Websites:
http://www.sciencepub.net/newyork
http://www.sciencepub.net

Emails:
newyorksci@gmail.com
editor@sciencepub.net

New York Science Journal

MARSLAND PRESS
Multidisciplinary Academic Journal Publisher

Assessment Of Access To Safe Drinking Water And Water Quality Of Rural Communities Of Akpabuyo Local Government Area Of Cross River State, Nigeria

Alain Simon Inah[1], Chiamaka Goodness Mgboji[1], Ebi Jimmy Eko[1], Randymay Eja Kalu[2], Matthew Egbobor Eja[1]

[1]Department of Public Health, University of Calabar, Calabar, Nigeria
[2]Federal Medical Centre, Yenogoa, Bayelsa State, Nigeria
pharmalain2006@gmail.com, goodieganda@gmail.com, jimmyyeko@gmail.com, randymaykalu@gmail.com, matthewejaeja@gmail.com

Abstract: Water is the major source of pathogenic microorganisms causing several enteric diseases, and therefore lack of access to safe drinking water of acceptable quality is not acceptable globally. The aim of this study was to investigate the water supply sources and quality of the water accessible by the rural communities of Akpabuyo Local Government Area (LGA) besides the proportion of community members who have access to quality water sources. Descriptive cross-sectional and analytical study designs were adopted for this study. To obtain information on water sources and improved water sources, a cross-sectional design was used to generate data from 420 respondents who were selected and administered questionnaires, followed by bacteriological and physicho-chemical analyses of the water sources of the communities using standard procedures. Two-way analysis of variance using SPSS version 22, was performed on the data on physicho-chemical parameters to determine differences in means of the water quality of the sources of the water. Result shows that public/private borehole 200(47.6%) and surface water from stream 172(41.0%) were the main sources of drinking water. While only 84(20.0%) of respondents have access to improved water supply source, i.e., public/private borehole, most respondents 330(78.6%) prefer mostly borehole water. Total coliform and faecal coliform counts of all the surface water sources exceeded WHO and NSDWQ limits. All the physic-chemical parameters of the drinking water sources met the WHO and NSDWQ standards except pH of all the water sources that were below WHO and NSDWQ standards. There was no significant difference ($p > 0.05$) between the water sources of the villages. In conclusion, access to water sources and quality of water are inadequate and calls for intervention of government and water treatment in the home.

[Alain Simon Inah, Chiamaka Goodness Mgboji, Ebi Jimmy Eko, Randymay Eja Kalu, Matthew Egbobor Eja. **Assessment Of Access To Safe Drinking Water And Water Quality Of Rural Communities Of Akpabuyo Local Government Area Of Cross River State, Nigeria.** *N Y Sci J* 2020;13(5):50-58]. ISSN 1554-0200 (print); ISSN 2375-723X (online). http://www.sciencepub.net/newyork. 7. doi:10.7537/marsnys130520.07.

Keywords: Drinking water, Akpabuyo, rural communities, streams, borehole

1. Introduction

Sufficient and wholesome water supply is the most essential and important prerequisite for the sustenance and maintenance of healthy living. Improvement in water supply brings about the corresponding improvement in the health of the public (Park, 2015). Evidently, access to potable water is one of the important criteria for sustainable development of any country. The importance is not only in relation to potable water availability which is required to achieve good personal and domestic hygiene, but most vitally its quality which presents the major threat to man's health and longevity. Poor quality of water has a great impact on public health by causing acute infectious diarrhoea, and has also been implicated in the spread of water-related diseases such as typhoid, cholera, dysentery, hepatitis, giardiasis, guinea worm and schistosomiasis (Peter, 2013). Water-related diseases place socio-economic burden on the population and health service systems of many countries globally and in particular, those of low income earners (WHO, 2015).

