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Public perception of potable water sources, quality and treatment in five Local Government Areas of Edo South Senatorial District, Nigeria

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Abstract

The perception of water quality treatment and the source of water for household consumption in Benin City was investigated. In total, 125 participants from five local government areas in Edo South Senatorial District were included in this cross-sectional study. A semi-structured questionnaire was used as a data collection tool to assess water purity, quality, and treatment. The data obtained were analysed via descriptive statistics. Frequencies and percentages of participants' responses were recorded. Approximately 83 (66.4%) of the participants reported sachet water as the primary source of drinking water; 121 (96.8%) used borehole water for cooking; 42 (33.6%) reported washing their water tanks once a year. Seventy-seven participants (61.6%) did not use water treatment methods, 58.9% treated their water through boiling, and 11 (22.9%) used filtration, from the 38.4% that treated. Sixty-three (50.4%) of the participants believed that water treatment and purification procedures are expensive, and 105 (85.6%) of them agreed to pay for affordable treatment measures. Sachet water and that from borehole sources were more commonly used. However, poor water treatment and purification practices were also observed. These findings highlight the need for improved public education on water safety and affordable household purification methods.

Keywords: Household water safety; Public health; Water purity; Water Source; Water treatment

INTRODUCTION

Water is essential for human survival, health, and the sustainable development of societies [1]. Globally, freshwater sources such as rivers, lakes, boreholes, hand-dug wells, and tap water serve as the main supplies for drinking, domestic use, and agriculture. However, the safety of these sources is often compromised, leading to significant public health challenges. Contaminated water and poor sanitation are the leading causes of various waterborne diseases, including cholera, typhoid, hepatitis A, and diarrhoeal illnesses [2–4]. According to the World Health Organization, nearly 2 million lives are lost annually owing to inadequate access to water, sanitation, and hygiene (WASH) services, with children being the most affected [4].

The burden of unsafe water is particularly heavy in Sub-Saharan Africa, which accounts for 60% of disability-adjusted life years (DALYs) and 53% of global deaths attributed to poor WASH conditions [4]. Recognizing this crisis, the United Nations General Assembly in 2010 declared access to clean water and adequate sanitation a basic

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human right [5]. Despite this, as of 2020, over 489 million people globally still lacked access to improved drinking water sources, and 122 million relied on unsafe surface water [6,7].

In Nigeria, the situation remains critical. Despite substantial governmental efforts and investments in water infrastructure, approximately 52% of the population still lacks access to safe drinking water [8]. In many communities, especially in urban centres like Benin City, residents, women, and children often walk long distances to obtain potable water. Surprisingly, an estimated 140 million Nigerians are exposed to water contaminated with harmful bacteria, heavy metals, pathogens, and suspended particles, which contribute to various health problems [9].

Therefore, we sought to assess the sources of drinking water available to residents of five Local Government Areas (LGAs) in Edo South Senatorial District, Nigeria, as well as public perceptions regarding the purity, quality, and treatment of these water sources. Our aim was to answer the research question: What are the primary sources of drinking water in these five LGAs, and how do residents perceive and manage the quality and safety of their water supply? The findings will provide insights into the underlying causes of water contamination and inform practical interventions to promote access to safe drinking water in the region.

EXPERIMENTAL METHODS

Study participants. Administrative approval was granted by the Medical Services Department of the Edo State Ministry of Health (Protocol Number No- HA-737/23/D/08210154). Residents, students, and workers from the five selected local governments, Egor, Oredo, Ikpoba Okha, Orhionmwon, and Ovia North East, were included. Individuals outside these areas, those unwilling to consent, or those who submitted incomplete questionnaires, were excluded from participation in the study. All study participants were verbally briefed on the study's goals and the assurance of their anonymity before the study commenced. Informed consent was obtained from all participants. Furthermore, all gathered data were treated with strict confidentiality.

Study design/setting. This was a cross-sectional, prospective study conducted among residents in five local government areas in Edo South Senatorial District: Egor, Oredo, Ikpoba Okha, Ovia North East, and Orhionmwon.

