British Microbiology Research Journal
12(2): 1-13, 2016, Article no.BMRJ.22444
ISSN: 2231-0886, NLM ID: 101608140

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Prevalence of Waterborne Diseases and Microbial Assessment of Drinking Water Quality in Ado-Ekiti and Its Environs, Southwestern, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors BMO, JOO and OF designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and managed literature searches. Authors BMO and OF managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BMRJ/2016/22444
Editor(s):
(1) Vijay Kumar Eedunuri, Greehey Children's Cancer Research Institute, UT Health Sciences Center, San Antonio, Texas, USA.
Reviewers:
(1) Triveni Krishnan, National Institute of Cholera and Enteric Diseases, Kolkata, India.
(2) Anonymous, University for Development Studies, Tamale, Ghana.
Complete Peer review History: http://sciencedomain.org/review-history/12793

Original Research Article

Received 1st October 2015
Accepted 8th December 2015
Published 25th December 2015

ABSTRACT

Aims: This study aimed to determine the prevalence of waterborne disease and assess the microbial quality of drinking water sources in Ado-Ekiti and its environs.
Study Design: Cross-sectional, descriptive type of study.
Place and Duration of Study: Ado-Ekiti and its environs, Ekiti State, Nigeria, between January 2014 and August 2014.
Methodology: A well structured questionnaire was used to observe the prevalence of waterborne disease in Ado-Ekiti and its environs. Questionnaires were administered to 1000 residents in the different communities from where the samples were collected. Also, 500 drinking water samples from different water sources were collected and analyzed using standard pour plate method for total viable bacterial (TVBC) and *E. coli* count and standard multiple fermentation test for total viable coliform count (TVCC). All data obtained in the study were analyzed using Pearson Chi-square test and Pearson correlation between variables. The significance level was set 0.05.
Results: The results revealed that prevalence of waterborne disease was found to be 27.7%. The

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study also showed a significant association between the independent variables except residential status and waterborne diseases ($P < 0.05$). The microbiological assessment of the water samples revealed that 21%, 73.6% and 47.2% did not meet the WHO standard for TVBC, TCC and *E. coli* count respectively. Also, a strong positive correlation was observed between TVCC and *E. coli* count ($r = 0.885$) and TVBC and TVCC ($r = 0.902$).

Conclusion: The detection of total coliforms and *E. coli* in some of the water samples from different water sources in Ado-Ekiti in large colony forming unit implies that the contaminated drinking water may be responsible for the prevalence of waterborne disease in the city. Therefore, effort should be made by appropriate authorities to conduct quality assessment of water sources from time to time to ensure that safe drinking water of good quality is available to everyone.

Keywords: Drinking water; total viable bacteria count; total coliform count; Escherichia coli prevalence of waterborne disease.

1. INTRODUCTION

Water is a major component of the environment and therefore, is the most indispensable natural resource which is essential for life and health on earth [1]. However, World Health Organization (WHO) documented that more than one billion people worldwide do not have access to safe drinking water [2]. Developing countries are faced with critical challenge of lack of adequate supply of safe drinking water. In Nigeria, quantity and quality of water are two main problems Nigerians contend with over the years. Water is not adequate in desirable amount and quality. This has led to the growing rate of waterborne diseases like diarrhoea, dysentery, typhoid fever and cholera experienced in this part of the world [3]. In general, waterborne diseases are transmitted through the ingestion of water and food which are contaminated by faecal materials that carry the infective dose of various pathogens [4]. And this occur in form of epidemic as it tends to affect people who share a common source of water supply.