WHO/UNICEF (2014) reported that an estimated 1.1 billion people worldwide lack access to safe drinking water while 2.4 billion do not have access to good sanitation. It is also reported that water supply contributes 80% of the disease burden affecting humans, while some 2.2 million people still lose their lives each year due to poor water and sanitation-related diseases (WHO/UNICEF, 2014). According to the same report, 946 million people still practise open defecation. This has a major implication on health especially where surface water is the major source of drinking water. The global water and sanitation report reveals that drinking of contaminated water is responsible for 88% of the over 4 billion cases of diarrhoeal diseases that occur in the world every year (WHO, 2014). It is also stated that 94% of the diarrhoeal diseases could be prevented by modifying the environment with improved access to potable water alone which is able to reduce the disease burden by between 20 to 35% in Sub-Saharan African (WHO, 2014). Exposure to unsafe drinking water, inadequate sanitation and hygiene are the leading causes of cholera and a variety of other infectious diseases especially in low income countries (Cunningham & Cunningham, 2007).

Due to the rapid population growth in Nigeria without commensurate provision of basic infrastructures and services like access to wholesome water supply and sanitation especially in rural communities, the quality of life of members of the communities is reduced. Over the years, the lack of access to wholesome water in rural communities in Nigeria has contributed significantly to high prevalence of communicable diseases and accounts for a significant percentage of morbidity and mortality in the country (Mark, 2010). Despite huge amount of money spent by successive Nigerian Governments at the federal and states levels in ensuring access to potable water, coverage in rural communities seems to be either poor or totally absent. Even in a neighboring Akwa Ibom State, access to water sources and the quality of the water are not adequate (Okon *et al.*, 2018), implying that it is a national problem. Absence of access to water and sanitation leads to open defecation which results in serious health consequences like dysentery, typhoid fever, cholera, etc. (Kalu, *et al.*, 2019). This is evident in the coastal communities of the oil rich region of Nigeria where there is no access to wholesome water, and sanitation and defecation into open water is the practice (Cookey *et al.*, 2008).

The aim of this study was to investigate the water supply sources and quality of the water accessible by the rural communities of Akpabuyo Local Government Area (LGA) besides the proportion of community members who have access to quality water sources.

2. Materials and Methods

2.1 Study location

The study location is Akpabuyo Local Government Area (LGA) of Cross River State, Nigeria which covers an area of 816 km^2 (National Population Commission, 2013). It is bounded to the North by Akamkpa Local Government Area, to the East by the Republic of Cameroon, to the South by Bakassi Local Government Area and to the West by Calabar South Local Government Area and Calabar Municipality Local Government Area.

Akpabuyo Local Government Area has a projected population of 397,328 people as at 2006 National Population Census. Akpabuyo Local Government Area consists of ten (10) political wards: Atimbo East, Atimbo West, Eneyo, Idundu, Ikang Central, Ikang North, Ikang South, Ikot Edemodo, Ikot Eyo and Ikot Nakanda. Their major occupations are fishing and farming.

2.2 Study design

Both descriptive cross-sectional design and analytical methods were applied in this study. This involved the administration of structured questionnaires to sampled respondents, the use of observation checklist on sources of drinking water as well as collection and laboratory analysis of water samples collected from the selected communities to assess the quality of drinking water sources in the study area. The study population was made up of household heads or adult members of sampled households (both male and female) who were 18 years and above residing in the sampled households. Twelve (12) villages were initially randomly sampled from the ten wards, followed by systematic selection of 35 households from each of the villages for questionnaire administration. The minimum sample size was calculated based on the statistical formula of Lutz (1982), Bluman (2004) and Uwaezuoke *et al.* (2016) in which $n = Z^2(P_q)/d^2$ where n is minimum sample size, Z is confidence limit (1.96), P is estimated rural population with access to improved water sources (0.47) and q is 1-p (1-0.47) which is 0.53, d is the precision which is 5% (0.05).

$$\text{Therefore, } n = \frac{(1.96)^2 * 0.47 * 0.53}{0.05^2}$$

Considering an attrition bias of 5%, i.e. 382.8/0.95, equivalent to 402 to obtain the required sample size, 35 households were selected from each of 12 villages, given a study population of 420 respondents.

