Vol.2(1); pp.11-20, Aug. 2021.
Article Number: AJ2342102011120
ISSN: 0794–1668

Website: www.josedet.org

Journal of Science, Engineering Development, Environment & Technology (JOSEDET)

ASSESSMENT OF WATER SOURCES, PREVALENCE OF WATERBORNE DISEASES AND SOCIO-DEMOGRAPHIC CATEGORIES FOR BETTER FOCUSING OF INTERVENTION EFFORTS IN HOUSEHOLD DRINKING WATER SUPPLIES

Amatobi, Damiana A.[1] and Adenaike, Oluwaseun A.[2]

[1, 2] Department of Civil Engineering Technology, Akanu Ibiam Federal Polytechnic Unwana, Afikpo, Ebonyi State, Nigeria
[1]Corresponding Author: amatobiada@gmail.com

Received: 23rd July, 2021; Accepted: 27th August, 2021

Abstract

This paper provides the basic data for better focusing of intervention efforts for the provision of safe drinking water for household communities. The study surveyed households in 11 communities and obtained information from 330 water consumers in Afikpo North Local Government Area of Ebonyi State, Nigeria. Data was generated on the sources of drinking water, prevalence of waterborne diseases and socio-demographic categories. Water samples from the major sources of drinking water in the study area were taken and analyzed for colonies of microorganisms, coliform organisms and *E-coli*. The sources of drinking water in the study area are the water boreholes (71.21%) sachet water (9.70%), spring water (8.79%), harvested rainwater (6.67%) and others (3.63%). The prevalence of waterborne disease include typhoid fever (20%), diarrhea (14.55%), dysentery (7.27%) and Hepatitis A (1.52%). The prevalence of typhoid fever and diarrhea was high among consumers of water from boreholes and sachet water, which are the major sources of drinking water. The study found a strong association between age bracket and prevalence of waterborne diseases (($R^2 = 0.855$, $F = 15.720$, $P < 0.005$). The study concludes that safe drinking water interventions in the study area should focus more on improving microbial water quality in terms of water abstraction, treatment and storage. The study recommends that stakeholders who offer safe drinking water interventions supply in Afikpo and Unwana Towns should consider the provision of hardware/technical facilities that are simple to maintain and that guarantee safe water quality in the long run.

***Keywords**: Assessment, diseases, drinking water, interventions, stakeholders*

1.0 Introduction

Drinking water is a necessity of life, and access to clean drinking water is a basic human right (Anan 2002: Bichi and Amatobi, 2013). In many poor countries, such as abound in sub-Saharan Africa, the supply of safe drinking water remains grossly inadequate (Rodriguez, 2019). In the rural, peri-urban and even in many urban communities of these countries, there is a near absence of functional infrastructure for public/municipal or centrally distributed clean water. Even where safe drinking water is available, accessibility and affordability are serious issues that most times relate to each other. Failure of government at all levels to provide adequate municipal or centrally distributed portable water makes drinking water to become a largely household effort.

The supply of clean drinking water, even at a household level is however not cheap. If the water is obtained from groundwater, wells/boreholes have to be dug/sunk, abstraction equipment or other resources have to be deployed. Surface water will need some form of treatment facility, and some form of protection and maintenance. Of course, households who purchase clean drinking water must be financially empowered. Therefore, the supply of clean drinking water should not be left for the individual or household alone, as is largely the case in sub-Saharan African countries. This is because of the tendency of the poor, who are in the majority, to access water from unclean or contaminated sources. Experts warn that the manner individuals obtain their drinking water has an effect on their economic and social wellbeing (Powers, 2019). Consumption of drinking water obtained from unsafe and unprotected sources are one of the major causes of the spread of waterborne diseases. Globally over 2 billion people consume drinking water from source contaminated with faeces. The consequence is the transmission of diseases such as diarrhea, dysentery, typhoid, cholera, and polio (WHO, 2019).

To manage the poor drinking water supply situation and reduce the associated high water borne-disease burden in poor countries, many stakeholders including country governments find the need to assist households, albeit palliatively, in the form of intervention to access clean drinking water. These interventions are in the form of "source protection, mechanical abstraction, storage, treatment and distribution'' (Pedley, Pond & Joyce, 2011).

