



Original Article



Evaluation of Physicochemical Properties, Heavy Metal Contamination and Health Risk Implications, and Microbial Integrity of Borehole Water in Odogunyan-Ikorodu, Lagos, Nigeria

Tajudeen O. Yahaya^{1*}, Umar Faruk Mohammed², Abdulmalik Abdulazeez¹¹Department of Biological Sciences, Federal University Birnin Kebbi, Nigeria²Department of Pure and Industrial Chemistry, Federal University Birnin Kebbi, Nigeria**Article history:**

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***Corresponding author:**

Tajudeen O. Yahaya,

Emails: yahaya.tajudeen@fubk.edu.ngyahayatajudeen@gmail.com**Abstract****Background:** Contaminated water remains a major cause of disease worldwide, emphasizing the need for regular safety evaluations of water sources in residential areas. This study aimed to assess the physicochemical properties, heavy metal concentrations, and microbial contamination of borehole water in Odogunyan-Ikorodu, Lagos.**Methods:** The water samples were collected from Ademotu, Three Brothers, Olafiku, Cammy, Leke Silas, Alaba, Opeloyeru, Sakajojo, AOJS, and Omeji streets and analyzed using standard procedures. The results for each parameter were compared with the World Health Organization (WHO) guideline values. Also, the average daily intake (ADI) and hazard quotient (HQ) of the heavy metals were calculated to evaluate potential health risks.**Results:** Physicochemical analysis indicated that temperature, pH, dissolved oxygen (DO), conductivity, total dissolved solids (TDS), and hardness were within permissible limits. However, concentrations of lead (Pb) and mercury (Hg) exceeded the limits (≤ 0.01 mg/L for Pb and ≤ 0.006 mg/L for Hg) at all locations. Iron (Fe) levels were also above the permissible limit (≤ 0.3 mg/L) in samples from Ademotu, Three Brothers, Olafiku, Cammy, and Leke Silas, whereas zinc (Zn) and chromium (Cr) concentrations were within acceptable ranges. Although the ADI values for all heavy metals were within the threshold, the HQ exceeded the acceptable value (≤ 1) in all sampling sites. Microbiological analysis showed that all samples contained non-permissible levels of bacteria and coliforms.**Conclusion:** These findings indicate that the borehole water poses potential health risks. Regular monitoring and appropriate treatment are vital to protect public health in the community.**Keywords:** Average daily intake, Borehole, Coliforms, Lead, Mercury

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Introduction

Water is essential for human health and development, serving as the most important natural resource that sustains all living organisms. It constitutes about 70% of the human body mass and plays a critical role in various biological functions.¹ These functions include serving as a medium for chemical reactions, transporting nutrients and waste products, facilitating cell functions, providing lubrication, and regulating body temperature and pH levels, among others.² Moreover, water is a key component of several body fluids, such as blood, saliva, and tears, all of which are vital for biological processes. Unfortunately, water sources such as rivers, streams and groundwater are prone to contamination, compromising the functions

of water.

Contamination of water sources occurs when water quality is compromised by natural phenomena or human endeavours such as mining, agriculture, and the release of domestic and industrial waste. This contamination not only affects the aesthetic value of water but also alters its physicochemical properties, including taste, odour, colour, turbidity, conductivity, temperature, pH, and hardness.³ In addition, it increases levels of harmful chemicals, such as persistent organic pollutants and heavy metals, as well as microorganisms beyond acceptable limits.⁴

Among water contaminants, heavy metals received more global attention consequent of their persistence, widespread distribution, and toxicity.⁵ Common heavy



metals often detected in water include arsenic (As), lead (Pb), mercury (Hg), cadmium (Cd), chromium (Cr), nickel (Ni), and zinc (Zn).⁶ While trace amounts of these elements are necessary for biological functions such as metabolism, they become toxic at higher concentrations.⁷ Heavy metals exposure can damage tissue and DNA, disrupt protein function and enzyme activity, induce carcinogenesis, and contribute to health issues such as cancer, liver and kidney damage, diabetes, and hypertension.^{8,9}

Apart from heavy metals, waterborne pathogens—bacteria (e.g., *Vibrio cholera*, *Salmonella*, *Escherichia coli*), parasites (e.g., *Cyclospora*, *Giardia*, *Entamoeba*), and viruses (e.g., hepatitis A and E, rotavirus)—also pose noticeable health risks.¹⁰ Globally, waterborne diseases claim at least 1.5 million lives annually, with children in developing countries being the most affected.¹¹ In Nigeria, approximately 70,000 children under five years die each year from waterborne diseases.¹² Addressing this crisis requires comprehensive safety assessments of all water sources in residential areas.