Recruitment of participants. The study involved a total of 125 participants who were selected from residents of the following local government areas: Egor, Oredo, Ikpoba Okha, Ovia North East, and Orhionmwon. These local government areas were purposively selected based on their strategic location within Edo State, including their proximity to the state capital, Benin City, and accessibility to the researchers, which made them suitable for participant recruitment and ensured a broader representation of the study population. The sample size was calculated using the Taro Yamane formula [10]. Because comprehensive data on the study population were not available, the population of Benin City was used as a reference, which was estimated at 1,904,631 according to the United Nations World Urbanization Prospects (2019). The calculated sample size was approximately 400 participants. However, owing to the limited study period and the short undergraduate academic calendar, only 125 participants were included in the study. In total, 125 houses were conveniently sampled across all local government areas, and participants were selected from the sampled houses. To ensure that participants fully understood the questions in each section, a brief and comprehensive explanation was provided before recording their responses. This explanatory session lasted between 5 and 10 minutes. In cases where necessary, the explanations were conducted in Nigerian Pidgin English, which is an English-based creole language spoken as a

common language throughout Nigeria, to cater to the literacy level of the participants**.**

Data collection. A self-structured, validated questionnaire designed based on the study objectives and pretested (Cronbach's alpha for internal consistency: 0.79) using 10% of the study sample served as the tool for this investigation. The questionnaire was used to collect data from approximately 125 participants in five local government areas. The questions were broken down into six sections. Section one comprised socio-demographic data of participants, section two had five subsections and comprised assessment of participant's response on water usage (frequency and sources), perception of water quality level of study participants were found in section three, and section four through six was used to evaluate participants' perceptions on water treatment, knowledge of respondents on water contamination and response on water treatment service respectively.

Statistical analysis. The data obtained were entered into an Excel sheet and sorted. Subsequently, analysis was performed using the Statistical Package for Social Sciences (SPSS) software version 21. Descriptive statistics were performed to summarise the data collected. The findings are presented in tables as numbers and percentages.

RESULTS

Socio-demographic data of participants. The study included five local governments, involving a total of 125 participants. The distribution of participants across these local governments was as follows: Egor, 24 (19.2%); Ikpoba Okha, 22 (17.6%); Oredo, 26 (10.8%); Orhiomwon, 24 (19.2%); and Ovia-Northeast, 29 (23.2%). A substantial majority, 88 (70.4%), were single among the study participants. In terms of educational background, the majority, 96 (76.8%), had attained a tertiary level of education. Only a small proportion (2, 1.6%) of participants reported having no formal education. Regarding employment, the majority of participants, 109 (87.2%), were employed. Furthermore, 38.4% (n=48) of the participants had fewer than three individuals living in their homes, and 4.8% (n=6) had more than twelve people. The rest of them had three to twelve individuals in their households. These findings are presented in Table 1.

Table 1: Socio-demographic data of study participants

Variable	Classification	Frequency	Percent
Local Government	Egor	24	19.2
	Ikpoba Okha	22	17.6
	Oredo	26	10.8
	Orhiomwon	24	19.2
	Ovia-northeast	29	23.2
Marital Status	Single	88	70.4
	Married	37	29.6
Educational level	None	2	1.6
	Primary	5	4.0
	Secondary	22	17.6
	Tertiary	96	76.8
Occupation	Government employee	7	5.6
	Private employee	55	44.0
	Self employed	47	37.6
	Unemployed	16	12.8
Number of persons in home	Less than three	48	38.4
	Three to six	49	39.2
	Seven to twelve	22	17.6
	Greater than twelve	6	4.8

Water consumption and usage. Participants' responses regarding water consumption and usage are presented in Table 2. Approximately 68 (54.4%) of the participants reported consuming water three to five times daily. However, only 2 (1.6%) never drink water from sources outside their homes. Twenty-six (20.8%) of the participants used water from borehole sources. Furthermore, 62 (49.9%) individuals indicated that they stored their water in refrigerators. However, sachet water was reported as the primary source of drinking water by 83 (66.4%) of the participants. For cooking purposes, a large percentage, 96.8% (n= 121), used borehole water.