Technically, examples of these interventions include provision of water wells, boreholes fitted with hand pumps, motorized boreholes, solar powered boreholes, various types of point-of-use water treatment facilities, and so on. The stakeholders include government agencies, International organizations (eg WHO, World Bank, UNICEF), Corporate Organizations, NGOs, Charitable/faith-based organizations, and politicians.

It is observable in Nigeria, that in many instances the interventions in water supply (and sanitation) do not serve the beneficiary communities with the desired level of effectiveness or efficiency. In some cases, the host communities of the intervention projects do not assume ownership of the facilities. Consequently there are many wells, hand pumps, motorized boreholes, solar powered boreholes and other devices meant to provide drinking water to communities, but have stopped working for a considerable period and seemingly nothing is being done about them.

Nevertheless, the poor accessibility to safe water and high prevalence of water borne diseases persist despite the siting of the projects. One of the major causes of this is that the nature and the needs of the host communities were not adequately articulated during the planning and the implementation stages of the intervention effort. Thus, the focus of the intervention effort could easily be misplaced. For instance, it may be wrong to donate a motorized borehole to a poor household neighborhood that has no access to electricity. In another instance, it may be more appropriate to intervene in the area of point-of-use water treatment facilities to communities that already have a reasonable access to drinking water boreholes instead of sinking more boreholes.

Availability of accurate information on drinking water sources, prevalence of waterborne diseases and socio-demographic information of water on targeted benefiting communities can help stakeholders properly focus intervention efforts including awareness campaigns, improve access to safe drinking water and reduce prevalence of waterborne diseases.

The aim of this study is to determine sources of drinking water, socio-demographic categories and the prevalence of water borne diseases information for proper focusing and prioritizing of safe drinking water intervention in Afikpo and Unwana Towns, Ebonyi State Nigeria. The specific objectives of the study include:

1. Conduct a survey of household drinking water sources and prevalence of waterborne diseases in Afikpo and Unwana Towns of Ebonyi State Nigeria.
2. Examine relationship between hierarchical socio-demographic categories and the prevalence of waterborne diseases in communities within Afikpo and Unwana Towns.
3. Conduct microbial analysis of water samples taken from the major sources of drinking water in Afikpo and Unwana towns, and compare the result with safe drinking water limits set by the WHO and the Nigerian Standards for Drinking Water Quality[NSDWQ].

amatobiada@gmail.com

4. Identify issues of special concern, and evaluate the impact that interventions on clean drinking water supply may have on the prevalence of diarrhea diseases in the study area.

2.0 Materials and Methods

2.1 Sample Selection

Individual water consumers in households were sampled to obtain primary information on the sources of drinking water, socio-demographic categories and the prevalence of waterborne diseases in Afikpo and Unwana Towns in Afikpo North Local Government. A descriptive survey was conducted using a structured questionnaire administered in 11 communities spread across the study area. The communities are Akanu Ibiam Federal Polytechnic Unwana, Unwana Town, Ngodo, Amuro, Eke Market, Ndibe, Ukpa, Mgbom, Government College Environs, Amachi and Amaizu.

The total sample size was determined based upon achieving a 95% confidence interval, ± 5% around the most conservative estimate of the various outcome measures of potential interest. Afikpo North Local Government Area has a population density of 768.1/km² (Brinkhoff, 2016), which is relatively large. Hence, the Cochran's formula was considered appropriate for the determination of the sample population. A total of 341 questionnaires' were administered to individuals during this study. Proxies were used to obtain information for some children and illiterates who could not complete the questionnaire forms on their own. Eleven questionnaires were discarded due to inconsistencies in the entries. Therefore, 330 properly completed questionnaires were analysed.

2.2 Household Visits

At each of the 11 study communities, 31 individuals in different households were randomly selected and a questionnaire was administered to each of them. The questionnaire was designed to obtain information about sources of drinking water, prevalence of waterborne diseases and socio-demographic categories. In addition, water samples were collected from the major sources of drinking water identified from the analysis of the returned questionnaires.

2.3 Water Sampling and Testing

The three major sources of drinking water identified in the study area include water boreholes (71%), sachet water 10%, and spring water 9%. Sixty water samples were randomly and proportionally collected from the identified sources. Thus 48 samples were collected from the water boreholes, and 6 samples each from sachet water source and spring water source respectively. Each sample volume was about 60cl. The samples were examined in the laboratory for determination of the colonies of microorganisms, coliform organisms, and *E-coli*. The sampling procedures and tests followed the methodologies suggested by Bichi and Amatobi (2013).