The usual sources of drinking water in Ado-Ekiti include well, borehole, pipe-borne, spring and stream water. Ground water (well and borehole) is an important water source in both rural and urban areas of Ado-Ekiti. Government, non-governmental agencies and individuals are involved in sinking boreholes and wells to provide water for communities, companies and their families due to the rapid urbanization of the state. The risk of ground water being contaminated increases particularly in areas where shallow aquifers exist and in an environment where the topographic features favour contamination. Contaminants can find their way into drinking water sources through surface runoff, seepage of microbial landfills, septic tank effluents and indiscriminate dumping of wastes in streams [5]. These may contribute to out-break of waterborne diseases in the state. Waterborne diseases outbreak such as *Gardia, Cryptosporidium, Salmonella, Shigella, E. coli, Vibrio, cholera, Campylobacter jejeni* [6] occurs when drinking water are contaminated with enteric pathogens [7]. For the assessment of drinking water quality, the standard test for bacterial contamination is a laboratory analysis of coliform bacteria. The presence of faecal coliforms *(E. coli)* serves as an indicator of contamination by sewage [8,9]. In Nigeria, microbial contamination of drinking water sources have been reported in several states [10-15].

The prevalence of these diseases is particularly linked to the dearth of potable water in most parts of the developing countries. For instance, diarrhoeal diseases are largely caused by unsafe water, inadequate sanitation and poor hygiene among human population [4]. In Ado-Ekiti, many residents drink water from ground water source (well, borehole) not adequately monitored by appropriate agencies. Also, during the raining or dry season, scarcity of potable water becomes a major issue which causes many residents to look for alternative drinking water source such as packaged water. During this time, many residents become susceptible to various waterborne diseases.

In as much as the environmental factor, quality of “water” and prevalence of waterborne disease especially diarrhoeal disease are associated with the supply of contaminated water and or lack of water for domestic use (for including for personal hygiene), this study was conducted to investigate the prevalence of waterborne disease in relation to microbial quality of different water sources in Ado-Ekiti and its environs.

2. MATERIALS AND METHODS

2.1 Study Design

A cross-sectional and descriptive study designed was employed. This was conducted between January and August 2014.

2.2 Study Area / Population

The study was conducted in Ado-Ekiti and its environs, the capital city of Ekiti State (Fig. 1). The city is located within the North Western, part of the Benin-Owena River Basin development Area. The city lies between Latitude7° 34' and 7° 44' north of the Equator and Longitude 5° 11' and 5° 18' east of the Greenwich Meridian. It has a number of Satellite towns around it. To the North is Iworoko, about 16 kilometers away from the city; to the east are Are and Afao, about 16 kilometers; to the West are Iyin and Igede, about 20km and to the South is Ikere, about 18 km. The change in the economic and political status of the city has brought a corresponding increase in the number of its inhabitants. The city had a projected population of 274,205 in the year 1995 while that of 2013 is put at 1.11 million given the current growth rate of 4 per annum out of which 82 percent are living in urban centre [16]. Ado-Ekiti setting is majorly an urban setting where different higher education institutions are situated.

2.3 Sample Size Determination

According to Franscis et al. [17], the sample size was calculated using the formula: Sample (n) = $Z^2*(S.D)*(1-S.D)/C^2$ where Z score at 99% confident level, S.D is standard deviation while C is confidence interval or margin of error. Z score at 99% is 2.576, S.D is 0.5 while C is +/- 4%. The sample size was calculated to be 1036.84. For convenience, a sample size of 1000 respondents in all the study sites were administered questionnaires in this study.

2.4 Sampling of Water Samples

A total of five hundred (500) samples of drinking water sourced from ground water (boreholes and wells), surface water (streams), commercially produced water (sachet water) and pipe-borne water were randomly collected from different locations in Ado-Ekiti and its environs (Fig. 1) for bacteriological analysis as described by Abera et al. [7]. Observation of relevant sanitary conditions and practices around each water source were carried out.