In Odongunyan-Ikorodu, Lagos, Nigeria, boreholes and hand-dug wells are the primary sources of water due to their affordability, relative cleanliness, constant availability, and the inadequacy of public water supplies. However, the quality of borehole and well water can deteriorate due to poor management and environmental factors, underscoring the need for regular safety assessments. A recent search of the literature revealed that recent

safety assessments of borehole water in Odongunyan are lacking. Therefore, the current study aimed to assess the concentrations of chemical elements and microorganisms in borehole water in Odongunyan. This is particularly crucial because studies conducted in nearby towns by Chika et al¹³ and Ezechinyere et al¹⁴ revealed unsafe levels of chemical elements and microorganisms in drinking water. The results from this assessment may form essential baseline data for regulatory agencies and policymakers in the areas.

Materials and Methods

Description of the Study Area

Odongunyan, the focus of this study, is located in the Ikorodu Local Government Area of Lagos State, Nigeria (Figure 1). The town lies at approximately latitude 6°36'00.0"N and longitude 3°30'00.0"E.¹⁵ The terrain is predominantly flat and lies between 10 and 25 meters above sea level. There is dearth of literature on the size of Odongunyan; however, it has a population of approximately 200, 000 people, predominantly from the Yoruba and Igbo ethnic groups, along with some representation from other ethnicities in the country.¹⁶ The area experiences a tropical climate and vegetation, with an average daily temperature of 28.67 °C. It also records high annual precipitation, averaging 132.01 mm and 193.63 rainy days.¹⁷

Because of the high rainfall and favourable geology, the town has abundant groundwater sources, including boreholes and hand-dug wells, as the water table is