2.4 Data Reliability, Validity and Management

The reliability of the survey was tested using Cronbach's alpha coefficient method. The reliability (r) and alpha (α) values all lay between 0.72 and 0.79, and were considered appropriate. To ensure validity of the survey, experts in the field of psychometrics were consulted in the design of the questionnaires. The experts agreed that the questionnaire and the research method were in line with the aim of the research and that the survey was valid for the desired outcome. To ensure clarity and proper understanding, a pilot questionnaire was administered to 22 households. Thereafter proper adjustment was made to develop the final questionnaire administered during the main survey.

amatobiada@gmail.com

2.5 Data Processing and Management

Data were processed with the aid of the Micro-soft Excel spread sheet and the IBM SPSS software.

3.0 Results and Discussion

3.1 Household Drinking Water Sources and Prevalence of Waterborne Diseases

Fig. 1 shows the seven sources of drinking water in Afikpo and Unwana Towns. The water boreholes is the source of drinking water for about 71.21% of the population, followed by sachet water(9.70), spring water (8.79%) , harvested rainwater (6.67%) and others (3.63%). This result is not surprising since there is no municipal drinking water supply in the area like similar communities in Nigeria, and many see the water borehole as a credible alternative (Kumolu, 2012).

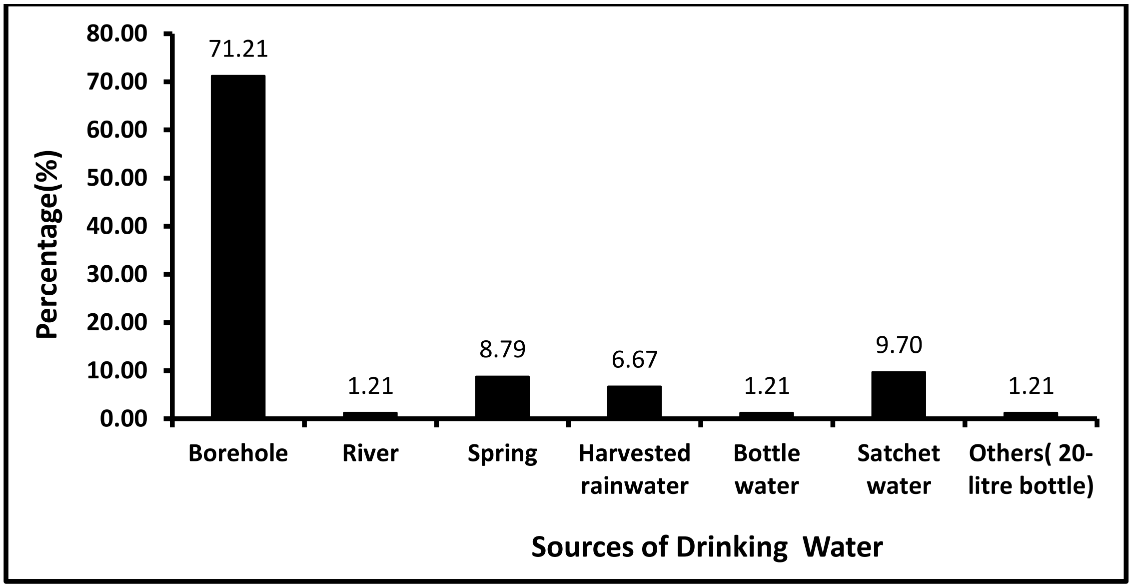
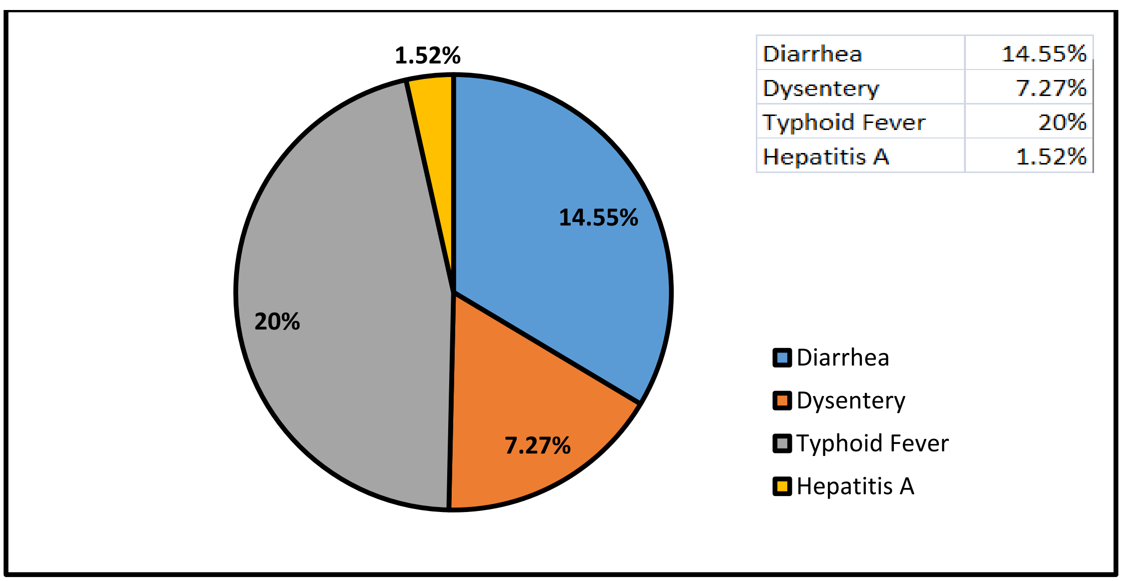