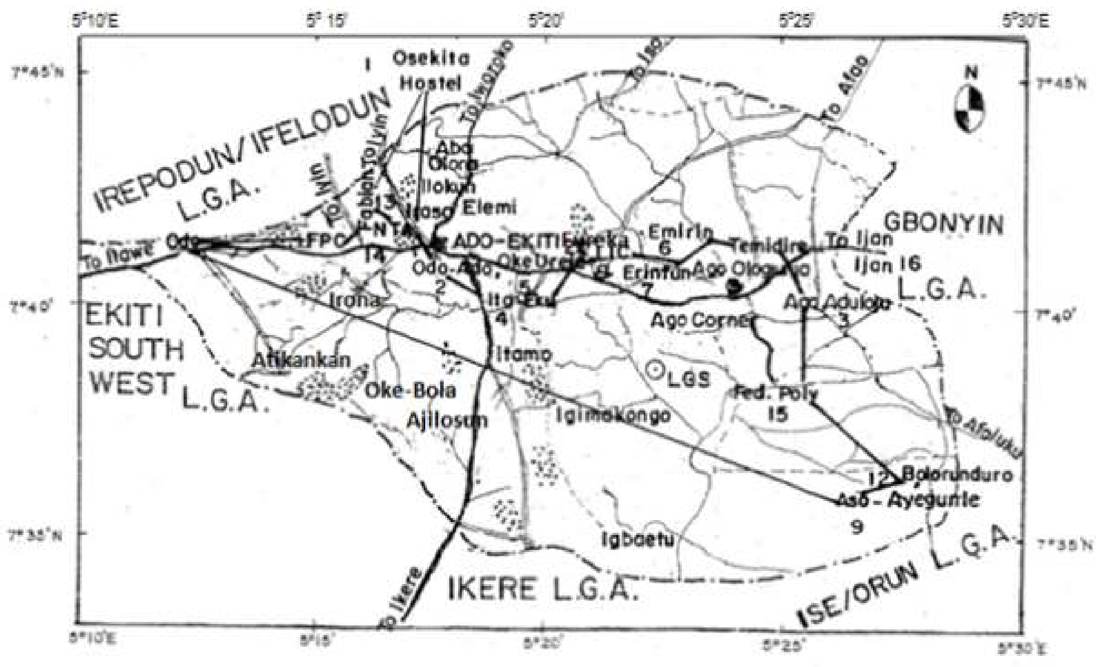

Fig. 1. The study locations within Ado-Ekiti and its environs showing communities that participated in the study

2.5 Bacteriological Analysis of Water Samples

Total viable bacteria count (TVBC) was determined using the standard plate count method employed by Oyedeji et al. [18]. Total viable coliform counts (TVCC) and isolation and identification of *E. coli* were carried out according to the standard multiple tube fermen-tation techniques recommended in Methods for the Examination of Water and Waste Water [19].

2.6 Data Collection

A well-structured questionnaire was designed and administered to residents of the communities from where water samples were collected.

2.7 Study Variables

In this study, one (1) dependent and eighteen (18) independent variables were selected for the analysis. The dependent variable is waterborne disease while independent variables include: age, sex, marital status, educational status, occupation, residential status, household size, duration of residence, presence of pets and livestock, availability of toilet facilities, condition of cleanliness around the residence, source of drinking water, treatment of drinking water, location and topographic features of water source, susceptibility of location of water source to erosion, presence of septic tank and activities around drinking water source.

2.8 Data Analysis

The data obtained in this study was compiled and analyzed descriptively using Ms Excel (Microsoft corp. USA) and Statistical Package for Social Sciences (SPSS version 16) data analyzing software. Descriptive statistics were used to summarize the results of the water samples. Pearson's correlation was used to compare water quality under various conditions. Also, the Pearson's chi-square test was used to assess the association between the dependent and independent variables. The level of significance was set to 5%.

3. RESULTS AND DISCUSSION

The frequency and percentage of variables that depict the socio-demographic profile of the respondents is given in Table 1. This Table showed that majority (61.3%) of the respondents fall within the age group of 31-40 whereas only 2.3% were within the age group of 50 and above. Only 58.4% were female and 41.6% were males. Among the respondents, 86.5% were singles and a higher percentage of them had higher education degree. Different occupations were employed by the respondents whereas a higher percentage of 85.5% were students. Also, 84.0% were indigenes and 16.0% were non-indigenes.