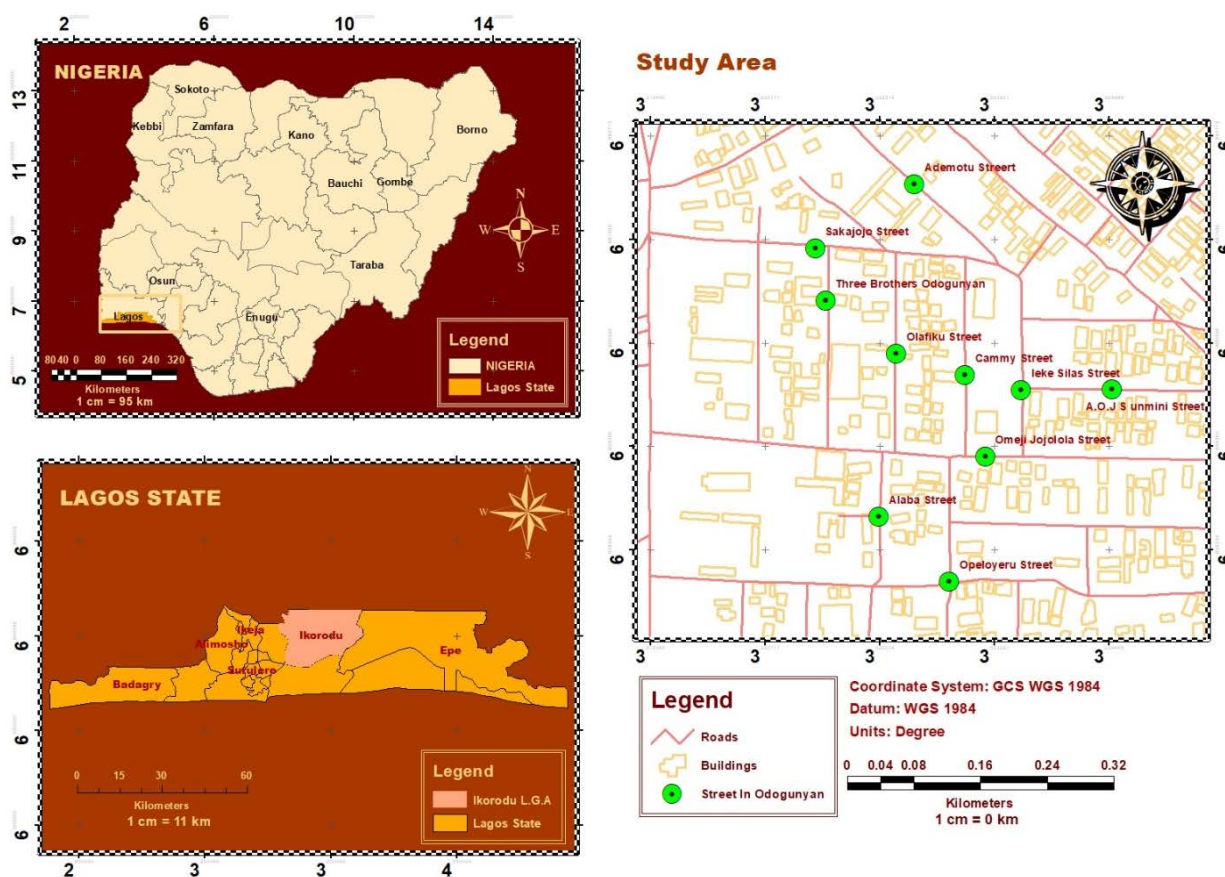


Figure 1. Map of the study areas

relatively high. Unfortunately, Odogunyan is surrounded by several heavy-polluting industries, including those in the steel and textile sectors.¹⁷ Industrial activities, domestic discharges, and urban runoff collectively increase the risk of groundwater pollution, underscoring the need for regular monitoring.

Sample Collection

Three (3) water samples were randomly obtained from a borehole located in each of the selected 10 streets in Odogunyan between June 2024 and September 2024. These streets included Ademolu, Three Brothers, Olafiku, Cammy, Leke Sillas, Alaba, Opeloyeru, Sakajojo, AOJS, and Omeji. In total, 30 samples were gathered for the study. The samples were obtained with clean 2.5 L polyethylene bottles. Water was drawn from each borehole via a tap after allowing it to run for 10 minutes to ensure a representative sample. The bottles were then securely sealed and transported to the laboratory for further analyses.

Physicochemical Properties and Heavy Metal Analyses

Time-sensitive water quality properties such as colour, temperature, taste, odour, dissolved oxygen (DO), conductivity, and pH were measured onsite to ensure data integrity and minimize changes due to sample handling or transportation. Colour was assessed using a Lovibond Tintometer (TB350), which was calibrated with certified colour standards prior to each use to ensure accuracy and repeatability. Taste and odour were evaluated using a Lovibond Osmoscope (MD 100), which was verified with standard reference solutions to ensure consistency in sensory detection thresholds. Temperature was measured using a TP300 multipurpose digital thermometer, calibrated against a mercury-in-glass reference thermometer to maintain measurement accuracy within ± 0.1 °C. The METTLER TOLEDO portable meters were employed for the measurement of pH, conductivity, and dissolved oxygen. These instruments were calibrated daily using standard buffer solutions (pH 4.00, 7.00, and 10.00 for pH meters) and certified calibration solutions for conductivity and DO. The pH meter had an accuracy of ± 0.01 pH units, while the conductivity meter and DO probe provided accuracies of $\pm 1\%$ and ± 0.2 mg/L, respectively. All instruments were operated according to the manufacturers' specifications, and routine checks were performed during field measurements to ensure consistent data quality.