2.3 Instruments for data collection

Primary data for this research were collected using questionnaires and observation checklist. The questionnaire was designed to generate quantitative data from the respondents. The questionnaire consisted of three parts with sixteen items. The first part was used to sample information on respondents' socio-demographic characteristics; the second part consisted of questions on the sources of water used by respondents, while the third section sampled respondents' accessibility to water sources and quality of drinking water.

2.4 Water sample collection

Water samples were collected aseptically with sterilized sampling bottles from various surface drinking water sources of selected communities, labeled and stored in cooler bags and transported to the quality control laboratory of Cross River State Water Board Limited, Calabar within 6 hours for microbiological analysis. Also, borehole water was equally collected according to standard procedures (APHA, 1998) and transported to the laboratory for microbiological analysis. Collection of samples was duplicated. Also, water samples were collected in polyethylene bottles and carried to the laboratory for physico-chemical analysis.

2.5 Determination of the microbiological quality of water

The analysis involved the enumeration of viable bacteria, total coliform and faecal coliform (*Escherichia coli*).

The media used include: Endo agar for total coliform count, MF-C agar base for faecal coliform count and nutrient agar for heterotrophic count. These were prepared based on manufacturer's instruction and sterilized in the autoclave at 121^{o}C for 15 minutes. These were poured into sterile petri dishes (120ml each) and allowed to cool before inoculation. The glass wares and the stainless steel filtration units used were also sterilized in the hot air oven at 150^{o}C for 1 hour.

The samples were shaken to mix and 100ml filtered through the membrane filter (0.45µm pore size) and placed on the Endo agar, MF-C agar and Nutrient agar for the different counts. These plates were incubated for 24 hours at 37^{o}C. Emerging colonies after the period of incubation were enumerated using a colony count. Counts were recorded accordingly.

2.6 Determination of the physico-chemical properties of water

Physico-chemical characteristics of the water samples were analysed using standard methods (APHA, 1998). The pH, temperature and turbidity were measured using a pH meter equipped with a temperature probe thermometer and turbidity meter respectively.

Chemical parameters such as iron, zinc, and manganese were analysed using methods described by APHA (1998) using the atomic absorption spectrometer (AAS). Digestion was done for all the water samples meant for metal analyses. In this case, fifteen millimeters (15ml) of concentrated HNO_3 was again added to the 15ml of the mixture obtained. The mixture was then diluted to 50ml with distilled water. This was heated slowly to obtain a gentle refluxing action.

Further heating continued until digestion was complete (a light colored solution). The sample was transferred to a 50ml volumetric flask and diluted to the mark, then allowed to cool for about 30 minutes. The level of the individual metals was then determined using an Atomic Absorption Spectrometer.

2.7 Method of data analysis

Data collected from this study was coded, analysed, presented in tables, and expressed in percentages, proportions, means, charts and graphs. Data entry and analysis was done using Statistical Package for Social Sciences (SPSS) version 22 (SPSS for Windows, Armonk, NY: IBM Corp).

2.8 Ethical consideration

A letter of introduction was obtained from the Department of Public Health, University of Calabar, Calabar, which served as a permit for entry into the community. A verbal consent was obtained from the Akpabuyo Traditional Council, granting permission to carry out analysis of drinking water sources in their communities. Verbal consent was also duly sought and obtained from respondents who participated in the study. The objectives, benefits and significance of the study were explained to the respondents and participation was strictly voluntary. The participants were also assured of confidentiality of information provided.

3. Results

3.1 Demographic characteristics of respondents

The results obtained in this study are presented in Table 1 which indicate that 150(35.7%) of respondents were aged between 30 and 39 years, 206(49.0%) were males, 214(51.0%) were females, 173(41.2%) had secondary school education, 137(32.6%) were farmers, 232(55.2%) were single and 188(44.8%) had between 7 and 9 persons in their households.