Table 1. Socio-demographic profile of respondents

Independent variables	Frequency	Percentage (%)
Age of respondents		
10-20	34	3.4
21-30	262	26.2
31-40	613	61.3
41-50	68	6.8
51 and above	23	2.3
Sex		
Male	416	41.6
Female	584	58.4
Marital status		
Married	91	9.1
Single	865	86.5
Divorced	44	4.4
Educational status		
Primary cert.	76	7.6
Secondary cert.	252	25.2
ND	122	12.2
NCE	103	10.3
HND	211	21.1
B. Sc.	150	15.0
Other higher degree	86	8.6
Occupation		
Students	855	85.5
Teaching	22	2.2
Trading	43	4.3
Civil servants	27	2.7
Farming	27	2.7
Artisan	22	2.2
Others	4	0.4
Residential status		
Indigenes	840	84.0
Non indigenes	160	16.0

Table 2 depicts the characteristics of respondents' residence. Majority (36.5%) of the respondents had between 6-10 residents whereas only 7.2% had between 16-20 residents in their house. A least of 1.1% indicated that they had resided in their house for over 20years and most (84.2%) respondents had only resided in a house between 1 and 5 years. Also, 59.0% respondents possess pets and livestock in their residence whereas 41.0% did not. The Table also revealed that most (86.5%) residence had toilet facility whereas 13.5% lacked this facility. It was also shown in the Table that 50.4% residence had waste dumped nearby and 20.1% even with uncovered drainage.

Table 2. Characteristics of residence of respondents

Independent variable	Frequency	Percentage (%)
Number of residents in your house		
1-5	328	32.8
6-10	365	36.5
11-15	75	7.5
16-20	72	7.2
Above 20	160	16.0
Duration of residence (year)		
1-5	842	84.2
6-10	100	10.0
11-15	29	2.9
16-20	13	1.3
Above 20	11	1.1
Undecided	5	0.5
Presence of pets and livestock in your residence		
Yes	590	59.0
No	410	41.0
Indication of yes (specify)		
Livestock	238	40.3
Pets	329	55.8
Unspecified	23	3.9
Availability of toilet		
Yes	865	86.5
No	135	13.5
Indication of yes (specify)		
Pit	167	19.3
Semi-water closet	559	64.6
Water closet system	16	1.8
Bush	7	0.8
Others	4	0.6
Undecided	112	12.9
Condition of cleanliness in the surrounding		
Waste dumped nearby	504	50.4
Uncovered drainage	201	20.1
Other activities	287	28.7
Undecided	8	0.8

The frequency and percentage table of characteristics of respondents' drinking water source is presented in Table 3. The Table showed that different water sources were used by the respondents with well water being the predominant (32.4%) water source. Also, 60.1% took some measures to treat their water before drinking whereas 39.3% did not. Higher percentage (37.0%) had their water source located within the residence. Majority (69.2%) had their water source located on a plain area and as such (75.5%) were not susceptible to erosion and flooding. A fewer respondents (11.7%) had septic tank around their water source with majority who could not give detail about the distance of the septic tank from water source. Quite a number of respondents (62.8%) had no activities that take place around the source of their drinking water.

Table 4 showed the characteristics of dependent variable. The prevalence of waterborne disease in Ado-Ekiti and its environs showed that 27.7% of the respondents had experienced waterborne disease within the last three years. Diarrhoea was prevalent (51.9%) among the waterborne disease and was mostly experienced in rainy season.

3.1 Association between Independent Variables and Dependent Variable

Pearson's Chi-square test showed different statistical significant associations between the dependent and independent variables (Table 5-7). Table 5 showed that a statistical association exists between waterborne diseases and the socio-demographic variables except residential factor of the respondents which had a *P*-value of 0.31. Also, there is a statistical relationship between the characteristics of residence of the respondents and waterborne disease as their *P*-values are <0.05 (Table 6). Furthermore, Table 7 revealed that the experience of waterborne disease within the last three years is dependent on variables of the characteristics of the respondents' drinking water source (*P* -value < 0.05), that is, a significant relationship exists between them.