In the laboratory, hardness was measured using the colorimetric method. Total dissolved solids (TDS) was analyzed using the gravimetric method, as described by Awoyemi et al.¹⁸

The levels of heavy metals (Pb, Hg, Cr, Zn, and Fe) in each water sample were determined using atomic absorption spectroscopy (AAS) as outlined in Yahaya et al.¹⁹ 100 mL of each sample was digested with 5 mL of concentrated HNO₃ in a beaker. The mixture was heated gently until its volume was reduced to 20 mL.

Additional concentrated HNO₃ was then added, and heating continued until a brightly coloured solution was obtained. The beaker walls were rinsed with distilled water, and the mixture was cooled and filtered using Whatman filter paper into a 100-mL volumetric flask. The solution was then diluted to the flask's meniscus, making it ready for analysis using a UNICAM 969 atomic absorption spectrophotometer.

Quality Control

All chemicals and reagents used were of analytical grade. Glassware employed during the analysis was pre-cleaned by soaking in 5% HNO₃ overnight, thoroughly rinsed with deionized water, and finally rinsed with the reagent or sample to be introduced. Background contamination during heavy metal analysis was minimized by consistently analysing blank samples alongside the test samples. Furthermore, each heavy metal was evaluated in triplicate, and the results were reproducible with a 95% confidence level.

Microbial Analyses of Borehole Water Samples

The microbial populations (total bacteria, total coliforms, and total fungi) in the water were assessed using the membrane filtration method as outlined in Yahaya et al.¹⁹ To prepare each water sample, 1 mL was transferred into sterile physiological saline (9 mL) and mixed rigorously. Serial dilutions were then performed until the desired dilution was achieved.

For bacterial enumeration, the spread plate method was employed. A 0.1 mL aliquot of the dilution was inoculated onto sterilized nutrient agar plates. Besides, a sterile cellulose filter was used to filter 100 mL of the water and placed on the agar plates and incubated at 36 °C for 24 hours. A colony counter was then used to count the resulting bacterial colonies. The coliform counts in the water were determined using a two-step enrichment process. The filter laden with bacteria was placed on a lauryl tryptose broth medium and incubated for 3 hours at 34 °C. It was then transferred to M-Endo medium and incubated for an additional 22 hours at the same temperature. The resulting coliform colonies were counted. Also, for fungal enumeration, nutrient agar supplemented with an antibiotic to inhibit bacterial growth was used. The fungal colonies were then incubated and enumerated accordingly.

Health Risk Assessment

The associated health risks of heavy metals in the water samples were evaluated using their average daily ingestion (ADI) and hazard quotient (HQ), calculated according to Equations 1 and 2.²⁰

$$D_{ing} = C_x \times IR \times EF \times \frac{ED}{Bwt} \times AT \quad (1)$$

In Equation 1, D_{ing} represents ADI of a heavy metal per kilogram of body weight (mg/kg/day). C_x is the

concentration of the heavy metal in water (mg/L), *IR* denotes the daily ingestion rate (2 L/day), *EF* is the exposure frequency (365 days/year), *ED* is the exposure duration (55 years, the average life expectancy in Nigeria), *B_{wt}* is the body weight (65 kg), and *AT* represents the average time, calculated as *ED* × *EF* (20,075 days).

$$HQ = \frac{Exposure}{RfD} \tag{2}$$

In Equation 2, *HQ* is the hazard quotient (unitless), while *RfD* refers to the oral reference dose of the heavy metal (mg/kg/day) provided by the USEPA.²⁰ The reference doses for the selected heavy metals are as follows: Pb=0.0035, Hg=0.0003, Iron (Fe)=0.007, Cr=0.0003, and Zn=0.3.

Data Analysis

The concentrations of each chemical element and microorganism were expressed as mean ± standard deviation (SD) using Excel 2016 software. Additionally, the software was utilized to calculate the *ADI* and *HQ* of the heavy metals.

Results and Discussion

Physicochemical Properties of the Water Samples

The physicochemical properties of the water samples were within the permissible limits of the World Health Organisation²¹ as shown in Tables 1 and 2.