3.2 Sources of drinking water and water use

The main sources as indicated by respondents are represented in Table 2 which shows that the sources of water were public/private borehole 200(47.6%) and stream 172(41.0%). Other essential uses of water were bathing 169(40.2%) and washing of cloth/other materials 132(31.4%). Most respondents 330(78.6%) indicated that public/private borehole was their most preferred source of drinking because of what 170(40.5%) respondents called good quality, not prone to contamination 110(26.2%) and always available 84(20.0%).

Table 1: Socio-demographic characteristics of respondents (n = 420)

Variables	Number of respondents	Percentage
Age (in years)	103	24.5
18-29	150	35.7
30-39	87	20.7
40-49	66	15.8
50-59	14	3.3
60+		
Sex	206	49.0
Male	214	51.0
Female		
Education	76	18.1
Primary	173	41.2
Secondary	130	31.0
Tertiary	41	9.8
No formal education		
Occupation	137	32.6
Farming	48	11.4
Trader/business	91	21.7
Civil servant	43	10.2
Student	71	16.9
Artisan	30	7.1
Unemployed		
Marital status	232	55.2
Single	184	43.8
Married	4	1.0
Divorced		
Number of persons in your household		
1-3	40	9.5
4-6	103	24.5
7-9	188	44.8
10+	89	21.2

Table 2: Source of drinking water and water use (n = 420)

Variables	Number of respondents	Percentage
Main source of drinking water	17	4.0
Spring	200	47.6
Public/private borehole	172	41.0
Surface stream	31	7.4
Sachet/bottle water		
Other essential use of water	86	20.5
Exclusively for drinking	132	31.4
Washing of cloth/other materials	169	40.2
Bathing	33	7.9
Drinking for domestic animals		
Most preferred source of drinking water		
Spring	3	0.7
Surface stream	31	7.4
Public/private borehole	330	78.6
Sachet/bottle water	56	13.3
Reasons for preferred source of drinking water		
Always available	84	20.0
Easily accessible	56	13.3
Good quality	170	40.5
Not prone to contamination	110	26.2

3.3 Water accessibility, storage and treatment

Data on water accessibility, storage and treatment are represented in Table 3. 145(34.5%) respondents indicated that average time spent to and from drinking water source is 31-40 minutes and 109(26.0%) respondents indicated 21-30 minutes. Plastic rubbers 202(48.1%) and jericans 103(34.5%) were containers used to store drinking water in most households. Though 150(35.7%) respondents acknowledge that they do not treat their water before drinking, 124(29.5%) respondents used the sedimentation method for treatment of drinking water. Embankment/protection of water source was identified by 191 (45.5%) respondents as the community effort in ensuring safety of drinking water sources while Ventilated Improved Pit Latrine (VIP)/Pit latrine with cover 173(41.2%) and pour flush 102(24.3%) were highlighted as the main types of excreta facility available.

3.4 Observational checklist for drinking water sources

Observational checklist for drinking water sources is shown in Table 4. Of the 20 drinking water sources sampled, 20(100%) drinking water sources were used for other purposes like bathing and washing of materials, 17(85.0%) were drinking water source were odourless, 17(85.0%) tasteless and 20(100%) were colorless. Waste disposal methods were satisfactory in 11(55.0%) households and excreta disposal pattern in 15(75.0%) households were satisfactory. While human activities like farming were found around 80% drinking water sources, only 10(50.0%) drinking water sources have a distance of less than 1km from human residence.

