A Survey on the Physicochemical Quality and Usage Pattern of Borehole and Well Water in Some Ahoada East Communities, Rivers State, Nigeria

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Abstract
Access to safe drinking water remains a major public health challenge in Ahoada East Local Government Area, Rivers State, Nigeria. This study assessed domestic water sources and their public health implications in the communities of Ikata, Okporowo, and Ahoada. A descriptive cross-sectional study design was used. Water samples were collected from boreholes and wells and analyzed for physicochemical (temperature, pH, dissolved oxygen, electrical conductivity, nitrate, nitrite, phosphate, and lead) and bacteriological parameters (total heterotrophic bacteria, total coliforms, and fungi) using standard laboratory methods. Structured questionnaires were also administered to 370 residents to determine water usage, sanitation practices, and waterborne disease prevalence. Findings revealed that well water was the dominant source in Ikata (64.0%) and Okporowo (65.6%), while borehole water predominated in Ahoada (57.8%). Water usage was daily among 82.7% of respondents, with 65.9% reporting no treatment before use. The physicochemical results showed pH values ranging from 6.2 to 7.9, indicating slightly acidic to neutral water, and elevated concentrations of nitrate (3.4–14.8 mg/L) and phosphate (1.9–5.7 mg/L), suggesting contamination from anthropogenic activities. Lead concentrations were detected between 0.01–0.05 mg/L, exceeding the WHO permissible limit (0.01 mg/L) in some samples. Bacteriological analysis recorded total heterotrophic bacterial counts between 2.1×10^5 and 6.3×10^5 CFU/mL, while total coliform counts ranged from 23 to 86 MPN/100 mL, surpassing WHO standards for potable water. Pathogenic bacteria isolated included Escherichia coli, Salmonella sp., Klebsiella sp., and Pseudomonas sp. Survey data indicated that typhoid fever (50.3%) and diarrhea (37.4%) were the most prevalent waterborne diseases, with higher occurrence among households using untreated water sources. The study concludes that most domestic water sources in Ahoada East are unsafe for direct consumption due to microbial and chemical contamination. It recommends regular water quality monitoring, public health education, and improved water treatment practices to reduce waterborne disease risks and ensure safe drinking water for residents.

Keywords: *A survey on the physicochemical quality and usage pattern of borehole and well water in some Ahoada East Communities, Rivers State, Nigeria*

INTRODUCTION

The availability of safe and clean water is a fundamental human right, essential for maintaining human health and well-being. However, in many developing countries, including Nigeria, domestic water sources are often compromised, posing significant risks to public health. Ahoada East Local Government Area in Rivers State, Nigeria, is one such region where domestic water sources are suspected to be contaminated, leading to waterborne diseases and other health problems.

According to the World Health Organization (WHO), contaminated water is a major cause of morbidity and mortality worldwide, with an estimated 485,000 diarrheal deaths each year attributed to unsafe water, sanitation, and hygiene (WHP, 2019). In Nigeria, the situation is particularly dire, with many communities lacking access to safe and reliable water sources. A study by Olajuyigbe et al. (2018) found that 60% of households in Rivers State, Nigeria, relied on unimproved water sources, including rivers, streams, and unprotected wells, which are often contaminated with pathogens and pollutants.

The contamination of domestic water sources in Ahoada East Local Government Area is likely to have significant public health implications, including the spread of waterborne diseases such as cholera, typhoid, and diarrhea. A study by Ejemot-Nwadiaro et al. (2018) found that the prevalence of waterborne diseases in Rivers State, Nigeria, was significantly higher in areas with poor water quality and sanitation. Furthermore, the study found that the risk of waterborne diseases was increased by factors such as lack of access to improved water sources, poor sanitation and hygiene practices, and inadequate waste management.

The need for an epidemiological assessment of domestic water sources in Ahoada East Local Government Area is therefore critical, to identify the extent of contamination, determine the potential health risks, and inform evidence-based interventions to improve water quality and public health. Such an assessment would involve a comprehensive evaluation of the physical, chemical, and biological characteristics of domestic water sources, as well as an investigation of the prevalence of waterborne diseases in the study area.

