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Access to Potable Water Supply in Nigerian Cities Evidence from Yenagoa Metropolis

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Abstract The importance of safe water supply to human health cannot be over emphasized. However, potable water supply to most Nigerian cities is still inadequate. This study was designed to determine households' access to potable water supply in Yenagoa, in terms of quality and quantity. To achieve this aim, 15 borehole water samples were collected from 15 neighbourhoods, which the metropolis was structured. 375 questionnaires were randomly distributed in these neighbourhoods using the systematic sampling technique. The analyses revealed that both the quality and quantity of water supply in Yenagoa were inadequate. For instance, turbidity values (20.70-41.20 NTU) in all the sampled water were above the WHO 5 NTU threshold; while 7 (46.67%) samples have pH values below the WHO minimum value of 6.5, indicating acidity. Similarly, iron and lead also have 4 (26.67%) and 3 (20%) samples above the WHO thresholds of 0.3mg/l and 0.01mg/l respectively. The analyses of the quantity of water supply in Yenagoa also show that in spite of the proliferations of wells and boreholes, and the short distances to sources of major water supply, 29.28% of sampled respondents used below 20 litres of water per capita per day. This is mainly attributed to the high cost of water supply (average of N4, 500 per month) in relation to the monthly minimum national wage of N18, 000. It is therefore recommended that the State Government should as a matter of urgency revive and increase the capacity of the state water corporation to deliver potable water supply to the people at reasonable cost.

Keywords: *access, potable water, Nigeria, Yenagoa, metropolis*

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1. Introduction

The extent to which water resources development contributes to economic productivity and social well being is not usually appreciated, although all social and economic activities rely heavily on adequate quality or quantity of freshwater supply. Safe drinking water and basic sanitation are crucial to the preservation of human health, especially children. Water-related diseases are the most common cause of illness and death among the poor in developing countries [1].

The World Bank while commenting on the world water challenge stated that access to water supply services and sanitation is a major factor in reducing child mortality. It revealed that of about 1.7 million deaths that occur every year worldwide (90 per cent of which are children) are attributed to unsafe water, poor sanitation and hygiene, mainly through infectious diarrhea [2]. According to the WHO/UNICEF Joint Monitoring Programme, meeting the Millennium Development Goal (MDG) 7; Target 10 (halving the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015) would avert 470,000 deaths per year. The report also noted that the health impact of such improvements will vary from one region to another because they depend on the existing levels of water supply and sanitation access and the region-specific levels of morbidity and mortality due to diarrhea diseases. Health impacts would however be greater in regions where the number of those not served is high and where the diarrhea disease burden is significant [3].

In spite of the importance of adequate water supply to humans, access to potable water supply in Nigerian cities lag behind demand. For instance, the joint report on water and sanitation by the WHO/UNICEF reveals that Nigeria and many other Sub-Sahara African countries are lagging behind in achieving the millennium development goals and targets set for water and sanitation, as drinking water coverage in Nigeria decreased from 49 per cent in 1990 to 48 per cent in 2004, as against the expected 65 percent coverage [4]. Such shortages can lead to serious economic disruptions and human suffering [5]. Although Nigeria is blessed with abundant water resources, governments at all levels (federal, state and local) have not been able to successfully harness these resources to ensure a sustainable and equitable access to safe, adequate, improved and affordable water supply and sanitation to the population [6].