Table 3: Water accessibility, storage and treatment (n = 420)

Variables	Number of respondents	Percentage
Average time spent to and from drinking water source	22	5.2
<11 mins	45	10.7
11-20 mins	109	26.0
21-30 mins	145	34.5
31-40 mins	99	23.6
>40 mins	11	2.6
Container used to store drinking water	202	48.1
Clay earthen pot	87	20.7
Plastic rubbers	103	24.5
Open basin	17	4.0
Jericans	45	10.7
Get water directly from the tap for drinking	78	18.6
Methods of treatment of drinking water	124	29.5
Boiling		
Cloth filtration	23	5.5
Sedimentation	150	35.7
Addition of alum/chlorine	97	23.1
No treatment	42	10.0
Community effort in ensuring safety drinking water source		
Regular cleaning	191	45.5
Regulations/law on usage		
Embankment/protection water source	11	2.6
Demarcation for drinking and other purposes	79	18.8
No safety plans		
Type of excreta disposal facility available	45	10.7
Water closet	102	24.3
Pour flush		
Ventilated Improved Pit Latrine (VIP)/Pit latrine with cover	173	41.2
Pit latrine without cover	49	11.7
No toilet	51	12.1

Table 4: Observational checklist for drinking water sources (n = 20)

Variables	Yes (%)	No (%)
Drinking water sources is used for other purpose like bathing and washing of materials	20(100)	0(0.0)
There is observed evidence of human activities like farming/residence around drinking source	4(20.0)	16(80.0)
Drinking water source has objectionable odour	3(15.0)	18(85.0)
Drinking water source has objectionable taste	3(15.0)	17(85.0)
Drinking water source has colour	20(100)	0(0.0)
Drinking water source contain debris and suspended particulate matters	4(20.0)	16(80.0)
Waste disposal pattern observed is satisfactory	11(55.0)	9(45.0)
Excreta pattern as observed is satisfactory	15(75.0)	5(25.0)
Observed longest distance to water source less than 1km	10(50.0)	10(50.0)

3.5 Microbiological quality of drinking water sources

Results on microbiological quality of drinking water sources (Table 5) show that total coliform count and faecal coliform count in addition to heterotrophic count for all water samples 20(100%) exceeded WHO and NSDWQ limits for drinking water (0/100ml).

3.6 Physico-chemical quality of drinking water sources

The results presented in Table 6 show the mean values of physico-chemical quality of drinking water sources in the ten villages of Akpabuyo Local Government Area.

Temperature of water samples ranged between 24.6 ± 0.012-$25.5\pm0.0^{o}C$, indicating that the temperature for all water samples fall within the WHO and NSDWQ acceptable limits for temperature in drinking water.

The pH of the water samples ranged from $4.57 \pm 020 - 8.54 \pm 0.024$. From the results it was observed that pH for all samples were below the WHO and NSDWQ acceptable range for pH in drinking water.

All other physical parameters such as turbidity (0.1 ± 0.00-16.6 ± 0.039 NTU), TSS ($0.009\pm0.01.0$ - 0.028 ± 0.032mg/L), TDS (6.36 ± 0.011-23.75 ± 0.39mg/L) and conductivity (2.25 ± 0.022-62.0 ± 0.0004 micromhos/cm) were within the WHO and NSDWQ limits. Equally, chemical parameters such as Manganese (0.000 ± 0.000-0.06 ± 0.012mg/L), Iron (Non-detectable-2.70 ± 0.039mg/L) and Arsenic (Below detectable limit) were within WHO and NSDWQ limits for drinking water. There was no significant difference ($p > 0.05$) between the water samples in the villages.

Table 5: Microbiological quality of drinking water sources

S/N	Drinking water sources	Total coliform count (cfu/100ml)	Faecal coliform count (cfu/100ml)
	Ikot Nakanda stream	TNTC	TNTC
1	Ikot Nakanda stream	TNTC	TNTC
2	Ikot Nakanda borehole	116	90
3	Ekpene Etete borehole	121	95
4	Ikot Asuquo borehole	TNTC	TNTC
5	Ikot Offiong borehole	108	86
6	Ikot Offiong borehole	110	92
7	Esuk Ekpenyong borehole	TNTC	TNTC
8	Esuk Ekpenyong stream	TNTC	TNTC
9	Ebisaereya stream	TNTC	TNTC
10	Ebisaereya stream	TNTC	TNTC
11	Ikot Eneyo borehole	TNTC	TNTC
12	Ikot Eneyo stream	TNTC	TNTC
13	Ikot Umo stream	TNTC	TNTC
14	Ikot Umo stream	TNTC	TNTC
15	Ikot Ekpo stream	TNTC	TNTC
16	Ikot Ekpo borehole	TNTC	TNTC
17	Ifano King stream	TNTC	TNTC
18	Edemikot stream	TNTC	TNTC
19	Edemikot stream	TNTC	TNTC
20	WHO safe limits	0	0
	NSDWQ limit	0	0