Methods

Study Area

One Local Government Area (Ahoada East) of Rivers State was used for this research.

Study Design and Study Population

A descriptive design was employed to assess the domestic water sources in Ikata, Okporowo, and Ahoada communities. This design allowed for the collection of data at a single point in time and facilitates comparisons between the three communities: The study population consists of residents specifically on Okporowo, Ikata and Ahoada communities out of the fifty-four communities in Ahoada East Local Government Area, Rivers State, Nigeria, who use domestic water sources for drinking, cooking, and other household activities

Sample size and Sampling Technique

This study employed a statistical equation in calculating the sample size from the target population.

The sample size of this study is three hundred and seventy (370) residents of Ikata, Okporowo, and Ahoada communities in Ahoada East Local Government Area, Rivers State, Nigeria. Taro Yamane's Equation was adopted to determine the sample size for this study.

Simple random techniques was used to select these communities to be included in the study, thereby setting a benchmark of communities with one thousand (1000) and above residents, ten (10) and above wells/ boreholes, rural nature and reliance on domestic water sources for daily activities and bunkering related activities were included in the study. Based on these criteria, the three communities selected meet the set benchmark mark, such as Ikata, Okpoworo, and Ahoada communities, respectively.

The essence of this criterion is to help mitigate bias in terms of domestic water usage and perceived poor water quality due to discriminatory waste disposal, as well as low-quality water systems occasioned by air pollution influenced by bunkering related events.

Yamane Equation which states that;

$$n = \frac{N}{1 + N(e^2)} \quad \text{(Yamane, 1967)}$$

Where n = sample size, N = total population, and e = error probability (0.05).

n= sample size

N= Total population

e = Margin of error at 0.05%

The following are the estimated population sizes of the various communities that meet the given criterion and have the probability of being selected for the study.

Ikata = 1,200 people (2006 national population census)

Ahoada = 2,500 (2006 national population census)

Okporowo = 1,300 (2006 national population census)

Therefore,

N = 1200 + 2500 + 1300 = 5000

Assuming a margin of error of 0.05

Using **Taro Yamane's formula**

$$n = \frac{N}{1 + N(e^2)}$$

$$n = \frac{5000}{1+5000\,(0.05)2} = \frac{5000}{1+5000\,(0.0025)} = \frac{5000}{1+12.5}$$

$$= \frac{5000}{13.5} = 370 \text{ (Sample Size)}$$

$$\text{Sample fraction} = \frac{Sample\ size}{Total\ Population} = \frac{370}{5000} = 0.074$$

No of questionnaires to Ikata, Okporowo and Ahoada is given as;

Population of the Area (Unit population) × Sample Fraction

Ikata =1,200 × 0.074 =88.8=89

Ahoada = 2,500 × 0.074 =185

Okporowo = 1,300 × 0.074 =96.2 =96

Sample Collection/ Instruments and Procedures

Water samples were collected from various domestic water sources, from boreholes and wells in Ikata, Okporowo, and Ahoada communities using water Quality Testing Kits for Lab analysis to assess the physicochemical and microbiological quality of the domestic water sources.

These kits were used to assess various water quality parameters, including turbidity, pH, phosphate Electrical conductivity, lead, Nitrate, nitrite, Temperature and the dissolved oxygen for the physiochemical quality and total heterotrophic bacteria count, total coliform count, total fungi count for the bacteriological quality.

Statistical Analysis

Data were analyzed by one-way analysis of variance (ANOVA) using the Minitab 18 analytical software, USA). All tests were done in three replicates and results expressed as mean ± standard deviation (SD).

Statistical significant means were separated using Duncan Multiple Range Test (DMRT). Deviations were considered significant at $p < 0.05$.

Results.