The lack of access to safe drinking water and sanitation is probably directly related to poverty and in many cases to corruption and the inability of governments to develop the political will to provide water and sanitation systems for their citizens. Hence, the public sector has not been successful in meeting more than a small portion of the demand for water for residential and commercial uses. For example, out of the 85 million people living in urban and semi-urban areas, less than half have reasonable access to reliable water supply [7]. This situation has compelled many households, often the poor, to end up buying water from water vendors at great expense. This situation has been confirmed by studies of different cities in Nigeria. For instance, despite investments and reforms, Lagos still lacks adequate treatment capacity to deliver enough clean water for drinking and household use. By the end of 2008, vigorous efforts by the state water authority achieved a water delivery capacity of 200 million gallons per day against a demand of 600 million gallons, a gap of about 66 per cent. This has made households to turn to private wells or street vendors to meet drinking water needs, which has exposed consumers to bacterial and heavy metal contamination exceeding local regulatory standards [8]. Similarly, the Warri Urban Water Board is moribund, making it incapable of supplying potable water to households in Warri-Effurun metropolis. This situation has forced the inhabitants of the metropolis to depend on other sources of water supply (wells, boreholes, etc), whose quality may not be guaranteed because of their susceptibility to quality degradation by leachate from waste disposal dumps and other sources of pollution [9].

Research reports from other cities in Nigeria equally echoed similar situations as obtained in Lagos and Warri-Effurun metropolis. For example, in Jema'a Local Government Area of Kaduna State, people that have pipe borne water in their houses are not satisfied with the water supply because whenever the water is pumped, it does not last more than two hours in a day. As a result, the use of alternative sources of water is indispensable. It was also revealed that the low service level of water accounts for the prevalence of water borne diseases in the area, which could get to epidemic scale if not attended to promptly [10]. In a similar vein, in Nnewi, a town, popular for its commercial and industrial activities in Anambra State, most of the households depend on borehole, well water and 'sachet water' as major potable water sources [11]. Access to potable water supply in Ibadan is not different from what is obtainable in most cities in Nigeria. Water supply shortages have been very critical in Ibadan city since the 1980s and less than 30% of her residents are served with the public water system [12].

Some of the causes of inadequate access to potable water supply in Nigerian cities are highlighted in the Water Supply and Sanitation Interim Strategy Note on Nigeria [7]. The report stated that the operational efficiency of the State Water Authorities (SWAs) is unacceptably low as indicated by the monitoring indicators compiled under the National Water Rehabilitation Project (NWRP).

The WHO/UNICEF Joint Monitoring Programme, which produced the Global Assessment of Water Supply and Sanitation data, describes reasonable access to water supply as 'the availability of at least 20 litres per person per day from a source within one kilometer of the user's dwelling' [4]. In addition however, access to potable water supply also means 'having access to safe drinking water with microbial, chemical and physical characteristics that meet the WHO guidelines'. Hence, this study analyses the access of households to potable water supply in terms of quality and quantity in Yenagoa, Nigeria. There is a dearth of literature on the analysis of access to potable water supply based on quality and quantity especially in Nigeria. This study investigated the quantity of water supply to households and analysed water samples from boreholes using some selected quality parameters thresholds set by the WHO for Yenagoa metropolis.

2. Method of Study

This study adopted the sample survey method. The sample survey involves the administration of questionnaires, oral interview, direct observation, and collection of water samples and laboratory analysis of the water samples. This was done to determine households' access to potable water supply in Yenagoa, in terms of quality and quantity.

The water samples were collected at designated points adequately distributed throughout Yenagoa metropolis. For a representative sampling of the water samples and distribution of the questionnaires, Yenagoa was stratified into fifteen neighbourhoods. The water samples and the questionnaires for the study were collected and administered respectively to households in the fifteen selected neighbourhoods. A total of fifteen borehole water samples were collected to determine the quality of drinking water supply in the metropolis. Borehole water was chosen because it is the major source of drinking water supply in Yenagoa, based on a reconnaissance survey earlier conducted. The fifteen water samples were randomly collected from each of the sampled fifteen neighbourhoods. Before the tap water samples were collected, cotton wool soaked in 70 per cent ethanol was used to sterilize the nozzle of the tap and the tap was allowed to run for two-three minutes. The water samples were then collected with the aid of 15 two-litre plastic cans after thorough washing and rinsing with the respective water samples. As soon as each of the 2-litre plastic cans was filled to the brim to avoid air bubbles, the cap was used to seal it firmly, the bottle labeled and were kept in a cooler box containing ice, before being sent to the laboratory for analyses. The water quality parameters selected for the study are: lead, zinc, iron, manganese, total dissolved solid, total suspended solid, pH, turbidity, temperature and dissolved oxygen. The physico-chemical characteristics of the water samples were analyzed using standard methods. Unstable pH, temperature and DO parameters were measured in-situ, with an ATI-Orion pH meter, thermometer and probe and meter respectively; while turbidity, TDS and TSS were respectively measured with a 214 A turbidity meter, conductivity and photometric methods. While heavy metals such as Iron (Fe), lead (Pb) and zinc (Zn) were determined with the aid of the Atomic Absorption Spectrophotometer (AAS) respectively at 248, 283 and 213.9 nm wavelengths. The results were compared with the WHO thresholds for potable water supply.