The pH indicates the concentrations of hydrogen ions (H⁺) in water. A low pH increases the availability and toxicity of heavy metals, while a high pH reduces their toxicity.²² Water temperature affects physical properties such as density, viscosity, conductivity, boiling and melting points, taste, and odour. Drinking room-temperature water enhances hydration, digestion, circulation, and toxin elimination, while cold water constricts blood vessels in the stomach and intestines.²³ TDS reveals the concentrations of dissolved minerals and substances in water. High TDS values are generally not harmful but may affect individuals with kidney or heart conditions.²⁴ Water conductivity reflects the water's ability to conduct

electricity, serving as an indicator of dissolved ionic solids and salinity. Although high conductivity does not directly harm health, it can cause mineral-like taste in drinking water.²⁴ DO measures the amount of oxygen dissolved in water. While high DO levels improve water taste, they can corrode water pipes. Low DO levels are indicative of contamination and are crucial for assessing water quality.²⁵ A hard water has high levels of magnesium and calcium ions, along with other dissolved metals like aluminium, barium, strontium, and manganese. Health effects of hard water are primarily linked to the salts dissolved in the water, particularly calcium and magnesium.²⁶ The findings of the current study suggest that the borehole water in Odogunyan are safe for drinking and domestic use concerning the assessed parameters. Previous studies corroborate these findings. For instance, Adeleke et al²⁷ reported good physicochemical water quality in Odogunyan, while Adeyemi et al²⁸ found acceptable physicochemical parameters in groundwater in nearby Imota town. Similarly, Adekunle et al²⁹ documented permissible levels of physicochemical properties in water samples from Likosi, Ogun State, a border town near the study area. However, contrasting results have been reported in other parts of Lagos State. Ezechinyere et al¹⁴ found elevated levels of turbidity, TDS,

Table 1. Physical parameters of borehole water in Odogunyan

Locations	Colour	Taste	Odour
Ademotu	Colourless	Tasteless	Odourless
Three Brothers	Colourless	Tasteless	Odourless
Olafiku	Colourless	Tasteless	Odourless
Cammy	Colourless	Tasteless	Odourless
Leke Silas	Colourless	Tasteless	Odourless
AOJS	Colourless	Tasteless	Odourless
Omeji	Colourless	Tasteless	Odourless
Alaba	Colourless	Tasteless	Odourless
Opeloyeru	Colourless	Tasteless	Odourless
Sakajojo	Colourless	Tasteless	Odourless
WHO standards ²¹	Colourless	Tasteless	Odourless

WHO=World Health Organization

Table 2. Chemical parameters of borehole water in Odogunyan

Locations	pH	Temperature	Conductivity	TDS	DO	Hardness
Ademotu	6.06 ± 0.02	22.14 ± 0.40	38.12 ± 0.99	257 ± 4.00	0.87 ± 0.04	24.61 ± 0.55
Three Brothers	5.90 ± 0.01	23.58 ± 0.52	41.00 ± 0.52	235 ± 2.00	0.80 ± 0.00	19.80 ± 0.74
Olafiku	6.94 ± 0.03	22.61 ± 0.55	45.73 ± 0.55	252 ± 1.00	0.84 ± 0.02	24.61 ± 0.55
Cammy	6.00 ± 0.00	20.00 ± 0.00	39.88 ± 0.22	211 ± 1.00	0.77 ± 0.01	17.01 ± 0.45
Leke Silas	5.85 ± 0.05	21.88 ± 0.50	40.90 ± 0.76	216 ± 3.00	0.81 ± 0.03	21.16 ± 0.77
AOJS	5.99 ± 0.01	22.61 ± 0.55	39.88 ± 0.22	220 ± 2.00	0.75 ± 0.02	18.22 ± 0.50
Omeji	5.97 ± 0.06	23.24 ± 0.50	41.25 ± 0.94	189 ± 1.00	0.81 ± 0.01	14.61 ± 0.92
Alaba	6.04 ± 0.02	23.17 ± 0.55	42.17 ± 0.02	195 ± 5.00	0.72 ± 0.01	12.00 ± 0.00
Opeloyeru	5.56 ± 0.05	20.50 ± 0.55	39.85 ± 0.55	178 ± 2.00	0.77 ± 0.02	11.98 ± 0.56
Sakajojo	6.05 ± 0.08	22.61 ± 0.55	45.73 ± 0.55	165 ± 2.00	0.74 ± 0.02	10.09 ± 0.15
WHO standards ²¹	6.5-8.5	26-28	<300	500-1500	6.5-8.0	100-250