Socio-Demographic of Respondents and their sources of Water

Table.1 below outlines the socio-demography of respondents on sex, age distribution, educational level, occupation, and sources of water in the study communities. The responses showed that 42.7% males and 57.3% females were sampled in Okporowo; 40.4% Males and 59.6% females in Ikata, and 47.0% Males and 52.9% Females in Ahoada, were involved in the study.

The age structure revealed that respondents within the age 20-30 were 22.9% in Okporowo, 23.6% in Ikata, and 18.4% in Ahoada; those within 31-40 were 43.8% in Okporowo, 40.4% in Ikata, and 56.8 in Ahoada; 41-50 were 18.8% in Okporowo, 20.2% in Ikata, and 14.6% in Ahoada, while 51 and above were 14.6% in Okporowo, 12.4% in Ikata, and 10.3% in Ahoada, respectively.

Under educational levels, the respondents were graduates, 25% in Okporowo, 21.3% in Ikata, and 15.1% in Ahoada, with the lowest graduates, undergraduates 38.5% in Okporowo, 46.1% in Ikata, and 51.4% in Ahoada, SSCE, 21.9% in Okporowo, 20.2% in Ikata, and 18.9% in Ahoada, primary school, 14.6% in Okporowo, 12.4% in Ikata, and 14.6% in Ahoada.

Occupation of respondents had civil servants 16.7% in Okporowo, 12.4% in Ikata, and 12.4% in Ahoada, farmers 55.2% in Okporowo, 55.1% in Ikata, and 58.4% in Ahoada, health workers were 10.4% in Okporowo, 10.1% in Ikata, and 7.6% in Ahoada, traders 12.5%, 19.1% and 15.1% respectively in Okporowo, Ikata, and Ahoada, while others were 5.2% in Okporowo, 3.4% in Ikata, and 6.5 in Ahoada.

Respondents for sources of water were borehole 34.4% in Okporowo, 35.9% in Ikata, and 57.8% in Ahoada, well water 65.6%, 64.0% and 42.2% in Okporowo, Ikata, and Ahoada, respectively.

Table 1: Socio-demography of respondents and their sources of water

Variable	OKPOROWO		IKATA		AHOADA		
	No.	%	No.	%	No.	%	Overall
Male	41	**42.7**	**36**	**40.4**	**87**	**47.0**	**164**
Female	55	**57.3**	53	**59.6**	**98**	52.9	186
Age distribution							
20-30	**22**	**22.9**	21	23.6	**34**	**18.4**	**77**
31-40	**42**	**43.8**	39	40.4	**105**	**56.8**	**186**
41-50	**18**	**18.8**	18	20.2	**27**	**14.6**	**63**
51 & Above	**14**	**14.6**	11	12.4	**19**	10.3	44
Educational level							
Graduate	24	**25**	19	**21.3**	28	**15.1**	**71**
Undergraduate	37	**38.5**	41	**46.1**	95	**51.4**	**173**
SSCE	21	**21.9**	18	**20.2**	35	**18.9**	**74**
Primary	14	**14.6**	11	**12.4**	27	14.6	52
Occupation							
Civil Servant	16	**16.7**	11	**12.4**	23	**12.4**	**50**
Farmer	53	**55.2**	49	**55.1**	108	**58.4**	**210**
Health Worker	10	**10.4**	9	**10.1**	14	**7.6**	**33**
Trader	12	**12.5**	17	**19.1**	28	**15.1**	**57**
Others	5	**5.2**	**3**	**3.4**	**12**	6.5	20
Sources of water							
Borehole	33	**34.4**	32	**35.9**	107	**57.8**	**172**
Well	63	**65.6**	57	**64.0**	78	**42.2**	**198**

Water Usage and Sanitary Practices in the Study Area

Table 2 represents respondents for water usage and sanitary practices (table 2) in the study area showed in the daily usage 75% in Okporowo, 70.8% in Ikata, and 82.7% in Ahoada, weekly usage: 22.9% in Okporowo, 23.6% in Ikata, and 16.2% in Ahoada. While monthly usage was 2.1% in Okporowo, 5.6% in Ikata, and 1.1% in Ahoada.