In addition to the above, a total of 375 questionnaires were administered to households in the fifteen selected neighbourhoods, at the rate of 25 questionnaires each, using the systematic sampling technique. Every fifth house was selected for questionnaire survey. The questionnaires were administered directly to female heads of each household. This was done because females are more involved in providing water supply for their households in the study area. However, in the absence of a female head, the questionnaire was administered to the male head. The questionnaires were analyzed using descriptive statistics to determine the quantity dimension of water supply in Yenagoa.

3. Results and Discussion

3.1. Quality Dimension of Water Supply

3.1.1. Turbidity, Temperature, DO, TDS, TSS and pH

Turbidity values of sampled water were found to range from 20.70 - 41.20 NTU, (Table 1). The lowest value of 20.70 NTU was recorded at Opolo neighbourhood; while the highest value of 41.20 NTU was recorded at Akenfa neighbourhood. These values are respectively 314% and 724% higher than the World Health Organization (WHO) 5 NTU threshold for potable water supply. These values show that all the fifteen sampled boreholes have unsatisfactory turbidity concentrations. The probable reason for the high turbidity values is the high water table, which leads to low depths (4-10m) of most of the boreholes. This makes the water in the affected neighbourhoods to be unsafe for human consumption without proper treatment because high turbidity is known to interfere with disinfection and facilitate microbial growth [5].

The in-situ temperatures of the sampled water from the neighborhoods range from 28.5° – 29.4°C (Table 1), while the atmospheric temperature was 28.9°C. Out of the fifteen water samples, seven (46.67%) have temperatures above the 28.9°C ambient temperature. The lowest temperature of 28.5°C was recorded at Onopa neighbourhood while the highest value of 29.4°C was recorded at Swali neighbourhood. High temperature is known to increase the toxicity of some toxic substances such as ammonia, reduce the concentration of dissolved oxygen, increase water acidity and influence the activities of some bacterial. The temperature values and the varying depths of the boreholes where the water samples were collected probably explain the low dissolved oxygen concentrations of the sampled water in the neighborhoods. The DO values range from 3.40 mg/l - 5.40 mg/l, with Onopa neighbourhood recording the highest value and Akenpai neighbourhood recording the lowest value. All the water samples in the neighbourhoods except from Akenpai recorded values below the 5 mg/l WHO threshold as revealed in Table 1. Adequate dissolved oxygen is necessary for good water quality and the lack of oxygen in body tissues creates a defect of red blood cells. Drinking water with low dissolved oxygen concentration further exacerbates the condition by constricting blood vessels in the lungs.