TNTC = Too Numerous to Count; WHO = World Health Organization
NSDWQ = Nigerian Standards for drinking Water Quality
Public/private borehole water had zero facecal coliform

Table 6: Mean of physico-chemical parameters of samples

Quality parameter	Water sources									
	Ikot Nakanda	Atimbo East	Atimbo West	Eneyo	Idundu	Ikang Central	Ikang North	Ikang South	Ikot Edem-Odo	Ikot Eyo (Micromhos/cm)
Temp. (°C)	25.5±0.010	25.5±0.020	25.5±0.110	24.80±.000	25.10±.120	24.90±.019	25.10±.021	25.10±.020	25.10.002	24.6±0.012
pH	6.02±0.092	5.930±.011	8.540±.024	4.89±0.030	4.57±0.020	5.88±0.022	4.86±0.001	4.74±0.100	4.74±0.010	6.0±0.001
Turbidity (Ntu)	16.6±0.039	8.54±0.029	5.71±0.010	1.47	41.1±0.020	2.12±0.012	16.06±0.001	4.21±0.002	4.20±0.010	1.0±0.000
TSS (mg/L)	0.018±0.021	0.020±0.010	0.016±0.003	0.022±0.002	0.028±0.032	0.009±0.010	0.012±0.021	0.010±0.020	0.010±0.100	0.016±0.002
TDS (mg/L)	6.97±0.001	9.05±0.030	10.04±0.001	20.16±0.011	8.29±0.029	23.78±0.039	65.67±0.012	12.77±0.025	12.51±0.020	6.36±0.011
Conductivity	62.0±0.0004	15.09±0.020	14.67±0.005	33.60±0.122	13.81±0.023	39.63±0.030	22.09±0.210	24.6±0.001	24.6±0.001	2.25±0.021
Manganese (mg/L)	0.06±0.012	0.02±0.022	0.05±0.011	0.05±0.091	0.03±0.000	0.02±0.010	0.01±0.010	0.00±0.000	0.00±0.000	0.10±0.001
Iron (mg/L)	2.70±0.039	1.20±0.001	ND	ND	1.90±0.001	0.02±0.000	0.01±0.000	3.0±0.011	3.0±0.011	6.36±0.011
Arsenic (mg/L)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

ND = Not Detectable; BDL = Below Detection Limit; NTU = Nephelometric Turbidity Unit; TSS = Total Suspended Solid; TDS = Total Dissolved Solid

4. Discussion

This study shows that different proportions of the population of communities in Akpabuyo Local Government Area have access to differing sources of water for drinking and domestic use. These sources were public/private borehole, spring, stream water and sachet/bottle water. However, only 84(20.0%) of the population have access to improved water, i.e., public/private borehole, which a good number of the population 330(78.6%) describe as easily available and good quality water. This proportion is significantly small, compared to neighboring Akwa Ibom which recent study reports that 83.33% of upland and 58.10% coastal area populations have access to improved water sources (Okon *et al*., 2017). However, 13.3% of Akpabuyo rural communities also have irregular access to sachet/bottle water which is processed water. In Nigeria, only about 58% of its citizens have access to improved drinking water sources (Okon *et al.*, 2017).