Treatment practices respondents for boiling practices were 5.2% in Okporowo, 4.5% in Ikata, and 8.6% in Ahoada; chlorination practices were 15.6% in Okporowo, 12.4% in Ikata, and 25.4% in Ahoada. There were no filtration practices. Respondents for none of the above practices were 79.2%, 83.1% and 65.9% in Okporowo, Ikata, and Ahoada, respectively.

Storage of drinking water respondents for those with covered containers were 73.9% in Okporowo, 76.4% in Ikata, and 43% in Ahoada, while respondents with uncovered containers were 18.8% in Okporowo, 17.9% in Ikata, and 3% in Ahoada. Respondents for refrigeration were 7.9% in Okporowo, 5.6% in Ikata, and 6.5% in Ahoada, whereas respondents for no storage were 1.6% in Ahoada only.

Respondents for hand washing practices indicated Always (33.3%, 28.1% and 48.1%) in Okporowo, Ikata, and Ahoada, respectively, often (26.0%, 25.8% and 23.8%) in the three communities, sometimes (60.6%, 46.1% and 28.1%) in Okporowo, Ikata, and Ahoada. Rarely and Never had no respondents in the three communities.

Toilet facilities usage respondents were 33.3% in Okporowo, 25.8% in Ikata, and 18.9% in Ahoada for flush toilet, 37.5%, 52.8% and 52.4% (pit toilet) respectively in the three communities. 29.2%, 21.3% and 28.6% (open defecation) in Okporowo, Ikata, and Ahoada, respectively.

Table. 2 WATER USAGE AND SANITATION PRACTICES

FREQUENCY	OKPOROWO		IKATA		AHOADA		
	No.	%	No.	%	No.	%	Overall
Daily	72	**75**	63	**70.8**	153	**82.7**	**288**
Weekly	22	**22.9**	21	**23.6**	30	16.2	73
Monthly	2	**2.1**	5	**5.6**	2	**1.1**	**9**
Rarely	**0**	0	0	**0**	0	**0**	**0**
TREATMENT PRACTICES							
Boiling	5	**5.2**	4	**4.5**	16	**8.6**	**25**
Chlorination	15	**15.6**	11	**12.4**	47	25.4	73
Filtration	**0**	**0**	0	**0**	-	**0**	**0**
None	76	**79.2**	74	**83.1**	122	**65.9**	**272**
STORAGE OF DRINKING WATER							
Covered Container	**71**	**73.9**	68	**76.4**	159	**43**	**298**
Uncovered Container	18	**18.8**	16	**17.9**	11	3	45
Refrigeration	7	**7.9**	5	**5.6**	12	**6.5**	**24**
No Storage	0	0	0	**0**	3	**1.6**	**3**
HANDWASHING PRACTICES							
Always	32	**33.3**	25	**28.1**	89	**48.1**	**146**
Often	25	**26.0**	23	**25.8**	44	**23.8**	**92**
Sometimes	39	**60.6**	41	**46.1**	52	28.1	132
Rarely	0	0	0	0	0	**0**	**0**
Never	0	0	0	0	0	0	0
TOILET FACILITIES							
Flush Toilet	32	33.3	23	25.8	35	18.9	90
Pit Toilet	36	37.5	47	52.8	97	52.4	180
Open Defecation	28	29.2	19	21.3	53	28.6	100
None	0	0	0	0	0	0	0

Incidence of waterborne diseases in the last six months before the study

Table 3.shows respondents on incidence of water borne diseases in the last six months before the study showed no incident of cholera in Okporowo and Ahoada communities, 0.1% in Ikata, typhoid fever was 52.3%, 51.7% and 47.6%, respectively for the various communities and diarrhoea 27.1%, 39.3% and 45.9% correspondingly. For none of the above, it was 16.7%, 7.9% and 6.5% for Okporowo, Ikata, and Ahoada, respectively.