Figure 1 Sources of drinking water in Afikpo and Unwana Towns



amatobiada@gmail.com

Figure 2 Prevalence of waterborne diseases in Afikpo and Unwana Towns

Fig. 2 shows the prevalence of waterborne diseases in the study area. Typhoid fever has the highest prevalence of 20%, followed by diarrhea (14.55%), dysentery (7.27%) and Hepatitis A (1.52%). The high prevalence of these diseases that are of fecal origin suggests microbial contamination of the drinking water sources. This assertion was confirmed from the microbial analysis of the water samples (Table 11). The prevalence rates are consistent with other studies conducted in Nigeria (Akinyemi, 2019, Akinloye & Umar, 2018).
Table 1 shows the sources of drinking water in relation to the prevalence of waterborne diseases. For individuals who use the water boreholes as source of drinking water, 20.43% experience typhoid fever, 17.45 % diarrhea, 8.09% dysentery and 1.28% Hepatitis A. For sachet water consumers the experiences are, 25%, 3.13%, 6.23% and 3.13% respectively for the four diseases. For spring water consumers, the experience is 17.24%, 8.79%, 0.00% and 0.00% respectively for the four diseases. The experience of waterborne diseases among the population that consume harvested rain water include 13.64% for typhoid fever, 9.09 % for diarrhea, 4,55% for dysentery and 0.00% for Hepatitis A. These high incidences, especially among consumers of water from water boreholes suggest that urgent intervention is required on enhancement of water quality at water sources such as provision of point-of-use water treatment facilities, and ensuring that borehole sinking is regulated.

Table 1 Sources of drinking water and waterborne disease prevalence in Afikpo and Unwana Towns

Source of Drinking Water	No of Respondents by Source	%	Diarrhea	%	Dysentery	%	Typhoid Fever	%	Hepatitis A	%
Borehole	235	71.2	41	17.45	19	8.09	48	20.43	3	1.28
River	4	1.21	3	75.00	2	50.0	2	50.00	1	25.0
Spring	29	8.79	1	3.45	0	0.00	5	17.24	0	0.00
Harvested rainwater	22	6.67	2	9.09	1	4.55	3	13.64	0	0.00
Bottle water	4	1.21	0	0.00	0	0.00	0	0.00	0	0.00
Sachet water	32	9.70	1	3.13	2	6.25	8	25	1	3.13
Others (20-litre bottle)	4	1.21	0	0.00	0	0.00	0	0	0	0.00
Total	330	100	48	14.55	24	7.27	66	20.00	5	1.52

Table 2 Age distribution and waterborne disease prevalence in Afikpo and Unwana Towns

