadmium, nitrate, sulphate, and phosphate.

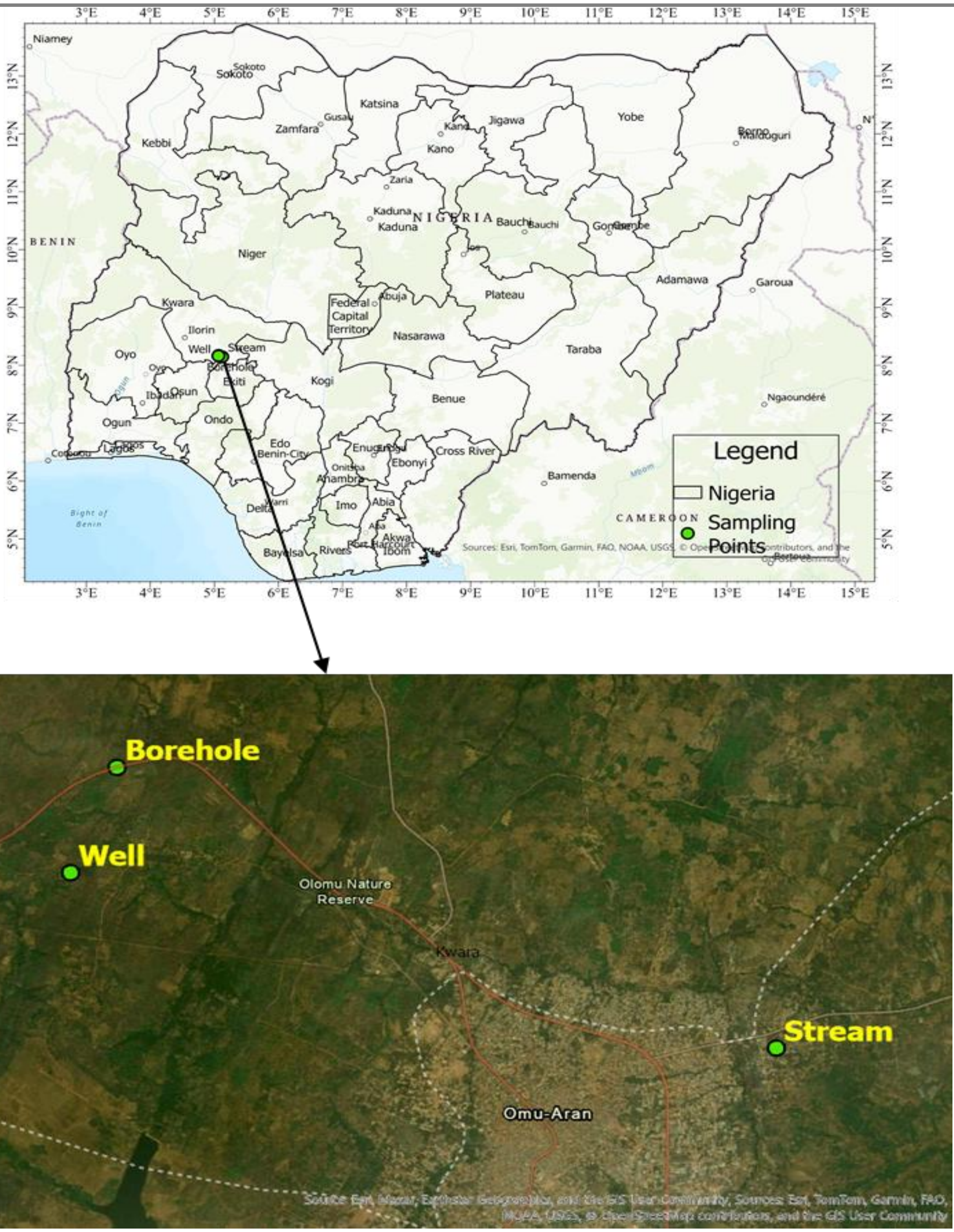

Figure 2: Map Showing the Study Area

Table 1: Geographical Coordinates of the Sampling Points

Sampling Point	Latitude	Longitude
Stream	8°8’48.2138” N	5°7’14.4142” E
Borehole	8°10’19.6734” N	5°4’0.8573” E
Well	8°9’45.3021” N	5°3’47.1250” E