Table 2: Water consumption, perception of water purity and quality, and treatment

Variable	Classification	Frequency	Percent
How often do you consume water daily?	<3 times	5	4.0
	3 – 5 times	68	54.4
	6 – 10 times	38	30.4
	>10 times	14	11.2
How often do you drink water from sources other than your home?	Daily	65	52.0
	Occasionally	37	29.61
	Rarely	21	16.81
	Never	2	1.6
How do you store your drinking water at home?	In a covered container	44	35.2
	In an uncovered container	4	3.2
	In a refrigerator	62	49.6
	Others	15	12.0
What is the source of your drinking water?	Borehole	26	20.8
	Water dispenser	5	4.0
	Sachet water	83	66.4
	Bottle water	11	8.8
What is the source of your cooking water?	Borehole	121	96.8
	Water dispenser	1	0.8
	Sachet water	1	0.8
	State Water board	2	1.6
Have you ever had your home water tested for purity and quality?	Yes	20	16.0
	No	105	84.0
If yes, what method did you use to test the water	Chemical test	18	90.0
	Laboratory test	2	10.0
	Microbial testing	0	0
Have you ever received any education or training on water purification?	Yes	87	69.6
	No	38	30.4
If yes, where did you receive the education or training?	At work	5	5.7
	In school	63	72.4
	In a seminar	15	17.2
How important is it to you that your water is free from contamination?	Extremely important	105	84.0
	Somewhat important	18	14.4
	Not very important	2	1.6
How do you currently ensure that the water you drink is safe?	I rely on water utility company	43	34.4
	I use a home water filter	19	15.2
	I purchase bottled water	37	29.6
	I do not take any specific precaution	26	20.8
What would motivate you to test your home's water purity?	Concern about local water quality	53	42.4
	News of contamination in the area	54	34.2
	Govt/community initiative	26	20.8
	Health threat	49	39.2
How frequently should you test your home's water purity and quality?	Once a year	13	10.4
	Every 3 – 6 months	82	65.6
	Only with specific concern	12	9.6
	Not sure	18	14.4

Table 2 cont'd

Variable	Classification	Frequency	Percent
How often is your borehole tank washed?	Every 3 months or less	19	15.2
	Every 6 months	30	24.0
	Yearly	42	33.6
	>yearly	34	27.2
Do you use a water treatment method at home?	Yes	48	38.4
	No	77	61.6
If yes, what treatment do you use? (n=48)	Boiling	28	58.3
	Use of chlorine	8	16.7
	Filtration	11	22.9
	None	1	2.1
How long does your water treatment process take?	<10 minutes	13	27.0
	30 minutes	22	45.8
	1 hour	8	16.7
	>1 hour	5	10.4
How much do you spend on accessing drinking water daily?	<1000 naira	58	46.4
	1000 – 3000 naira	45	36.0
	3000 – 6000 naira	13	10.4
	>6000 naira	7	5.6

Water purity and quality. Assessment of water purity and assessment practices by participants are presented in Table 2. The majority (105, 84%) of the participants had never conducted water purity testing; however, 87 (69.6%) had received education or training regarding water purification. In addition, only 18 (90%) opted for chemical testing methods, from those who had their water tested for purity. However, 105 (84.0%) of the participants strongly emphasised the importance of consuming uncontaminated drinking water.

Perception of water purification, quality, and treatment. Table 2 also shows the perception of water purification, quality, and treatment. Approximately 13 (10.4%) of the participants agreed that testing the purity of home water should be done annually, whereas a larger proportion, 82 (65.6%), reported 3–6 months. Interestingly, 42 (33.6%) of the participants reported washing their water tanks just once a year. Notably, a significant portion, 70 (61.6%), did not implement any water treatment methods at home, and an even higher percentage, 105 (84.0%), had never personally tested the quality of their home water. However, a substantial number of participants (104, 83.2%) acknowledged that unclean water could potentially lead to the contraction of typhoid.