Table 1. Physico-Chemical Parameters of Sampled Borehole Water in Yenagoa

Neigh.	Turb. NTU	Temp °C	DO mg/l	TDS mg/l	TSS mg/l	pH	Fe^{+2} mg/l	Pb mg/l	Mn mg/l	Zn mg/l
Akenfa	41.20	28.6	4.80	80.4	3.80	6.43	0.28	0.00	0.02	0.25
Akenpai	38.60	29.0	5.40	66.8	1.60	6.30	0.32	0.01	0.01	0.15
Amarata	41.00	28.9	4.20	78.8	2.74	6.58	0.40	0.01	0.02	0.20
Azikoro	34.60	29.0	3.80	87.0	1.48	6.55	0.15	0.02	0.01	0.25
Biogbolo	30.50	28.8	4.00	88.3	0.85	6.44	0.30	0.01	0.01	0.32
Edepie	28.20	29.0	4.30	67.3	0.70	6.90	0.24	0.02	0.02	0.18
Etegwe	30.10	28.8	3.65	53.7	0.80	6.48	0.33	0.00	0.02	0.08
Igbogene	25.40	28.8	4.80	96.1	0.70	6.43	0.15	0.00	0.03	0.78
Kpansia	30.50	29.0	4.40	86.4	0.80	6.48	0.20	0.01	0.02	0.34
Okaka	21.50	29.0	4.00	79.6	0.85	6.59	0.18	0.00	0.01	0.20
Onopa	24.60	28.5	3.40	77.7	0.90	6.45	0.12	0.02	0.02	0.18
Opolo	20.70	28.6	3.50	52.4	0.50	6.70	0.32	0.01	0.02	0.15
Ovom	23.50	29.0	3.80	64.8	0.70	6.56	0.28	0.00	0.03	0.20
Swali	26.50	29.4	4.20	79.5	0.80	6.53	0.16	0.00	0.01	0.20
Yenezue	21.60	28.6	3.50	72.0	0.80	6.67	0.24	0.00	0.02	0.20
Range	20.50	0.9	2.00	43.7	3.30	0.60	0.28	0.02	0.02	0.73
Mean	29.23	28.9	4.12	75.4	1.20	6.54	0.24	0.01	0.02	0.25
SD	6.92	0.23	0.56	12.5	0.90	0.11	0.08	0.00	0.00	0.16
CV	23.67	0.80	13.59	16.58	75.00	1.68	33.33	0.00	0.00	64.00

SD: Standard deviation, CV: Coefficient of variation

Source: Authors' Fieldwork, 2013.

Total dissolved solid values range from 52.4 – 96.1 mg/l (Table 1). These values are all below the WHO 500 mg/l threshold for TDS concentration in potable water supply. The lowest value of 52.4 mg/l, which is 854.20% lower than the WHO threshold, was recorded at Opolo neighbourhood; while the highest value of 96.1 mg/l, which is 420.29% lower than the WHO thresholds, was recorded at Igbogene neighbourhood. Similarly, all the values of TSS have concentrations below the WHO 5 mg/l thresholds for potable water. The TSS values range from 0.50 – 3.80 mg/l, with the lowest value of 0.50 mg/l recorded at Opolo, while the highest value of 3.80 mg/l was recorded at Akenfa neighbourhood.

The pH values range from 6.30 – 6.90 which implies that the sampled water is acidic (Table 1). Seven (46.67%) out of the fifteen water samples have pH values below the minimum WHO 6.5-8.5 thresholds for potable water supply. Akenpai neighbourhood has the lowest pH value of 6.30, while Edepie neighbourhood has the highest recorded pH value of 6.90. The acidity of the water samples may be related to the enormous volume of gas flaring by oil prospecting companies in the area, which has contributed to the occurrence of acid rain that eventually recharges the aquifers. The pH of a water body is very important because it may affect the solubility and toxicity of metals in the aquatic system, which may have adverse effects on human health.

3.1.2. Iron, Lead, Manganese and Zinc

The concentrations of heavy metals in drinking water supply is of crucial importance to health and water providers all over the world because of its health impacts if they should exceed the acceptable thresholds provided by the WHO. The likely health impacts of excessive concentrations of heavy metals above the WHO standards include neurological disorder, cancer, mental development in infants, and interference with vitamin D metabolism, central and peripheral nervous systems amongst other impacts [13].