The main sources of drinking water were mostly private/private borehole 200(47.6%) and surface water from the stream 172(41.0%). This result contradicts a study conducted by Cookey *et al*. (2008) at the coastal communities of Niger Delta where stream was the only source of drinking water for the residents in the rural area. There appears to be some disparity in the provision of water supply to various communities which may be geographical (between urban and rural), or socio-economic (between the rich and the poor) (Okon, 2017). In the rural areas, there is a high dependence on all forms of natural sources of water, e.g., streams, river, rain and wells. Dependence on these sources may result in water-related diseases such as salmonellosis, shigellosis, cholera, giardiasis, etc. (Eja, 2014).

Accessibility to natural water sources still remains a problem to the rural communities of Akpabuyo Local Government Area as 34.5% of respondents indicated that average time spent to and from drinking water sources was 30-40 minutes, indicating that access to potable water in rural areas is still a challenge which makes most people to travel far to fetch water. This agrees with Ravichaudra and Boopathy (2007) who report that more than two third of the world's poor households do not have access to improved water sources and majority have to fetch water from outside their homes.

The system of water storage was in jericans to avoid contamination, according to 24.5% of respondents, while the only method of treatment was sedimentation. It has been proposed by WHO (2013) that treatment of water may incorporate source protection (i.e., drawing water from a deep inlet away from shore) assisted by sedimentation (using coagulants), filtration (rapid sand) and disinfection (with ozone and chlorine).

The poor access to water of the rural communities of Akpabuyo Local Government Area is suggestive of inappropriate sanitary facilities in the area. Although 10.7% have water closet, 41.2% use ventilated improved pit latrine. 12.1% lack access to toilet facilities and as such defecate in the open. This agrees with the findings of Kalu (2019) who report that absence of sanitation facilities in Cross River and Akwa Ibom States of Nigeria led to open defecation. This indicates that absence of sanitation facilities and thus open defecation, leads to bacterial contamination of water.

Regarding the microbiological quality of drinking water in Akpabuyo communities, heterotrophic or total bacterial count, total coliform and faecal coliforms (*E. coli*) counts of all water samples exceeded WHO and NSDWQ limits for drinking water (WHO, 2006; NSDWQ, 2007). This result agrees with Ravichaudra *et al*. (2007) which detected the presence of faecal coliform over and above the permissible level in surface water sources making it unsafe for consumption.

Physico-chemical parameters such as temperature, conductivity, turbidity, TSS, TDS, Manganese, Arsenic, Iron for all the water samples met the WHO and NSDWQ acceptable limits for drinking water in the current study. This indicates that drinking water sources in Akpabuyo rural communities are safe for human consumption with respect to physico-chemical properties, although the pH levels ranged from 4.0 to 6.3 and were below the WHO and NSDWQ acceptable limits. This finding does not agree with that of Adeoye *et al.* (2013) in their study conducted in Kwara State, Nigeria, where over 70% of the water samples analysed had physico-chemical and bacteriological parameter values higher than WHO and NSDWQ limits. The water is fairly acidic, agreeing with what is known about borehole water in Calabar and neighboring Local Government Areas such as Akamkpa and Akpabuyo which borehole water is acidic (Ibid).

5. Conclusion

Water quality control within the permissible limits have become a top priority in Nigeria. This is significantly due to the spread of water-borne diseases affecting mostly the vulnerable populations. The World Health Organization expects that water meant for household use should be free from pathogenic microbes or any form of contamination from source to point of use. Findings in the current study observed that less than 50% of respondents had access to improved drinking water source and more than one third do not treat their water before use. While the pH for all water samples were below the WHO and NSDWQ acceptable range for pH in drinking water, microbiological analysis showed that total bacterial count, total coliform count and faecal coliform count for all water samples exceeded WHO and NSDWQ limits for drinking water. It is recommended that, to improve access to potable water and water quality, effective synergy between the host communities, implementing partners, and the government should be established.