Attitude towards contaminants in water. The results of participants' attitudes towards contaminants in water are shown in Table 3. Approximately 66 (52.8%) of the participants believed that Lead is a prevalent water contaminant, and 42 (33.6%) linked water contamination to pesticide and herbicide use. A substantial majority, comprising 104 (83.2%) of the study participants, reported that typhoid can be contracted from impure water sources.

Use of water treatment services. Table 3 also presents the use of water treatment services. A significant proportion, 50 (40%) of the participants, expressed a high level of concern regarding the purity of their drinking water. Additionally, half of the participants, comprising 63 (50.4%) individuals, believed that water purification methods came at a high cost. Furthermore, a substantial majority, representing 83 (66.9%) of the participants, were willing to pay for affordable water testing services.

Table 3: Knowledge of water contaminants, associated health risks, and attitudes toward water testing and purification

Variable	Classification	Frequency	Percent
What do you think are common contaminants of borehole water?	Lead	66	52.8
	Chlorine	41	32.8
	Mercury	26	20.8
	Pesticides/herbicides	42	33.6
	Others	8	6.4
What type of contaminants are most in your water supply?	Bacteria or microorganisms	89	71.2
	Chemicals	52	41.6
	Heavy metals	50	40.0
	Pesticides	21	16.8
	Others	1	0.8
What are the likely diseases from impure water?	Malaria	7	5.6
	Typhoid	104	83.2
	Diarrhoea	75	40.0
	Cholera	88	70.4
Which illnesses have you had from water?	Malaria	18	14.4
	Typhoid	63	50.4
	Diarrhoea	26	20.8
	Cholera	6	4.5
How concerned are you about purity of water?	Very concerned	50	40.0
	Somewhat concerned	40	32.0
	Not very concerned	31	24.8
	Not at all concerned	4	3.2
Do you think purification methods are expensive?	Yes	63	50.4
	No	62	49.6
How likely are you to pay for low-cost testing/purification?	Very likely	83	66.4
	Somewhat likely	24	19.2
	Not very likely	12	9.6
	Not at all likely	6	4.8
Are you aware of any local water testing resources?	Yes	15	12.0
	No	110	88.0
Have you ever tested your home water quality?	Yes	20	16.0
	No	105	84.0
If yes, how frequent?	Frequently (< 3 months)	4	20.0
	3 months interval	3	15.0
	6 months interval	6	30.0
	Yearly	7	35.0

DISCUSSION

The aim of this study was to assess the safety of drinking water among individuals and families in Benin City. Over half of the respondents, comprising 52.0%, reported regular use of water from sources outside their homes for drinking, emphasizing that water is essential and frequently needed even when away from home, including at work, school, church, or recreational activities. There was a positive attitude toward safe drinking water storage among residents in Edo State. However, a small fraction of the participants stored water in uncovered containers, possibly resulting from factors such as local conditions, economic constraints, or inadequate health education. Storing water in containers made of metals, including copper, gold, or silver, to enhance water quality has been reported in recent research, whereas using plastics could pose health risks if they exceed the WHO-established limits [11]. The study findings revealed that sachet water was the primary source of drinking water for most participants because it is easily accessible and affordable. However, there is a common misconception that sachet water is pure and free from contaminants [12].

The survey also revealed poor practices of water quality assessment among the respondents. This could result from several factors, possibly due to a lack of awareness, limited access to resources for assessment and experts, and cost considerations. Chemical tests emerged as the dominant method for assessing home water, whereas laboratory tests were less commonly used. A considerable proportion of participants reported having received education and training on water purification, predominantly through educational institutions, seminars, and workplaces. However, the practical application of these principles was insufficient [13]. Furthermore, the findings revealed a consensus among a majority of respondents regarding the importance of annual water purity assessments; nevertheless, there was a gap in understanding the necessity of periodic testing when water-related concerns arise.