The values of iron concentrations in the water samples range from 0.12 – 0.40 mg/l, with the lowest value measured at Onopa neighbourhood, while the highest value was measured at Amarata neighbourhood (Table 1). Out of the fifteen water samples, four, representing 26.67% have iron concentrations above the WHO 0.3 mg/l threshold for potable water. This shows that there is a gradual pollution of water supply sources with iron in the study area which may portend serious health challenges. Iron is concentrated in water by contact with rocks and minerals, and occasionally man-made materials like iron and steel pipes [14]. In a similar vein, the values of lead as revealed in Table 1 range from 0.00 – 0.02 mg/l, with three samples, representing 20% having concentrations above the WHO 0.01 mg/l threshold for potable water. The consumption of the affected water without adequate treatment may lead to serious health implications. The indiscriminate dumping of all sorts of metals and the location of the boreholes where the water samples were collected could be responsible for the observed lead concentrations in some of the water samples in the study area.

Manganese and zinc concentrations in the water samples were both satisfactory, as they were within the respective WHO thresholds for drinking water. The range of manganese was 0.01-0.03 mg/l, which is below the WHO thresholds of 0.2 mg/l; while zinc concentrations range from 0.08 – 0.78 mg/l, which is below the WHO 3 mg/l thresholds. These values indicate that the water samples are free of manganese and zinc pollution.

3.2. Quantity Dimension of Water Supply

The quantity dimension of water supply in the study was analyzed using the administered questionnaires. Out of the 375 questionnaires that were administered, representing 96.53%, 362 were returned.

3.2.1. Household Size

Household size was found to affect not only the quantity of water usage in a household but also the amount of money spent on water supply. From Table 2 it is revealed that 160 (44.20%) of the respondents have 1-3 persons per household, while 142 (39.23%), 34 (9.39%) and 26 (7.18%) of the respondents, have 4-6, 7-9, 10 and above persons per household respectively. Akenpai and Azikoro neighbourhoods have the highest number of respondents each (18) with 1-3 persons per household while Edepie has the highest number of respondents (5) with 10 persons and above per household. This implies that the quantity of water usage may be more in Edepie than other areas all things being equal.

Table 2. Household Size

Neigh.	1-3	4-6	7-9	10 and above
Akenfa	13	7	5	0
Akenpai	18	3	1	0
Amarata	8	9	6	2
Azikoro	18	6	0	1
Biogbolo	14	8	2	1
Edepie	5	12	1	5
Etegwe	13	8	3	1
Igbogene	10	12	0	3
Kpansia	5	16	0	4
Okaka	10	9	4	0
Onopa	16	6	2	0
Opolo	13	6	6	0
Ovom	9	11	0	3
Swali	5	15	1	4
Yenezue	3	14	3	2
Total	160	142	34	16
Percentage	44.20	39.23	9.39	7.18

Source: Authors' Fieldwork, 2013

3.2.2. Cost of Water Supply

The amount spent by households for daily water supply in Yenagoa is a function of several interconnected variables such as source of water supply (well, borehole and water vendors), quantity demanded, family size and income. Table 3 shows that 157 (43.37%) of the households spent below N100 per day for water supply; while 87 (24.03%) and 118 (32.60%) spent between N100-N200 and above N200 respectively. This shows that over 56% of households spent an average of N150 daily, which adds up to N4, 500 per month. This amount is quite high when compared to the national minimum wage of N18, 000 per month. This would impact negatively on the quantity of water usage per capita per day, which would compromise hygiene.

Table 3. Households Daily Cost of Water Supply

Neigh.	0-N100	100-N200	Above N200
Akenfa	9	8	8
Akenpai	13	0	9
Amarata	14	6	5
Azikoro	4	13	8
Biogbolo	8	5	12
Edepie	15	5	3
Etegwe	8	10	7
Igbogene	8	2	15
Kpansia	9	4	12
Okaka	2	12	9
Onopa	14	7	3
Opolo	14	6	5
Ovom	13	4	6
Swali	16	3	6
Yenezue	10	2	10
Total	157	87	118
Percentage	43.37	24.03	32.60

Source: Authors' Fieldwork, 2013.