RESULTS AND DISCUSSION

Condition and Functionality of Sanitation Infrastructure in Omu-Aran

Table 2 shows that sanitation infrastructure in the area is largely inadequate. Most residents rely on pit latrines (42.51%), while 30.83% practice open defecation and only 18.33% have private flush toilets. About 40.83% of toilets are located outside compounds and just 55% of residents maintain them regularly, indicating weak hygiene management. In addition, 56.67% lack adequate solid waste disposal services, increasing environmental contamination risks such as waste entering rivers and open wells. The overall condition of sanitation facilities was mostly rated as fair (53.33%), with only 18.34% describing it as good. Access to functional handwashing stations was limited to 20.83%, consistent with findings reported by Guo et al. (2017). Furthermore, 51.67% experience flooding and sewage overflows, which can cause water pollution and heighten disease risks like typhoid fever, reflecting clear infrastructural gaps. Poor infrastructure may heighten bacterial infections (Olalemi et al., 2023).

Table 2: Sanitation Infrastructure

Variable	Category	Percentage (%)
Type of Toilet Facility Used by Households	Private flush	18.33
	Pit latrine	42.51
	Shared facility	8.33
	Open defecation	30.83
Location of Toilet Facility	Within dwelling	21.67
	Outside compound	40.83
	Shared with others	37.5
Regular Cleaning and Maintenance of Toilet Facility	Yes	55
	No	27.5
	Occasionally	17.5
Access to Solid Waste Disposal Service	Yes	43.33
	No	56.67
Perceived Condition of Sanitation Infrastructure	Good	18.34
	Fair	53.33
	Poor	28.33
Access to Functional Handwashing Station	Yes	20.83
	No	79.17
Frequency of Flooding/Sewage Overflows in Neighbourhood	Never	48.33
	Rarely	30
	Sometimes	17.5
	Often	4.17

Water Quality Perception

Table 3 shows that more respondents obtained water from boreholes/wells (77.5%) compared to streams/rivers (22.5%). The physical appearance of the water was generally rated good as 83.33% and 69.17% of the respondents observed no colour and odour respectively in the water. Only 36.67% confirmed their water source had been tested, while 30% were uncertain. Though, 33.33% were certain that the drinking water was not treated, only 15.09% always treated the water. Majority (61.32%) never treated their water. 46.67% observed sewage or waste near their water source, which is consistent with the response of low access to solid waste disposal service. Only 27.5% believed poor sanitation can lead water contamination or unsafe water, reflecting a very poor WASH knowledge regarding water safety, despite visible environmental risks, consistent with the findings of Tahlil et al. (2025).

Table 3: Water Quality

Variable	Category	Percentage (%)
Household's Main Source of Drinking Water	Borehole/Well	77.5
	Stream/River	22.5
Appearance of Drinking Water	Clear	83.33
	Slightly coloured	16.67
Odour or Taste in Drinking Water	No	69.17
	Slight	30
	Strong	0.83
Water Supply Quality Testing History	Yes	36.67
	No	33.33
	Not Sure	30
Water Treatment Before Drinking	Always	15.09
	Sometimes	23.58
	Never	61.32
	Not sure	50
Observation of Sewage/Waste Near Water Source	Yes	46.67
	No	53.33
Perceived Link Between Poor Sanitation and Unsafe water	Strongly agree	14.17
	Agree	13.33
	Neutral	55
	Disagree	17.5

WASH and Health Perceptions

Table 4 reveals that malaria was the most frequently reported illness (56.67%) over the last six months, followed by typhoid (17.5%) and diarrhoea (12.5%). 28.33% and 15.83% linked the illnesses to contaminated water and poor sanitation respectively, while 45.83% were unsure. Satisfaction with water and sanitation services was generally low (24.16%). Good hygiene (adequate cleaning of facilities and environment) was the most cited recommendation (74.17%) for improved WASH system, which reflects in the high willingness (77.5%) of the respondents to participate in community-based improvement programs.