Prevalence of waterborne disease is an issue in developing countries [20]. The prevalence (27.7%) of waterborne disease in Ado-Ekiti, Ekiti State, prompted the bacteriological examination of different drinking water sources in the city. This is to determine the actual control measures to put in place in checking this menace. Although, microorganisms have been implicated in incidence of waterborne disease throughout the world [21,22] there are other influential factors of waterborne disease. Some of these factors include environmental factors, socio-economic factors and residential factors which were considered in the observational study. The findings in this study revealed a significant relationship between socio-demographic profile of the respondents and the experience of waterborne disease. Hence, age, sex, marital status, educational status and occupation are factors which determine an individual health status. Findings from previous studies have also highlighted these factors to have significant relationship with waterborne disease [1,15,23,24] However, residential status as indigene or non-indigene was not statistically significant (*P* -value = 0.31).

Furthermore, the variables considered under the characteristics of respondents' residents and drinking water sources are factors which can bring about predisposition to waterborne diseases as they have also been found statistically significant (*P* -value < 0.05). This finding corroborates the findings by Yassin *et al.* [25]. They investigated various characteristic of respondents' drinking water sources and found out a strong correlation (*r* = 0.7) between water sources and occurrence of waterborne disease.

3.2 On-site Observations

Assessment of relevant sanitary conditions and construction of each water source during sample collection revealed that only 6.7% of hand-dug wells sampled have a depth of between 31-40ft, 20% have depth of between 21-30ft, 33.3% have between 11-20 ft while the rest of the wells were not deep enough (<10ft). Some were poorly constructed and situated in a bushy environment while some were very close to where the households carry out their washing. Beside these, it was observed that 6.7% of the water sources sampled were situated close to septic tank while some have bushes around them where the nearby community defecates. The foot-paths that lead to some streams were littered with faeces, besides, some streams were used as dump-site for domestic wastes. It was also observed that in some wells, different containers from different households were used to draw water out from the wells while some wells did not have cover at all or partially. Pictures of few of the sources sampled are shown in Fig. 2.

3.3 Microbiological Analysis of Drinking Water Samples

The result in Table 8 revealed the microbiological quality of the water samples collected from different drinking water sources in Ado-Ekiti and its environs. The results showed that 79.0%, 26.4% and 52.8% of the 500 water samples analysed meet the WHO microbiological standard for total viable bacterial counts (TVBC) (100 cfu/ml), total viable coliform counts (TVCC) (<1MPN/100 ml) and *E. coli* counts (0 cfu/ml) respectively.

Table 3. Characteristics of drinking water source of respondents

Variables	Frequency	Percentage (%)
Source of drinking water		
Well	166	16.6
River	35	3.5
Tap	324	32.4
Borehole	237	23.7
Spring	12	1.2
Stream	8	0.8
Sachet water	167	16.7
Bottle water	23	2.3
Rain	22	2.2
Undecided	6	0.6
Any measures taken to treat water before drinking		
Yes	601	60.1
No	393	39.3
Undecided	6	0.6
Indication of yes (specify)		
Boiling	97	16.2
Use of filter	34	5.6
Addition of chlorine	81	13.4
Addition of alum	40	6.7
Use of water guard	308	51.3
Others	37	6.2
Undecided	4	0.6
Location of water source		
Nearby place	360	36.0
Within the house	370	37.0
Far away	270	27.0
Topographic feature of location of water source		
Sloppy	117	11.7
Plain	692	69.2
Hilly	62	6.2
Undulating	69	6.9
Susceptibility of location of water source to erosion and flooding		
Yes	239	23.9
No	755	75.5
Undecided	6	0.6
Presence of septic tank around water source		
Yes	117	11.7
No	883	88.3
Indication of yes (specify distance)		
0-5 ft	13	10.8
Above 5ft	24	20.3
Undecided	80	68.9
Activities around drinking water sources		
Poultry	12	1.2
Farming	35	3.5
Filling station	13	1.3
Others	312	31.2
None	628	62.8

Table 4. Characteristics of dependent variable (waterborne disease)