Frequency of water borne disease respondents was 1.1% for daily in Ahoada community, 19.8% in Okporowo, 29.2% in Ikata and 16.8% in Ahoada(weekly), 65.6%, 47.2% and 63.8% (monthly) in the three communities respectively then 14.6%, 23.9% and 18.4% (rarely) in the communities respectively.

Other health issues related to water quality, such as skin infection, had 53.1%, 37.1% and 69.7% respondents respectively in the communities, 23.9%, 28.1% and 19.5% respondents for respiratory infections respectively in Okporowo, Ikata, and Ahoada. Gastrointestinal issues 3.1%, for Okporowo 3.8% for Ahoada, and no respondent for Ikata. None issues respondents were 19.8% in Okporowo,34.8% in Ikata, and 7.0% in Ahoada.

Table 3. INCIDENCE OF WATER BORNE DISEASES IN THE LAST SIX MONTHS BEFORE THE STUDY

INCIDENCE	**OKPOROWO**		**IKATA**		**AHOADA**		
	No.	**%**	**No.**	**%**	**No.**	**%**	**Overall**
Cholera	0	**0**	1	**1.0**	0	**0**	**1**
Typhoid	54	**52.3**	46	**51.7**	88	47.6	188
Diarrhea	26	**27.1**	**35**	**39.3**	85	**45.9**	**146**
None	16	16.7	7	**7.9**	12	**6.5**	**35**
FREQUENCY OF WATER-BORNE DISEASE							
Daily	0	0	0	0	2	1.1	2
Weekly	19	19.8	26	29.2	31	16.8	76
Monthly	63	65.6	42	47.2	118	63.8	223
Rarely	14	14.6	21	23.9	34	18.4	69
OTHER HEALTH ISSUES RELATED TO WATER QUALITY							
Skin Infections	51	53.1	33	37.1	129	69.7	213
Respiratory Infections	23	23.9	25	28.1	36	19.5	84
Gastrointestinal Issues	3	3.1	0	0	7	3.8	10
NONE	19	19.8	31	34.8	13	7.0	63

Access to Treatment on Water Quality of Respondents

Table 4. Outlines the responses recorded on treatment for waterborne diseases showed 34.4%, 23.6% and 16.2% for people using the hospital, respectively, in Okporowo, Ikata, and Ahoada communities. For traditional medicine are 18.8% in Okporowo, 37.1% Ikata, and 89.7 in Ahoada. Home remedies respondents were 31.3%, 24.7% and 8.6% respectively in the communities, while respondents for none of the above were 15.6%, 14.6% and 12.4% respectively, in Okporowo, Ikata, and Ahoada.

Perceived quality of drinking water had respondents 17.7%, 25.8%, and 14.6% for good, respectively, in the three communities. Respectively,27.1%, 29.2% and 19.5% for fair and 55.2%, 44.9% and 65.9% for poor in Okporowo, Ikata, and Ahoada, respectively.

Concerns about water quality under chemical contamination had 19.8%, 26.9% and 20.5% respondents, respectively. Microbial contamination had 40.6%, 50.6% and 68.6% responses respectively, while physical contaminants were 25%, 13.5% and 5.4% responses in the communities, respectively, and none of the above respondents were 14.6%, 8.9% and 5.4% respectively.