Table 4: Health and Perceptions

Variable	Category	Percentage (%)
Illnesses Experienced in Last 6 Months	Diarrhoea	12.5
	Typhoid	17.5
	Cholera	5
	Skin rashes	8.33
	Malaria	56.67
Perceived Causes of Illnesses	Contaminated water	28.33
	Poor sanitation	15.83
	Food borne	6.67
	Don't know	45.83
	Other	3.33

Satisfaction with Water and Sanitation Services	Very satisfied	5.83
	Satisfied	18.33
	Neutral	44.17
	Dissatisfied	27.5
	Very dissatisfied	4.17
Suggested Improvements for Water-Sanitation System	Adequate cleaning	13.33
	Good facilities	11.67
	Cleanliness	32.5
	Always neat	14.17
	Water treatment	14.17
	Clean environment	14.17
Support for Community-Based Improvement Program	Yes	77.5
	Maybe	22.5

Association between perceived sanitation condition and satisfaction with water/sanitation services

Table 5 presents the chi-square results to examine the relationship between perceived sanitation condition and satisfaction with water and sanitation services. From Table 8, there was a significant association between the perceived condition of sanitation infrastructure and satisfaction with water and sanitation services, χ^2 (8) = 19.541, p = .012. Respondents who rated the infrastructure as "fair" showed the most diverse satisfaction levels, while those perceiving it as "poor" were predominantly dissatisfied.

Table 5: Association between Perceived Sanitation Condition and Satisfaction with Water and Sanitation Services

Condition	Satisfaction level				χ^2	df	p-value
	Dissatisfied	**Neutral**	**Satisfied**	**Very Satisfied**			
Poor	15	16	0	3	19.541	8	0.012
Fair	11	26	7	15			
Good	7	11	0	4			

Association between drinking water source and illness

Table 6 presents the chi-square results to examine the relationship between drinking water source and illnesses experienced. From Table 9, a chi-square test indicated a statistically significant relationship between drinking water source and illnesses experienced, χ^2 (8) = 32.642, p < .001. Households relying on boreholes/wells reported the highest diarrhoea cases. WHO estimated that 88% of all cases of diarrhoea globally were attributable to WASH (WHO, 2019). Table 9 shows that different water sources pose varying health risks, possibly due to differences in quality or contamination levels.

Table 6: Association between Drinking Water Source and Illnesses Experienced

Water Source	Illness					χ^2	df	p-value
	Cholera	**Diarrhoea**	**Malaria**	**Skin Rashes**	**Typhoid**			
Borehole/Well	2	5	41	0	9	32.642	8	0.000
Stream/River	0	1	19	4	3			

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Association between Sanitation Infrastructure Condition and Perceived Link to Unsafe Water

Table 7 presents the chi-square results to examine the relationship between sanitation infrastructure condition and perceived link to unsafe water. From table 10, a significant association was found between the condition of sanitation infrastructure and perceptions of its link to unsafe water, χ^2 (6) = 29.816, $p < .001$. Respondents who rated sanitation as "fair" or "poor" were more likely to agree or strongly agree that poor sanitation is related to unsafe water. This reflects a heightened perception of environmental health risks among those exposed to inadequate sanitation.

Table 7: Association between Sanitation Infrastructure Condition and Perceived Link to Unsafe Water

Condition	Satisfaction level				χ^2	df	p-value
	Disagree	**Neutral**	**Agree**	**Strongly Agree**			
Poor	0	28	3	3	29.817	6	0.000
Fair	21	26	9	8			
Good	0	12	4	6			

Comparison of measured parameters with standards

Table 8 presents the comparison of the concentrations of the water quality parameters for the drinking water sources in both dry and rainy season with the WHO recommended limit (WHO, 2022).