Values were expressed as Mean ± SD (n=3).

and electrical conductivity in groundwater from Ibeju Lekki. Yahaya et al¹ reported non-tolerable concentrations of calcium, TDS, chloride, hardness, sulfate, phosphate, nitrate, and electrical conductivity in borehole water from Lagos Island. These variations underscore the need for regular monitoring of groundwater quality, as local environmental factors may significantly influence water safety. The findings from this study emphasize the role of maintaining consistent quality checks of water sources in safeguarding public health.

Levels of Heavy Metals in the Water Samples

Table 3 shows the levels of Pb, Hg, Cr, Zn, and Fe in borehole water samples collected from ten streets in Odogunyan. Pb and Hg exceeded the permissible limits of the WHO in all the streets, while Cr was within the permissible limits. With the exception of Alaba, Opeloyeru, and Sakajojo, Fe exceeded the permissible limits in all the streets. Moreover, Zn was below detection levels in all the streets.

The primary entry points of heavy metals in groundwater are human activities, which significantly contribute to environmental pollution.³⁰ Environmental sources of Pb in the area studied included combustion of fossil fuels, paints, industrial waste incineration, lead-acid batteries, pesticides, urban runoff, and industrial dust and fumes.³¹ Hg, a naturally occurring element found in air, water, and soil, was linked to industrial wastewater, fossil fuel combustion, fluorescent bulbs, mercury arc lamps, municipal waste incineration, rubber and plastic manufacturing, and products like mercury amalgam and batteries.³¹ Fe, one of the most prevalent metals in the Earth’s crust, is influenced by natural processes, human activities, and environmental changes.³² In the study area, sources of Fe included urban farming, housing developments, industrial activities, market expansion, and landfill operations.³² These findings are consistent with the findings of earlier studies. For instance, Pessu et al³³ reported Pb levels above permissible limits in groundwater in Ikorodu, Lagos. Similarly, Chika et al¹³ observed non-permissible concentrations of Pb, nickel (Ni), magnesium (Mg), and Fe. In Odogunyan, Adeleke

et al²⁷ found that Cr, Ni, Pb, and Zn concentrations were well below WHO limits, but Cd levels exceeded acceptable thresholds. Salami et al³⁴ also documented elevated Cd levels in groundwater in Ewu Elepe, a nearby town. Notably, studies reporting abnormal Cd concentrations often sampled water near dumpsites, suggesting localized contamination sources.

Health Risks of Heavy Metals in the Water Samples

The average daily intake (ADI) and HQ of Pb, Hg, Cr, Zn, and Fe in the water samples are presented in Figures 2 and 3. The ADIs of all the heavy metals were within the recommended ranges. However, their HQ was greater than the threshold (>1), except for Fe in Omeji, Alaba, Opeloyeru, and Sakajojo streets.

Consistent with the findings of the current study, Yahaya et al¹ and Adeleke et al²⁷ reported non-permissible HQ of heavy metals in groundwater in Lagos Island and Ikorodu. However, Yahaya et al⁵ reported permissible HQ of heavy metals in water samples from Oworonsoki, Lagos. The findings of the current study indicate that borehole water in the study areas poses potential health risks due to heavy metal toxicity and may not be safe for consumption without proper treatment. Pb exposure affects multiple organ systems and is particularly harmful to young children and women of childbearing age. It accumulates in the brain, liver, kidneys, teeth, and bones, where it can persist over time, leading to chronic toxicity.³⁵ Inorganic Hg can cause congenital