Correspondence to:
Alain Simon Inah, Department of Public Health,
University of Calabar, Calabar, Nigeria.
Email: pharmalain2006@gmail.com

References

1. Park, K. A short textbook of preventive and social medicine. 20th ed. Jabalpur, M/S Banarsidas Bahnot, 2015;799-703.
2. Peter, H. Supply on Africa-building block for hand pump sustainability Water Engineering Development Centre. Lougbborough. 2013.
3. WHO. Progress on sanitation and drinking water updates and MDG Assessment. WHO Press, Geneva. 2015.
4. WHO/UNICEF. Global water supply and sanitation assessment report. Available. www.wssinfo.org. retrieved 15th April, 2017. 2014.
5. WHO/UNICEF. Progress on drinking water and sanitation. Yearly update, Geneva. From https://www.wssinfo.org/. 2014.
6. Cunningham, W. P. and Cunningham, M., 2007. Principles of Environmental Science: Inquiry and Application. 2nd ed. McGraw-Hill, London.
7. Mark, A., Ilo, C. and Bruce, L. Sustainable Water Development Programme for Rural Nigeria. International Journal of Environmental Health Research. 2010; 6, 44-52.
8. Okon, AJ., Olaniron, NS., Kalu, RE., Zacchaeus, U. A study of access to safe drinking water in rural upland and costal communities of Akwa Ibom State, Nigeria. International Journal of Applied Sciences, 2018; 13, 605-619.
9. Kalu, RE., Etim, KD., Okon, AJ., Eja, ME. Open Defecation Profile of Rural Communities in Cross River and Akwa Ibom States of the Niger Delta, Nigeria. International Journal of Current Microbiology and Applied Sciences, 2019; 8(12), 1-9.
10. Cookey, P., Angess, KB., Richard, AM., Weridongha, W., Chukwuemeka, JP. Assessment of water supply and sanitation of some coastal communities of Niger Delta. 33rd Water Engineering and Development Centre (WEDC) International Conference, Accra, Ghana. 2008 Pages 7-10.
11. National Population Commission. Nigeria Demographic and Health Survey, NGA-2013DHS. 2013.
12. Lutz, W. Sampling: How to select people, households, places to study community health. 3rd ed. International Epidemiological Association, Edinburgh. 1982.
13. Bluman, A. Elementary statistics (5th ed.). McGraw Hill, New Yok. 2004; Page 349.
14. Uwaezuoke, S., Okoli, C., Ubesie, A., Ikefuna, A. Primary hypertension among a population of Nigerian secondary school adolescents: Prevalence and correlation with anthropometric indices: A cross-sectional study. Nigerian Journal of Clinical Practice. 2016;19,1:649-654.
15. APHA. Standard methods for the examination of water and waste water. 20th ed., American Public Health. 1998; 1220pp.
16. Okon, A. J. A study of access, quality of drinking water and sanitation coverage in rural upland and coastal communities of Akwa Ibom State, Nigeria. A Ph.D thesis, University of Calabar, Calabar. 2017.
17. Eja, ME. Water pollution and sanitation for developing countries. 2nd ed. Seasprint (Nig.) Co. Calabar. 2014.

18. Ravichaudra, M. and Boopathy, S. Environmental management: Issues in potable water in rural Tamil Nadu. Concept Publishing Company, India. 2007.
19. WHO. Household water treatment and safe storage. Available at http/www.wpro.who.int/environmentalhealth/documents/docs/householdWater_Treatment_Safe-Storage_PARTICIPANT.pdf (12/10/2019). 2013.
20. WHO. Water, sanitation and health programme. World Health Organization, Geneva. 2006.
21. NSDWQ (Nigerian Standards for Drinking Water Quality), Nigerian Industrial Standard, NIS554, Approved by Standard Organization of Nigeria Governing Council. ICS 13.060. 2007; 20,15-19.
22. Adeoye, P., Adeolu, A., Ibrahim, H. Appraisal of rural water supply: Case study of Kwara State. International Journal of Basic and Applied Sciences, 2013; 5(2):23-31.

5/16/2020