Age	Number of Respondents	%	Diarr-hea	%	Dysent-ery	%	Typhoid Fever	%	Hepatitis A	%
0 -5	36	10.9	14	38.89	3	8.33	7	19.44	0	0.00
6 – 11	37	11.2	5	13.51	13	35.14	10	27.03	0	0.00
12 -17	44	13.3	10	22.73	3	6.82	10	22.73	0	0.00
18-23	42	12.7	12	28.57	1	2.38	17	40.48	2	4.76
24-29	36	10.9	2	5.56	0	0.00	5	13.89	1	2.78
30-35	25	7.58	2	8.00	2	8.00	6	24.00	1	4.00
36-41	23	6.97	1	4.35	1	4.35	4	17.39	1	4.35
42-47	24	7.27	1	4.17	0	0.00	1	4.17	0	0.00
48-53	20	6.06	1	5.00	0	0.00	4	20.00	0	0.00
54-59	13	3.94	0	0.00	0	0.00	0	0.00	0	0.00

 amatobiada@gmail.com

60-65	14	4.24	0	0.00	1	7.14	0	0.00	0	0.00
Above 65	16	4.85	0	0.00	0	0.00	2	12.50	0	0.00
Total	330	100	48	14.55	24	7.27	66	20.00	5	1.52

Table 3 Income distribution and waterborne disease prevalence in Afikpo and Unwana Towns

Monthly Income	No of Resp. by Income	%	Diarr-hea	%	Dysent-ery	%	Typhoid Fever	%	Hepatitis A	%
< N50,000	220	66.67	31	14.09	20	9.09	41	18.64	2	0.91
N51, 000 **--** N100, 000	101	30.61	17	16.83	4	3.96	21	20.79	3	2.97
N101, 000 – N200, 000	5	1.52	0	0.00	0	0.00	2	40.00	0	0.00
N201, 000 – N400, 000	2	0.61	0	0.00	0	0.00	1	50.00	0	0.00
N401, 000 **--** N800, 000	2	0.61	0	0.00	0	0.00	1	50.00	0	0.00
>N800, 000	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	330	100.00	48	14.55	24	7.27	66	20.00	5	1.52

Table 2 shows that waterborne disease prevalence is more among the younger generation.
This result is consistent with other studies (Raji & Ibrahim, 2011)**.** Table 3 shows the educational status of respondents together with the prevalence of waterborne diseases. Most of the population earn between < N50,000 per month and N100,000 per month. Thus, the study area may not be rightly described as an affluent community.

Table 4 Educational status and waterborne disease prevalence in Afikpo and Unwana Towns

Educational Status	Number of Respondents	%	Diarr-hea	%	Dysent-ery	%	Typhoid Fever	%	Hepatitis A	%
Primary and below	87	26.36	24	27.59	6	6.90	13	14.94	3	3.45
Secondary	59	17.88	5	8.47	6	10.17	9	15.25	1	1.69
Post Secondary	65	19.70	10	15.38	4	6.15	30	46.15	0	0.00
Graduate	102	30.91	8	7.84	8	7.84	11	10.78	1	0.98
Post-graduate	17	5.15	1	5.88	0	0.00	3	17.65	0	0.00
Others	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	330	100.00	48	14.55	24	7.27	66	20.00	5	1.52

Table 4 shows the educational status of the study area. The result shows that the study area has a large literate population. This status can be taken advantage of in interventions involving campaigns on water quality management, good sanitation and hygiene practices.

3.2 Relationship between key Hierarchical Socio-Demographic Categories

amatobiada@gmail.com

Tables 5 to 7 present the results of linear regression analysis of the relationship between age bracket and educational status. Table 5 indicate that Age bracket can be strongly associated with the prevalence of waterborne diseases with R^2 value of 0.855. Table 7 of coefficients shows that this association is negative, towards older age brackets. The experiences of waterborne diseases are more on the younger people. Table 6 shows that the linear regression model is a good fit for the data (F = 15.720, P < 0.005). This result is in tandem with many studies that suggest that children are most vulnerable to waterborne diseases (Abdulkadir *et al*., .2019; Raji & Ibrahim, 2011). Tables 8 to 10 show results for linear regression analysis of the relationship between educational status and prevalence of waterborne diseases. Table 8 suggests a strong association between educational status and the prevalence of waterborne diseases. However from table 9 the linear regression model does not suggest a good fit for the data (F = 2.681, P > 0.05). In addition, the prevalence of waterborne diseases does not move in same direction: diarrhea and dysentery moving in different direction with typhoid fever. This suggests that additional information or new models may be required to understand fully the relationship between educational status and the prevalence of waterborne diseases in the study area.