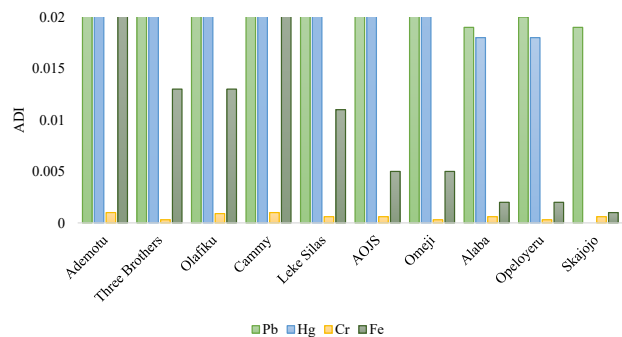


Figure 2. ADI of heavy metals in borehole water in Odogunyan

Table 3. Levels of heavy metal in borehole water in Odogunyan

Locations	Pb (mg/L)	Hg (mg/L)	Cr (mg/L)	Zn (mg/L)	Fe (mg/L)
Ademotou	0.81 ± 0.023	7.01 ± 1.22	22.04 ± 0.02	BDL	0.49 ± 0.08
Three Brothers	0.90 ± 0.011	7.72 ± 1.01	0.01 ± 0.00	BDL	0.41 ± 0.05
Olafiku	0.94 ± 0.001	7.12 ± 1.56	0.03 ± 0.00	BDL	0.43 ± 0.01
Cammy	1.01 ± 0.260	4.09 ± 0.89	0.04 ± 0.01	BDL	0.36 ± 0.05
Leke Silas	0.85 ± 0.050	6.42 ± 0.20	0.02 ± 0.00	BDL	0.35 ± 0.01
AOJS	0.69 ± 0.020	2.88 ± 0.67	0.02 ± 0.00	BDL	0.15 ± 0.08
Omeji	0.79 ± 0.030	2.90 ± 0.56	0.01 ± 0.00	BDL	0.19 ± 0.07
Alaba	0.62 ± 0.010	0.60 ± 0.01	0.02 ± 0.00	BDL	0.06 ± 0.00
Opeloyeru	0.76 ± 0.040	0.61 ± 0.02	0.01 ± 0.00	BDL	0.08 ± 0.01
Sakajojo	0.63 ± 0.020	0.01 ± 0.00	0.02 ± 0.00	BDL	0.05 ± 0.00
WHO standards ²¹	0.01	0.001	0.05	5.00	0.30

Values were expressed as Mean ± SD (n=3); BDL means Below Detection Levels.

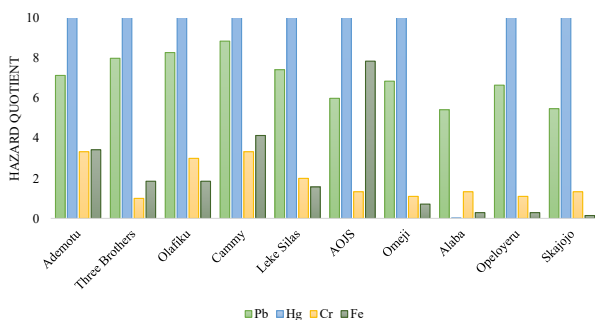


Figure 3. HQ of heavy metals in borehole water in Odogunyan

malformations, neurological disorders, brain damage, central nervous system impairment, and gastrointestinal issues.³⁶ Although Fe in drinking water typically does not cause adverse health effects, excessive levels can alter the water’s taste, appearance, and odour. Accumulation of inorganic Fe in inappropriate tissues has been linked to tissue damage. Cr(VI) is a carcinogen known for its mutagenicity and genotoxicity. Emerging studies also suggest genotoxic effects of Cr(III).³⁷

Levels of Microorganisms in the Water Samples

Table 4 shows the levels of bacteria, coliform, and fungi in the water samples. All the water samples contained non-permissible levels of bacteria and coliform whereas fungi were below detection levels.