Variable (waterborne disease)	Frequency	Percentage (%)
Experience of any waterborne disease within the last 3 yrs		
Yes	277	27.7
No	723	72.3
Indication of type of waterborne disease, if yes		
Diarrhoea	144	51.9
Typhoid fever	45	16.4
Dysentery	19	6.8
Cholera	10	3.5
Unspecified	59	21.4
Season in which waterborne disease was experienced		
Rainy season	195	19.5
Dry season	122	12.2
Any other	154	15.4
Undecided	529	52.9

Prevalence of waterborne disease in the last three years = 27.7%

Table 5. Association between socio-demographic profile of the respondents and waterborne disease

Independent variables	Experience of waterborne disease within the last 3 yrs		Total	Pearson's Chi-square test		
	Yes	No		X^2	df	*P* -value
Age				**62.744**	**4**	**.00**
0-10	15	19	34			
11-20	71	191	262			
21-30	137	476	613			
31-40	44	24	68			
41-50	10	13	23			
Sex				**19.457**	**1**	**.00**
Male	146	270	416			
Female	131	453	584			
Marital status				**21.849**	**1**	**.00**
Married	60	75	135			
Single	217	648	865			
Educational status				**13.234**	**2**	**.00**
Primary school certificates	30	46	76			
Secondary School Certificate	84	168	252			
Higher institutional qualification	163	509	672			
Occupation				**39.478**	**6**	**.00**
Student	220	635	855			
Teaching	2	20	22			
Trading	15	28	43			
civil servant	9	18	27			
farmer	17	10	27			
artisan	14	8	22			
others	0	4	4			
Residential status				**1.051[a]**	**1**	**.31**
Indigene	238	602	840			
Non-Indigene	39	121	160			

Table 6. Association between characteristics of respondents' residents and waterborne diseases

Independent variables	Experience of waterborne disease within the last 3 yrs		Total	Pearson's Chi-square test		
	Yes	No		X^2	df	*P* -value
Household size				**2.555E2[a]**	**33**	**.00**
1- 5	51	277	328			
6-10	111	254	365			
11-15	36	39	75			
16-20	16	56	72			
Above 20	63	97	160			
Duration of residence				**1.663E2[a]**	**15**	**.00**
1-5	216	626	842			
6-10	42	58	100			
11-15	0	29	29			
16-20	13	0	13			
21 and above	6	5	11			
Undecided	0	5	5			
Possession of pets and livestock in the residence				**3.723[a]**	**1**	**.05**
Yes	150	440	590			
No	127	283	410			
Toilet facilities				**88.932[a]**	**1**	**.00**
Yes	194	671	865			
No	83	52	135			
Condition of cleanliness around the residence				**17.769[a]**	**3**	**.00**
waste dumped nearby	164	340	504			
Uncovered drain	56	145	201			
other activities	57	230	287			
Undecided	0	8	8			

Table 7. Association between characteristics of respondents' drinking water sources and waterborne disease

Independent variables	Experience of waterborne disease within the last 3 yrs		Total	Pearson's Chi-square test		
	Yes	No		X2	df	*P* -value
Water source				**1.037E2[a]**	**9**	**.00**
Well	42	124	166			
River	29	6	35			
Tap	86	238	324			
Borehole	60	177	237			
Spring	12	0	12			
Stream	0	8	8			
Satchet	31	136	167			
bottle	6	17	23			
Rain	11	11	22			
Undecided	0	6	6			
Any Measures taken to treat water				**.259[a]**	**1**	**.61**
Yes	171	430	601			
No	106	287	393			
Location of water source				**44.344[a]**	**2**	**.00**
Nearby place	125	235		360		
In your own house	57	313		370		
Far away	95	175		270		

Independent variables	Experience of waterborne disease within the last 3 yrs		Total	Pearson's Chi-square test		
	Yes	No		X2	df	*P* -value
Presence of sewer closed to water source				**42.321[a]**	**1**	**.00**
Yes	62	55	117			
No	215	668	883			
Topographic features of water source				**7.744[a]**	**3**	**.05**
Sloppy	57	120	177			
Plain	196	496	692			
Hilly	12	50	62			
Undulating	12	57	69			
Susceptibility of location to erosion and flooding				**12.662[a]**	**2**	**.00**
Yes	86	153	239			
No	191	564	755			
3	0	6	6			
Activities that take place near the source pf drinking water				**49.578[a]**	**4**	**.00**
None	215	413	628			
Poultry	6	6	12			
Farming	0	35	35			
Filling station	0	13	13			
Others	56	256	312			