Table 5 Regression summary of age bracket versus waterborne diseases (typhoid fever, dysentery and diarrhea) prevalence

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.925[a]	0.855	0.801	1.61012

[a.] Predictors: (Constant), % Typhoid Fever, % Dysentery, % Diarrhea

Table 6 ANOVA- Age bracket versus waterborne diseases (typhoid fever, dysentery and diarrhea) prevalence

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	122.260	3	40.753	15.720	0.001[b]
1	Residual	20.740	8	2.592		
	Total	143.000	11			

[a.] Dependent Variable: Age Bracket
[b.] Predictors: (Constant), % Typhoid Fever, % Dysentery, % Diarrhea

Table 7 Coefficients[a] - age bracket versus waterborne diseases (typhoid fever, dysentery and diarrhea) prevalence

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	10.402	0.820		12.684	0.000
1	% Diarrhea	- 0.108	0.065	- 0.377	-1.657	0.136
	% Dysentery	- 0.333	0.521	- 0.133	- 0.639	0.541

amatobiada@gmail.com

% Typhoid Fever	- 0.812	0.484	- 0.503	-1.677	0.132

a. Dependent Variable: Age Bracket

Table 8 Regression summary- education status versus waterborne diseases (typhoid fever, dysentery and diarrhea) prevalence

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Model
1	0.943[a]	0.889	0.558	1.05165	1

a. Predictors: (Constant), % Typhoid Fever, % Dysentery, % Diarrhea

Table 9 ANOVA[a] – Education status versus waterborne diseases (typhoid fever, dysentery and diarrhea) prevalence

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.894	3	2.965	2.681	0.415[b]
	Residual	1.106	1	1.106		
	Total	10.000	4			

a. Dependent Variable: Educational Status
b. Predictors: (Constant), % Typhoid Fever, % Dysentery, % Diarrhea

Table 10 Coefficients [a] - education status versus waterborne diseases (typhoid fever, dysentery and diarrhea) prevalence

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.829	1.393		4.186	0.149
	% Diarrhea	- 0.121	0.061	- 0.682	-1.976	0.298
	% Dysentery	- 0.220	0.143	- 0.527	-1.534	0.368
	% Typhoid Fever	0.006	0.038	0.051	0.149	0.906

a. Dependent Variable: Educational Status

3.3 Microbial Analysis of Water Samples

Table 11 shows the microbial parameters for the three major drinking water sources in the study area: water boreholes, sachet water and spring water. Borehole and sachet water samples with colonies of microorganisms 41 CFU/ml and 22 CFU/ml respectively were both above the safe drinking water limit of 10CFU/ml set by WHO(2004) and the Nigerian Standards for Drinking Water Quality [NSDWQ] (2007). For coliform organisms, the borehole water and sachet water samples with mean concentrations of 15CFU/100ml and 11CFU/100ml

amatobiada@gmail.com

respectively were above the safe drinking water limit of zero CFU/100ml. For *E-coli* only the borehole water samples with the concentration of 5CFU/100ml were above the safe limit of zero CFU/ml. These results show that water from the borehole and sachet water, the two major sources of drinking water in the study area may not be safe for direct consumption without boiling or treatment. The presence of *E-coli* in borehole water samples indicate recent fecal contamination.

Table 11 Microbial parameters of major drinking water sources in Afikpo amd Unwana Towns

Microbial Parameters	Mean Values obtained from water samples from sources indicated			WHO (2004)/NSDWQ (2007)Limits
	Borehole	Sachet Water	Spring water	
Colonies of Microorganisms(CFU/ml)	41.00	22.00	8.00	10
Coliform Organisms (CFU/100ml)	15.00	11.00	0.00	0
E-coli (CFU/100ml)	5.00	0.00	0.00	0

4.0 Conclusion and Recommendations

This study has provided data on the current sources of drinking water; socio-demographic categories and prevalence of waterborne diseases in Afikpo and Unwana Towns of Ebonyi State, Nigeria. It has also examined the link between key hierarchical socio-demographic categories and the prevalence of waterborne diseases. In addition, the study generated data on the microbial parameters of the major sources of drinking water in the study area. These data are meant for planning, implementing and monitoring of safe drinking water interventions in Afikpo and Unwana Towns. The study concludes that the prevalence of waterborne diseases in the area is quite high, and that the quality of drinking water is suspect. There are opportunities for improvement on safe drinking water interventions in the study, especially in the area of improving microbial water quality in terms of water abstraction, treatment and storage.