The detection of bacteria and coliforms in the water samples above the permissible limits underscores their unsuitability for drinking. A survey by Jimoh et al³⁸ in the study area revealed that 22.8% of respondents reported cases of diarrhoea, 33.1% experienced dysentery, and 28.7% suffered from typhoid fever. Drinking water contamination by bacteria is a major public health concern, causing gastrointestinal diseases like diarrhoea and cholera, as well as fever.³⁹ The proliferation of bacteria in the water may be due to excessive Fe levels, which provide favourable conditions for bacterial growth.⁴⁰ Additionally, contamination may have resulted from polluted runoff and untreated sewage discharged into the environment, a common issue in the area. Coliform bacteria are generally harmless, but certain strains, such as *Escherichia coli* O157, can cause severe gastrointestinal issues, including diarrhoea.⁴¹ The detection of coliforms in the water samples suggests contamination with faecal matter, likely due to the indiscriminate placement of boreholes, septic tanks, and latrines. Boreholes located less than 30 meters from pit latrines or septic tanks are at a higher risk of faecal contamination.⁴² The poor sanitary conditions surrounding the boreholes further exacerbate the bacterial and coliform loads. Jimoh et al³⁸ reported *E. coli* levels exceeding permissible limits in well water in Odogunyan, while Yahaya et al⁴³ documented non-compliant bacterial and coliform levels in borehole water in Maryland, Lagos. Consistent with the findings of this study, these researchers also noted the absence of detectable fungi in groundwater.

Table 4. Levels of microorganisms detected in borehole water in Odogunyan

Locations	Total bacteria	Total coliform	Total fungi
Ademotu	4.1x10 ⁴ ± 34.0	3.0x10 ² ± 40.3	BDL
Three Brothers	6.4x10 ² ± 100.2	2.8x10 ² ± 10.0	BDL
Olafiku	9.8x10 ² ± 500	4.0x10 ¹ ± 10.5	BDL
Cammy	6.5x10 ² ± 34.0	1.1x10 ⁴ ± 22.0	BDL
Leke Silas	7.1x10 ³ ± 34.0	3.2x10 ² ± 34.0	BDL
AOJS	4.9x10 ³ ± 34.0	4.1x10 ⁴ ± 20.0	BDL
Omeji	6.2x10 ² ± 100	2.2x10 ³ ± 64.0	BDL
Alaba	4.1x10 ⁴ ± 34.0	4.5x10 ² ± 100.1	BDL
Opeloyeru	7.1x10 ³ ± 40.6	6.0x10 ² ± 50.0	BDL
Sakajojo	6.0x10 ³ ± 34.0	1.3x10 ² ± 30.0	BDL
WHO standard ²¹	≤ 100 cfu/mL	0 cfu/mL	0 cfu/mL

Values were expressed as mean ± SD (n=3) and CFU/mL; BDL=Below Detection Levels.

Conclusion

The results revealed that the physicochemical parameters of borehole water in Odogunyan, including pH, temperature, TDS, conductivity, DO, and hardness, were within the standards set by the WHO. The water samples were also odourless, tasteless, and colourless. However, they contained non-tolerable concentrations of Pb and Hg, as well as elevated Fe concentrations in some areas. Furthermore, the HQ for all heavy metals (Pb, Hg, Fe, Zn, Cr) in the water samples exceeded the safe threshold. Also, bacterial and fungal contamination exceeded the acceptable limits. Although the physicochemical parameters indicate that the water is generally safe for consumption, the detected levels of heavy metals and microbial contamination present serious health concerns. Regular monitoring and treatment of drinking water are therefore crucial to protect public health in the community.

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Not applicable.

Authors’ Contribution

- Conceptualization:** Tajudeen O. Yahaya.
- Data curation:** Abdulmalik Abdulazeez.
- Formal analysis:** Umar Faruk Mohammed.
- Investigation:** Abdulmalik Abdulazeez.
- Methodology:** Tajudeen O. Yahaya.
- Project administration:** Umar Faruk Mohammed.
- Resources:** Tajudeen O. Yahaya.
- Supervision:** Tajudeen O. Yahaya.
- Validation:** Umar Faruk Mohammed.
- Writing – original draft:** Tajudeen O. Yahaya.
- Writing – review & editing:** Umar Faruk Mohammed.

Competing Interests

The authors declared no conflict of interest.

Ethical Approval

Not applicable.

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