In addition, the awareness of diseases associated with impure water, such as typhoid and cholera, emphasises the significance of educational campaigns focused on waterborne illnesses and preventive measures [14,15]. Participant responses revealed that 50.4% (n=63) had experienced typhoid due to consuming unclean water, with 20.8% (n=26) associating water impurity with diarrhoea. These findings underscore the pressing need for enhanced water quality and purification practices, particularly at the household level, to prevent waterborne diseases. Globally, these waterborne diseases claim around 1.8 million lives each year.

Approximately 38.4% (n=48) of the participants reported using water purification methods at home, with common practices including boiling, chlorination, and filtration. Boiling emerged as the most prevalent purification method, offering a reliable means of ensuring safe drinking water. Nonetheless, energy requirements had rendered it impractical for some. Additionally, chlorination and filtration provide viable alternatives, with chlorination offering an efficient disinfection method, especially in resource-limited areas. Nevertheless, it carries the risk of overdose, potentially leading to kidney disorders and cancer if consumed excessively over an extended period [16, 17]. Filtration is effective for removing visible impurities; however, it requires careful selection of appropriate filters to comprehensively address specific water quality concerns [18].

Findings regarding participants' concerns about water purity and their willingness to invest in affordable water testing services suggest a considerable level of awareness and engagement with the issue of safe drinking water in the study population. Notably, our findings revealed the prevalence of contaminants in borehole water, with Lead contamination being a particular concern. These issues are particularly prominent in developing nations, where water pollution, often from agricultural sources, remains a serious concern [19,20]. In addition, water sold in small plastic bags is also susceptible to contamination if not properly regulated, posing health dangers such as gastrointestinal diseases [21, 22]. Furthermore, inappropriate disposal of plastic sachets adds to environmental contamination, commonly by blocking streams and endangering wildlife [23]. Packaged water kept in unsanitary conditions and in direct sunlight was frequently seen during the investigation. The high ambient temperatures of up to 33.1^{o}C, when combined with the potential for back-seepage into bags that are not well-sealed, considerably increase the ability for bacteria to regenerate. The unhygienic conditions observed increase the danger of helminthic and other parasite diseases because these packs harbour dirt during inappropriate storage.

In addition to the environmental implications, contamination from careless vendor handling puts unsuspecting customers' health at risk by frequently drinking from the

sachets without properly cleaning them. The standard method is to tear one end of the sachet open with your teeth after wiping it with your frequently dirty back of the hand. Food handlers in the distribution line remain at potential fault because they obstruct the safe transfer of the intended quality to the customer, posing a risk to public health, regardless of the level of treatment applied to the water in sachets within the industry [24].

Finally, more than one-third of participants expressed a high level of concern about water purity, which underscores the participants' desire for good-quality water for drinking, reflecting a genuine desire for clean and safe water. On the other hand, the belief of about half of the participants that water purification methods are costly may suggest a potential barrier to adopting such practices. This highlights the need for affordable and accessible water purification options and public awareness campaigns to inform individuals about cost-effective purification methods [25].

This study has some limitations. Causal relationships between water-related practices and health outcomes cannot be established because of the cross-sectional design. The reliance on self-reported data may also introduce recall and social desirability biases. Additionally, the sample was limited to five local government areas in Benin City, reducing the generalizability of the findings. Nonetheless, our findings provide actionable insights for public health policies to promote affordable water testing services, enforce hygiene regulations for sachet water vendors, and intensify community education on purification methods. Longitudinal designs with larger and more diverse populations should be established to evaluate long-term outcomes of water safety interventions.

Conclusion

Our study findings revealed that many participants used water purification methods at home, with boiling being the most common. Furthermore, concerns about water purity and willingness to invest in affordable quality assessment services indicated significant awareness and engagement; however, perceived cost barriers must be addressed through affordable and accessible purification options and public awareness campaigns**.** Longitudinal designs with larger and more diverse populations are required to evaluate long-term outcomes of water safety interventions.

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