Fig. 2. Some of the water sources sampled in the study

Table 9 shows the mean TVBC, mean TVCC and mean *E. coli* counts of the different water samples from different sources. The variations in the number of cfu/ml among the water samples revealed the corresponding sanitary quality of the water sources. Generally, the mean TVBC, TVCC and *E. coli* counts was relatively higher in unprotected sources as seen in streams compared to other sources. The mean TVBC ranged between 3.9542 log10 cfu/ml in springs and 4.9726 log10 cfu/ml in streams, mean TVCC ranged between 0.3010 log10 MPN/100 ml in springs and 1.0175 log10 MPN/ml in streams and mean *E. coli* counts 0.3010 log10cfu/ml in springs and 1.0649 log10cfu/ml in wells. Also, the table shows that there is a significant relationship between the water sources and their colony forming unit values as their *P* -value is <0.05.

Fig. 3 shows the relationship between TVCC and *E. coli* counts. The correlation between TVCC and *E. coli* counts was positive, strong and significant (*r*= 0.885). A similar correlation was also observed between TVCC and TVBC as *r*= 0.902 (Fig. 4). The general trend for this type of relationship is that the cfu of *E. coli* increases as the MPN of TVCC increases and vice versa (Fig. 3) and as the cfu of TVBC increases, the MPN of TVCC also increases (Fig. 4).

The results of the microbiological assessment of the different water samples depict the actual picture of the water sources and also justified the observation made during the on-site water source inspection. The detection of total coliforms and *E. coli* in some of the water samples from different water sources in Ado-Ekiti in large colony forming unit implies that the contaminated drinking water may be responsible for the prevalence of waterborne disease in the city. According to WHO standard for drinking water quality, there should be <1 MPN/100 ml of total coliforms and no *E. coli* in 1 ml of water. However, the results of some of the water samples in this study are not suitable for drinking purpose. This is in agreement with Tambe et al. [26] who also recorded that water samples were frequently contaminated with human feacal organisms. Also, a similar study by Salim et al. [27] reported 17.3% of *E. coli* recovered from drinking water.

It was also observed that a strong relationship exists between total coliform and *E. coli* counts as well as total bacterial and total coliform counts. This implies that as the colony forming unit of total coliform increases, the count of *E. coli* increases likewise for total coliform and total bacteria count. The unhygienic sanitary conditions or poor environmental conditions around the drinking water sources could contribute to this. This also strengthens a study by Gwimbi [28] which revealed a strong correlation between total coliform and *E. coli* count.

Table 8. Distribution of percentage number of water samples from different water sources in Ado-Ekiti and its environs according to WHO microbiological standards

Water sources (N)	TVBC (cfu/ml)		TVCC (MPN/100 ml)		*E. coli* counts (cfu/ml)	
	≤100/ ml	>100/ ml	<1/100 ml	>1/100 ml	>0/ ml	0/ ml
Sachets (87)	80 (91.9)	7 (8.1)	58 (66.7)	29 (33.3)	80 (91.9)	7(8.1)
Streams (68)	49 (72.1)	19 (27.9)	3 (4.4)	65 (95.6)	21 (30.9)	47 (69.1)
Pipe-borne (43)	37 (86.1)	6 (13.9)	12 (27.9)	31 (72.1)	24 (55.8)	19 (44.2)
Borehole (55)	42 (76.4)	13 (23.6)	17 (30.9)	38 (69.1)	31 (56.4)	24 (43.6)
Springs (2)	2 (100)	0 (0)	1 (50.0)	1 (50.0)	1 (50.0)	1 (50.0)
Wells (245)	185 (75.5)	60 (24.5)	41 (16.7)	204 (83.3)	79 (32.2)	166 (67.8)
Total (500)	395 (79.0)	105 (21.0)	132 (26.4)	368 (73.6)	236 (47.2)	264 (52.8)