Table 8: Summary of Water Quality Parameters in Water Sources during Dry and Rainy Seasons

Parameter *	Mean values					WHO Recommended limit (WHO, 2022)
	Well Water		**Borehole Water**			
	Dry Season	**Rainy Season**	**Dry Season**	**Rainy Season**	**Rainy Season**	
pH	10.80	8.91	10.75	9.06	8.15	**6.5 - 8.5**
DO	50.50	59.19	24.49	22.98	6.00	**> 5**
Cd	0.49	0.50	0.19	0.21	0.0035	**0.003**
Cu	6.78	6.83	6.36	6.55	0.26	**< 2**
Fe	4.61	5.26	2.31	2.26	0.33	**< 0.3**
Nitrate	1.64	2.37	1.65	1.56	2.92	**< 50**
Phosphate	0.56	0.57	0.47	0.48	0.70	**Not specified**
Sulphate	90.14	95.16	57.36	57.37	13.65	**Not specified**

* pH (no unit), others are in mg/L.

From Table 8, for the well water, pH value was clearly alkaline in both seasons, greater than the WHO guideline (6.5–8.5), with a significantly higher mean during the dry season (10.80) compared to the rainy season (8.91), although both remain outside acceptable limits. This is consistent with the findings of Aladese and Pondei (2021) who observed higher pH in dry months. The significant pH drop in the rainy season suggests dilution by rainwater. The concentration of DO increased in the rainy season, which can be linked to more infiltration. Cd and Cu concentrations remained relatively stable in both seasons. Higher concentrations were observed in the rainy season for iron (5.26 mg/L), nitrate (2.37 mg/L), phosphate (0.57 mg/L), and sulphate (95.16 mg/L). all heavy metals exceeded the WHO recommended limit. Increase in iron may be due to leaching from surrounding soils, while washing of nutrients such as fertilizer, from farmlands may have increased phosphate and nitrate levels in the rainy season.

The borehole water had high pH values, similar to well water, though slightly lower (10.75 in dry and 9.06 in rainy season respectively), which also exceeded the WHO limits. DO, Fe and nitrate concentrations reduced in the rainy season while all other parameters showed slightly higher concentrations in the rainy season.

Stream water had more neutral pH values (8.13–8.15), remaining within acceptable WHO standards, contrary to the well and borehole water. DO concentrations increased slightly during the rainy season, but were lower than the other two sources. The concentration of heavy metals (Cu, Fe, and Cd) reduced in the rainy season, and were generally lower than the well and borehole water. This may result from higher runoff from rainfall due to the open surface of streams and rivers. The concentrations of phosphate and sulphate increased in the rainy season, suggesting nutrient inflow due to runoff.

The high concentration of cadmium and iron in well and borehole water pose chronic risks. Cadium can result in gastrointestinal infections such as diarrhoea (Nwanaforo et al., 2024). The high phosphate concentration in streams can increase eutrophication risks, potentially fostering algal blooms and waterborne pathogens, a concern raised by Okesanya et al. (2024). The findings revealed poor water quality, inadequate sanitation infrastructure and significant public health risks in Omu-Aran.

CONCLUSION

This study provides a comprehensive evaluation of water quality, sanitation infrastructure, and the relationship to the well-being of health of residents in Omu-Aran. The study reveals the prevalent use of pit latrines and open defecation, limited access to functional handwashing stations, and inadequate waste disposal services. WASH practices such as seldom treatment of water before drinking and poor sanitation hygiene were also discovered. The study also shows that although, some diseases were associated with distinct water sources, the health risks from poor WASH practices were still evident.

The water quality assessment of the major sources of drinking water revealed significant seasonal variations, with well and borehole water exhibiting alkaline pH levels exceeding WHO guidelines, while stream water remained within acceptable limits. High levels of cadmium and iron in well and borehole pose significant health risks. The study concluded that sanitation infrastructure and water quality in Omu-Aran is in a critical state requiring urgent intervention to safeguard public health and environmental sustainability. Safeguarding the environment and the health of the residents of Omu-Aran can be achieved in a number of ways. The government should develop a comprehensive water and sanitation infrastructure upgrade program in Omu-Aran. Modern and well-constructed sewage facilities can be provided to replace pit latrines and open defecation sites and prevent sewage overflow. The municipal solid waste management system should be improved. Regular water quality monitoring should be established, and a public health campaign launched to educate residents on WASH practices. Comparative studies with other Nigerian towns facing similar challenges can provide broader insights, to develop a localised and comprehensive WASH standard for Nigeria.

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