3.2.3. Distance to Major Source of Water Supply

Reasonable access to water supply is 'the availability of at least 20 litres per person per day from a source within one kilometer of the user's dwelling' [4]. Going by this definition, one may conclude that all households in Yenagoa have reasonable access to water supply because the distance of households to their major source of water supply is below one kilometer as shown in Table 4. However, this access does not translate to effective demand because of the cost of water purchase in relation to households' disposable incomes. The reason for the short distances is because of the indiscriminate sinking of boreholes and wells by some water merchants in the metropolis, which may have negative impacts on water quality [9].

Table 4. Distance to Major Source of Water Supply

Neigh.	0-100m	101-200m	Above 200m
Akenfa	25	0	0
Akenpai	22	0	0
Amarata	25	0	0
Azikoro	19	5	1
Biogbolo	23	2	0
Edepie	23	0	0
Etegwe	22	3	0
Igbogene	20	5	0
Kpansia	17	2	6
Okaka	23	0	0
Onopa	22	2	0
Opolo	22	0	3
Ovom	20	3	0
Swali	25	0	0
Yenezue	22	0	0
Total	330	22	10
Percentage	91.16	6.08	2.76

Source: Authors' Fieldwork, 2013

3.2.4. Quantity of Water Usage by Households

Household average quantity of water usage per capita per day as presented in Table 5 revealed that 256 (70.72%) respondents use above the WHO/UNICEF critical threshold of 20 litres per capita per day. However, 106 (29.28%) respondents use below 20 litres of water per capita per day, which is below the WHO/UNICEF threshold. As noted above, one of the major limiting factors for the inadequate quantity of water usage per capita per day by some households in Yenagoa is the high cost of water supply in relation to households' disposable income. In spite of the proliferations of wells and boreholes in the metropolis, the cost of water is still very high in the absence of a reliable public water supply network. Swali neighbourhood has the highest number (13) of respondents with the lowest water usage (0-19 litres) per capita per day; while Azikoro and Okaka neighbourhoods have the highest number (5) each of respondents with the highest water usage (80 and above litres) per capita per day (Table 5). These data reveal that there is spatial variation in the quantity of water usage in the metropolis. The implication is that households with inadequate quantity of water usage may have issues of hygiene.

Table 5. Average Quantity of Water Usage per Capita per Day

Neigh.	0-19 litres	20-39 litres	40-59 litres	60-79 litres	Above 80 litres
Akenfa	8	16	0	0	1
Akenpai	4	10	2	2	4
Amarata	10	15	0	0	0
Azikoro	3	6	3	8	5
Biogbolo	6	12	3	1	3
Edepie	8	10	2	2	1
Etegwe	7	10	3	1	4
Igbogene	1	7	7	7	3
Kpansia	5	16	2	2	0
Okaka	5	10	3	0	5
Onopa	11	7	4	0	2
Opolo	7	13	1	1	3
Ovom	8	11	2	0	2
Swali	13	11	0	1	0
Yenezue	10	10	1	1	0
Total	106	164	33	26	33
Percentage	29.28	45.30	9.12	7.18	9.12

Source: Authors' Fieldwork, 2013

4. Conclusion

The study has been able to establish that access to water supply in terms of quality and quantity dimensions in Yenagoa is inadequate. The quality analyses of some of the selected quality parameters have concentrations above the WHO thresholds for potable water supply. For instance, turbidity values (20.70-41.20 NTU) in all the sampled water were above the WHO 5 NTU threshold; while 7 (46.67%) samples have pH values below the WHO minimum value of 6.5, indicating acidity. Similarly, iron and lead also have 4 (26.67%) and 3 (20%) samples above the WHO thresholds respectively. The analyses of the quantity dimension of water supply in Yenagoa also show that in spite of the proliferations of wells and boreholes, and the short distances to sources of major water supply, 29.28% of sampled respondents used below 20 litres of water per capita per day. This is mainly attributed to the high cost of water supply in relation to the disposal incomes of some of the respondents. It is therefore recommended that the State Government should as a matter of urgency revive and increase the capacity of the state water corporation to deliver potable water supply to the people at reasonable cost.

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