Table 9. Mean total viable bacterial count (TVBC), mean total viable coliform count (TVCC) and mean *E. coli* count of different drinking water sources in Ado-Ekiti and environs

Samples of drinking water sources(N)	Mean TVBC ± SD (log_{10} cfu/ml)	Mean TVCC ± SD (log_{10} MPN/100ml)	Mean *E. coli* ± SD (log_{10} cfu/ml)
Sachet (87)	4.4893±4.7263	0.3158±0.5575	0.6173±0.0271
Stream (68)	4.9726±4.9879	1.0175±0.6656	1.0302±1.2565
Tap (44)	4.8003±4.9498	0.8437±0.7608	0.8083±1.1345
Borehole (54)	4.8444±5.0037	0.8519±0.7634	0.7467±1.1637
Spring (2)	3.9542±3.1505	0.3010±0.4515	0.3010±0.1505
Well (245)	4.8884±5.0065	0.9179±0.7365	1.0649±1.2861
P -value	0.039	0.042	0.035

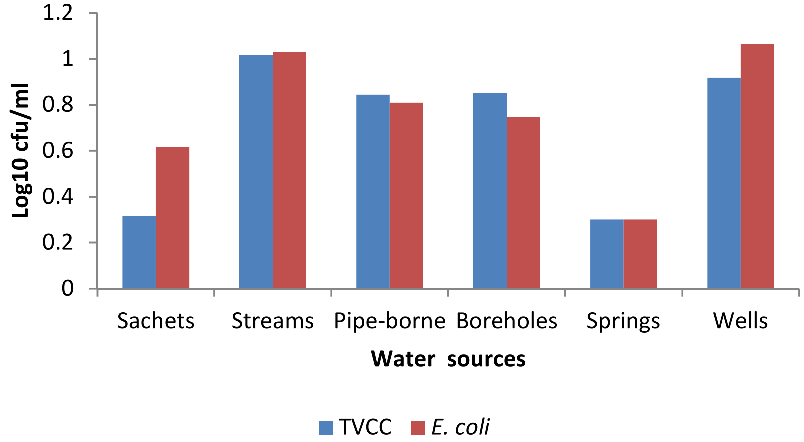

Fig. 3. Relationship between total viable coliform counts (TVCC) and *E. coli* counts

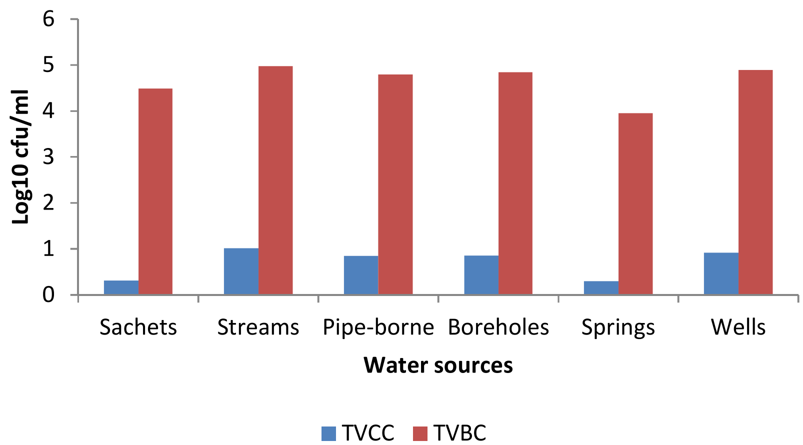

Fig. 4. Relationship between total viable coliform count and total viable bacterial count

4. CONCLUSION

The findings in this study points to the fact that the prevalence of waterborne disease is linked up with the quality of drinking water sources available in Ado-Ekiti and its environs. This implied that the quality of available drinking water serve as a tool in determining the health status of any community. Therefore, effort should be made by appropriate authorities to conduct quality assessment of water sources from time to time in order to ensure that safe drinking water of good quality is available to everyone. In addition, individual member of a community also have a role of ensuring and maintaining good hygienic condition around their water sources.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/12793