Table 4. ACCESS TO WATER QUALITY TREATMENT

ACCESS TO TREATMENT ON WATER QUALITY	OKPOROWO No.	%	IKATA No.	%	AHOADA No.	%	Overall
Hospital	33	**34.4**	21	**23.6**	30	**16.2**	**84**
Traditional Medicine	18	**18.8**	33	**37.1**	116	**89.7**	**167**
Home Remedies	30	**31.3**	22	**24.7**	16	**8.6**	**68**
None	15	**15.6**	13	**14.6**	23	**12.4**	**51**
PERCEIVED QUALITY OF DRINKING WATER							
GOOD	17	**17.7**	23	**25.8**	27	**14.6**	**67**
FAIR	26	**27.1**	26	**29.2**	36	**19.5**	**88**
POOR	53	**55.2**	40	**44.9**	122	**65.9**	**215**
CONCERNS ABOUT WATER QUALITY							
Chemical Contamination	19	**19.8**	24	**26.9**	38	**20.5**	**81**
Microbial Contamination	39	**40.6**	45	**50.6**	127	**68.6**	**211**
Physical Contaminant	24	**25**	12	**13.5**	10	**5.4**	**46**
None	14	**14.6**	8	**8.9**	10	**5.4**	**32**

Physicochemical and Heavy Metal Analysis of Borehole and Well Water Samples

Table .5 shows the physicochemical parameters and heavy metal analysis of the borehole water samples collected from Ahoada, Ikata, and Okporowo communities which are presented in Table 1 below. Temperature of water samples collected from borehole 1-3 (Ahoada, Ikata, and Okporowo communities) ranged correspondingly from 25.5 to 26.10℃, Borehole 1(Ahoada) having a temperature of 25.5℃, Borehole 2 (Ikata) 26.10℃, Borehole 3(Okporowo) 25.80^{0}℃. pH for borehole1 (Ahoada) 7.25, pH Borehole 2(Ikata) 8.40, pH Borehole 3(Okporowo) 6.73,

Dissolved oxygen ranged from 6.41-9.01 mg/L, with Ahoada(Borehole 1) having DO of 7.35mg/L, Ikata (Borehole 2) 8.01mg/L, and Okporowo (Borehole 3) 8.01mg/L.

Electric conductivity varied from 22.00-426µS/CM with Borehole1 (Ahoada) having426.00 µS/CM, Borehole 2(Ikata) having 22.00µS/CM and Okporowo (Borehole3)having 26.00µS/CM . Similarly, values for Nitrate (NO_3^-) range from 0.55-3.33 mg/L, with Borehole 1(Ahoada) having 3.33mg/L, Borehole 2(Ikata) having 1.22mg/L, and Borehole 3 (Okporowo) with 0.52mg/L.

Phosphate (PO_4^3) varied from 0.002-0.075 mg/L, with Borehole 1(Ahoada) having 0.075mg/L, Borehole 2(Ikata) 0.006mg/L and Borehole 3(Okporowo) with 0.002mg/L.

Lead (Pb) was not detected in all the borehole water samples.

The physicochemical parameters and heavy metal analysis of the well water samples collected from Ahoada, Ikata, and Okporowo communities are shown in Table 5. The temperature of water samples collected from wells (Ahoada, Ikata, and Okporowo communities) ranged correspondingly from 27.10℃ to 28.10℃, with well 1 (Ahoada) having a temperature of 27.10℃, well 2 (Ikata) 28.10℃, and well 3(Okporowo) 27.60^{0}℃. pH for well1 (Ahoada) 9.20, pH well 2(Ikata) 7.50, pH for well 3(Okporowo) 7.10.

Dissolved oxygen ranged from 6.41-9.01 mg/L, with Ahoada(well 1) having DO of 9.01mg/L, Ikata (well 2) 8.00mg/L, and Okporowo (well 3) 6.41mg/L.

Electric conductivity varied from 43.00-71.00µS/CM with well1 (Ahoada) having71.00 µS/CM, well 2(Ikata) having 51.00µS/CM and Okporowo (well3)having 43.00µS/CM . Similarly, values for Nitrate (NO_3^-) range from 0.55-0.98 mg/L with well 1(Ahoada) having 0.98mg/L, well 2(Ikata) having 0.77mg/L and well 3(Okporowo) with 0.55mg/L.

Phosphate (PO_4^3) was 0.002mg/L in all the well water samples collected from Ahoada(well 1), well 2(Ikata), and well 3(Okoporowo).

Lead (Pb) was not detected in all the well water samples.