Interventions on the provision of water boreholes can reduce access to surface water sources, and thereby reduce the prevalence of waterborne diseases in household communities.

The following are the recommendations:

1. It is strongly recommended that stakeholders who offer safe drinking water supply interventions in Afikpo and Unwana Towns should consider the provision of hardware/technical facilities that are simple to maintain and that guarantee safe water quality in the long run. Such facilities may include professionally sunk wells/borehole, point-of- use treatment devices, provisions for maintenance and training.
2. There is a need to regulate the sinking and operation of boreholes that supply drinking water in the communities to ensure proper location and operation for avoidance of fecal contaminations.
3. There is also a need for public enlightenment of households on the use of simple techniques such as boiling and exposure of water to sunlight for treatment of drinking water, especially water that children drink.

amatobiada@gmail.com

References

Abdulkadir1, N., Afolabi, R. O., Usman, H. M., Mustapha, G. & Abubakar, U. M. (2019). Epidemiological studies of waterborne diseases in relation to bacteriological quality of water. *Microbiology Res. J. Int.*, *28*(4), 1-12.

Akinrotoye K. P. & Uzal U. (2018). Combating diarrhoea in Nigeria: the way forward. *J. Microbiol. Exp.*, *6*(4), 191-197. DOI: 10.15406/jmen.2018.06.00213/

Akinyem, Y. C. (2019). Spatial pattern and determinants of diarrhoea morbidity among under-five-aged children in Lagos State, Nigeria. *Cities & Health.* DOI: 10.1080/23748834.2019.1615162

Bichi, M. H. and Amatobi, D. A. (2013) Assessment of the quality of water supplied by water vendors to households in Sabon-gari area of Kano, northern Nigeria. *The Int. J. Eng, and Sc. (IJES)*, *2*(7):09-17.

Brinkhoff, T. (2016). *Afikpo North Local Government Area in Nigeria*. https://www.citypopulation.de/en/nigeria/admin/ebonyi/NGA011002__afikpo_north/

Kumolu, C. (2012): WATER CRISIS: As borehole becomes ticking time bomb? *Vanguard* (Nigeria), May, 9, 2012. http://www.vanguardngr.com/2012/05/water-crisis-as-borehole-becomes-ticking-timebomb/

Pedley, S. Pond, K. & Joyce, E. (2011). Interventions for water provision. In J. Cameron, P. Hunter, P. Jagals & K. Pond (Eds.), *Valuing* water, *valuing livelihoods*. London, UK: IWA Publishing. Copyright 2011 by World Health Organization (WHO).

Powers, M. (2019). Water, justice, and public health. In A. C. Mastroianni, J. P. Kahn, and N. E. Kass (Eds.), *The Oxford handbook of public health ethics*,. DOI: 10.1093/oxfordhb/9780190245191.013.50.

Raji M. I. O. & Ibrahim Y. K. E. (2011). Prevalence of waterborne infections in Northwest Nigeria: A retrospective study. *J. PH. Epidemiol.*, 3(8), 382-385. https://academicjournals.org/journal/JPHE/article-full-text-pdf/AF39E5B1670.

Rodriguez, L. (2019). 4 Factors driving the water & sanitation crisis in Africa. *Global Citizens*, October, 17. https://www.globalcitizen.org/en/content/water-and-sanitation-crisis-sub-saharan-africa/#:~:text=Of%20the%20783%20million%20people,access%20to%20safe%20drinking%20water.&text=Natural%20disasters%2C%20increased%20pollution%2C%20and,crisis%20in%20sub%2DSaharan%20Africa.

World Health Organization. (2019). *Drinking-water*. https://www.who.int/news-room/fact-sheets/detail/drinking-water.

amatobiada@gmail.com