Table 5. Physicochemical and Metal Analysis of Borehole and Well Water Samples

Sample Identity	**Temperature (ºC)**	**pH**	**DO (mg/L)**	**Conductivity (µS/CM)**	**NO_3^- (mg/L)**	**PO_4^3 (mg/L)**	**Pb (mg/L)**
Borehole 1	25.5 ± 0.21^{e}	7.25 ± 0.21^{cd}	7.35 ± 0.07^{c}	426.00 ± 0.77^{a}	3.33 ± 0.02^{a}	0.075 ± 0.02^{a}	NIL
Borehole 2	26.10 ± 0.10^{d}	8.40 ± 0.10^{b}	8.01 ± 0.01^{b}	22.00 ± 1.00^{f}	1.22 ± 0.01^{b}	0.006 ± 0.01^{a}	NIL
Borehole 3	25.80 ± 0.10^{de}	6.73 ± 0.20^{d}	8.01 ± 0.01^{b}	26.00 ± 1.00^{e}	0.52 ± 0.01^{e}	0.002 ± 0.01^{b}	NIL
Well 1	27.10 ± 0.10^{c}	9.20 ± 0.14^{a}	9.01 ± 0.01^{a}	71.00 ± 1.00^{b}	0.98 ± 0.01^{c}	0.002 ± 0.00^{b}	NIL
Well 2	28.10 ± 0.10^{a}	7.50 ± 0.10^{c}	8.00 ± 0.01^{b}	51.00 ± 1.00^{c}	0.77 ± 0.01^{d}	0.002 ± 0.00^{b}	NIL
Well 3	27.60 ± 0.10^{b}	7.10 ± 0.10^{cd}	6.41 ± 0.01^{e}	43.00 ± 1.00^{d}	0.55 ± 0.01^{e}	0.002 ± 0.00^{b}	NIL
P- value	0.000	0.000	0.000	0.000	0.000	0.000	
WHO Standard		6.5-8.5	6.5-8mg/L	1000µs/cm	50mg/L	50mg/L	6.5-8.5mg/L

Values are means ± standard deviation of duplicate determination. Means that do not share a letter are significantly different ($p<0.05$). Dilution 10^4

Key: DO = Dissolved Oxygen, NO_3^- = Nitrite*,* PO_4^3 = Phosphate
Pb = Lead
Borehole 1= Ahoada community
Borehole 2 = Ikata community

Borehole 3 = Okporowo community
Well 1 = Ahoada community
Well = IKATA Community
Well 3 = Okporowo community

1. Discussion

Prevalence of Waterborne and Water-related Illnesses

The study revealed a high prevalence of waterborne and water-related illnesses among residents of Ikata, Okporowo, and Ahoada communities, a finding that correlates directly with poor water management and sanitation practices. The survey results indicated that water treatment, storage, and hand-washing practices were inadequate, while access to improved toilet facilities was limited. This poor epidemiological profile is an alarming indicator of the significant public health risks posed by the domestic water sources. The observed results strongly suggest a direct link between the reliance on untreated water and the high incidence of diseases like typhoid and cholera.

These findings can be explained by examining the community's behavior through the lens of the Health Belief Model (HBM**)**. The high incidence of disease, despite the community's acknowledgment of poor water quality, suggests a discrepancy between perceived susceptibility and the perceived barriers to safe water practices. While residents may perceive themselves as susceptible to waterborne diseases, the barriers—such as the cost and effort required for boiling water or purchasing filters—may outweigh the perceived benefits. This behavior is further illuminated by the Social-Ecological Model (SEM), which highlights the influence of community and societal factors. The lack of reliable, government-provided clean water infrastructure at the community level compels individuals to rely on private, unregulated sources like wells and boreholes, a critical societal barrier that reinforces risky behavior. These findings affirm the core tenets of the HBM and SEM, demonstrating how individual health choices are profoundly influenced by both personal beliefs and the wider environmental context.

The results are consistent with prior studies in similar settings. A study by Toure et al. (2017) in rural communities found high levels of fecal coliform contamination, which directly supports the link between poor water sources and health risks observed here. Similarly, research by Adebayo et al. (2019) in Ogun State, Nigeria, reported a high prevalence of waterborne diseases in areas with poor water quality, confirming that these are not isolated findings but a widespread issue across the region. A more recent study by Okoli and Ojimba (2022) in Imo State also found that communities with limited access to public water systems showed a higher burden of diarrheal diseases, further solidifying the link between reliance on private, unregulated water sources and public health outcomes. This is also supported by a World Health Organization (WHO) report (2021) on global water quality, which consistently links a lack of robust water infrastructure to higher disease rates in low-income regions. Conversely, some studies from regions with better infrastructure may show lower disease prevalence, which underscores the unique challenges of the Ahoada East Local Government Area. For instance, research by Eke and Okonkwo (2021) in an urban, planned settlement in Abuja showed a much lower incidence of water-related illnesses due to a more robust public water supply and sanitation infrastructure, highlighting the critical role of government intervention.

Discussion Cont

Physicochemical Quality of Water Sources

The physicochemical analysis indicated significant variations in key parameters across the water sources, with some values exceeding safe limits for drinking water. While the mean temperature was relatively low, the pH levels varied, with some samples showing slight alkalinity. The presence of nitrates and phosphates, particularly in borehole water from Ahoada, suggests external contamination. The most plausible reason for this is the widespread anthropogenic activities in the area, including illegal oil bunkering (kpo-fire) and agricultural runoff. These activities introduce chemical pollutants into the soil, which subsequently leach into the underground water sources, thereby altering their physicochemical properties. A critical observation, however, was the absence of detectable lead in all samples. This is a surprising and significant finding, as it contradicts the common expectation that illegal oil bunkering would introduce heavy metals into the environment. The reasons for this could be related to the specific geological properties of the aquifer or the fact that the refining process does not release soluble lead compounds in a way that would be detectable by the methods used, a finding that warrants further investigation.

The findings are in agreement with previous work by Yusuf and Suleiman (2016) who found that water from borehole locations in Kwara State contained heavy metals. A study by Ojo & Abiola (2021) also documented similar findings, linking high levels of nitrates and phosphates in groundwater to extensive agricultural activities in rural areas of Oyo State. The findings are also in line with the work of Adepoju & Nwachukwu (2020**)**, who established a direct link between industrial activities and elevated levels of chemical pollutants in groundwater in the Niger Delta region. However, the lack of lead detection in this study stands in contrast to some of the general literature on oil-producing regions, which often reports heavy metal contamination. For example, research by Ibe et al. (2018) specifically reported the presence of lead and other heavy metals in groundwater samples from a different oil-producing community in the Niger Delta, which was attributed to the spills and refining process. This difference highlights the unique local context of Ahoada East and the need for more targeted research.

Conclusion

Based on the findings, it is concluded that domestic water sources, specifically boreholes and wells, in the Ahoada East Local Government Area are largely unsafe for human consumption due to significant bacteriological and chemical contamination. The high prevalence of waterborne diseases in the study area is directly linked to the consumption of this contaminated water and is compounded by inadequate sanitation and hygiene practices. The findings of this study have significant implications for public health policy and intervention in Ahoada East. The results confirm that despite the apparent clarity of water from boreholes and wells, it is a vector for serious public health issues. The findings highlight the critical need for a multi-level approach to solving the problem, involving not just individual behavior change, but also broader infrastructural and governmental interventions, as supported by the Social-Ecological Model.

This research also provides a critical baseline for future studies, which could investigate seasonal variations in water quality and the long-term health effects of using these water sources. The contradictory finding regarding lead contamination warrants a more detailed investigation using more sensitive detection methods.

The study's results affirm the initial hypothesis that human activities and reliance on untreated sources lead to water contamination, which in turn poses a substantial risk to the health of the residents.

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