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WATER QUALITY AND THE PREVALENCE OF MICROBIAL WATER-RELATED DISEASES IN YAURI TOWN AND ITS ENVIRONS, KEBBI STATE NIGERIA

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ABSTRACT

Water quality and contacts pose serious threats to human health. This paper looks at the relationships between water quality and the prevalence of water related diseases in Yauri town and its environs, with the aim of identifying the types and causes of diseases in relation to gender and age. Disease data of between 2015 and 2018 were obtained from health facilities in Yauri town while water samples were collected from the River Niger, hand-dug wells and the public tap water supply. Water samples were analyzed for the Most Probable Number (MPN) of coliforms using using a statistical estimation method called Most-Probable-Number (MPN), expressed as MPN per 100 ml of water. A Spearman's Correlation was carried out to show the relationships while the Independent t-test was carried out to show the significance of the prevalence. Results show that the most prevalent disease is malaria across gender with males having an edge over the females in 2017 and 2018. However, the independent t test failed to discover a significant difference ($p = 0.93$) in the prevalence of all diseases among the gender. The prevalence of malaria, typhoid and diarrhoea was also highest among children aged 15 years and below, although the Spearman's correlation coefficient, showed an inversed relationship between diseases prevalence and age of patients ($r= -0.289$; $p<0.01$). The probable number of coliforms shows the highest number in water fetched directly from the river as well as from hand dug wells (1,100 coliforms). Conversely, water from boreholes had no coliforms, whilst that from the Water Board had the least number of coliforms (48). Also, water from tankers and wheel barrows from the Water Board had slightly higher number of coliforms (400). Thus, the

water is either poorly treated by the Water Board or gets contaminated by the transportation media. It is thus recommended that sanitary inspectors should ensure cleanliness or disinfection of all water transportation media.

KEY WORDS: Water quality, Human health, Water related diseases.

INTRODUCTION

There is a direct relationship between the prevalence of water-related diseases and contact with surface water bodies which has led the World Health Organization (during its decade of water development in the 1980s) to classify water-related diseases into three development-related categories: water-borne (which are ingested); water-washed (or unwashed - which are preventable by sanitation and hygiene practices); and water-based diseases that require vectors (Meade and Emch, 2010). Studies have also shown the links between water pollution and water-based diseases (Omole *et al*., 2015; Johnson and Paull, 2011; Griffiths, 2007), with the introduction of pollutant into nearly every available freshwater source by humans. According to Omole *et al* (2015: 778), aside poor supply of potable water to households, unsanitary practices by residents could also have contributed to the high incidence of water-related diseases. Thus, water contamination can affect humans directly through consumption of polluted water supplies or bathing in polluted streams, rivers, beaches and lakes, as well as from consumption of unwashed vegetables and fruits. Potable water supplies can also be contaminated from the source or in the distribution system after treatment, thus giving rise to infectious water-related diseases of faecal origins, such as Typhoid, Giardiasis, Amoebiasis, Ascariasis, and Hookworm (Fazal Rehman, Bertuzzo and Mari, 2017; Li, *et al* 2017; and Pirsaheb *et al*, 2017). Infections come through bacteria such as *Salmonella* that causes salmonellosis, *Shigella* that causes shigellosis and *Vibrio parasit* that causes cholera, as well as viruses such as rotavirus for hepatitis A virus; or even parasites such as *Entamoeba* that cause amebiasis and *Giardia* that cause Giardiasis. Diseases usually contracted through contacts with water include swimmer's itch and schistosomiasis. Adeyinka *et al* (2014) asserted that the incidence of waterborne diseases in Nigeria is attributable to poor access to portable water in the rural areas which drives people to consume unsafe water that exposes them to water-related diseases. This is particularly acute where general hygiene and environmental sanitation are poor and where there is inadequate supply of safe water (Maleke *et al*, 2003; Ejaz *et al*, 2011; Adeyinka *et al*, 2014 and Ozioma *et al*, 2016).

The WHO (2000) maintains that there are a number of health risks associated with drinking water contaminated with coliform bacteria (*Escherichia coli*) from faecal sources such as sewage and although the seriousness of such contamination is enormous, it is poorly addressed despite the high mortality rates recorded (Omole and Ndambuki, 2014). In Nigeria, there are reports that drinking water usually gets contaminated with microbes which could be of faecal origin (Biu *et al*., 2009; Adekunle *et al*., 2007; Ibrahim *et al*., 2000; Raji *et al*., 2010a; Junaidu *et al*., 2001; Nwidu *et al*, 2008). For example, Raji *et al*. (2010a) have observed the presence of pathogens far above the WHO's (2003) allowable limit in the drinking water samples collected in their study area. Thus, poor drainage and poor solid waste disposal systems available in most areas along river banks must have contributed to serious health risks to dwellers (Ejaz *et al* 2011). In a similar vein, Ozioma *et al* (2016) have claimed that a vast majority of people living along water sources fetch and drink from such sources, thus health hazards associated with surface water use and contacts, which could be occupational, hygiene and sanitation-related or disease vector biogeography related, exist. As such, fighting the menace of water-relayed diseases requires an understanding of their spread of which this paper tries to look at by examining the relationships of the prevalence of water-related diseases and the quality of domestic water supply in Yauri town and its environs, Kebbi State, Nigeria with the aim of achieving the following:

- identifying the types of water-related diseases prevalent in the area;
- examining water quality from different sources for domestic use;
- assessing the relationships of water quality and the prevalence of water-related diseases
- assessing the relationships of water-related diseases and age of patients; and
- examining the relationships of water-related diseases and gender of patients.

Study Area

Yauri town is located at the south-western part of Kebbi State on the eastern bank of the Niger River, about 200km from Birnin Kebbi, the State capital. It is the headquarters of Yauri Emirate as well as Yauri Local Government Area. Yauri town lies between Longitude $4^{o}17'0"E$ to $4^{o}52'0"E$ and Latitude $10^{o}43'0"N$ to $11^{o}14'0"N$ (see Figure 1)

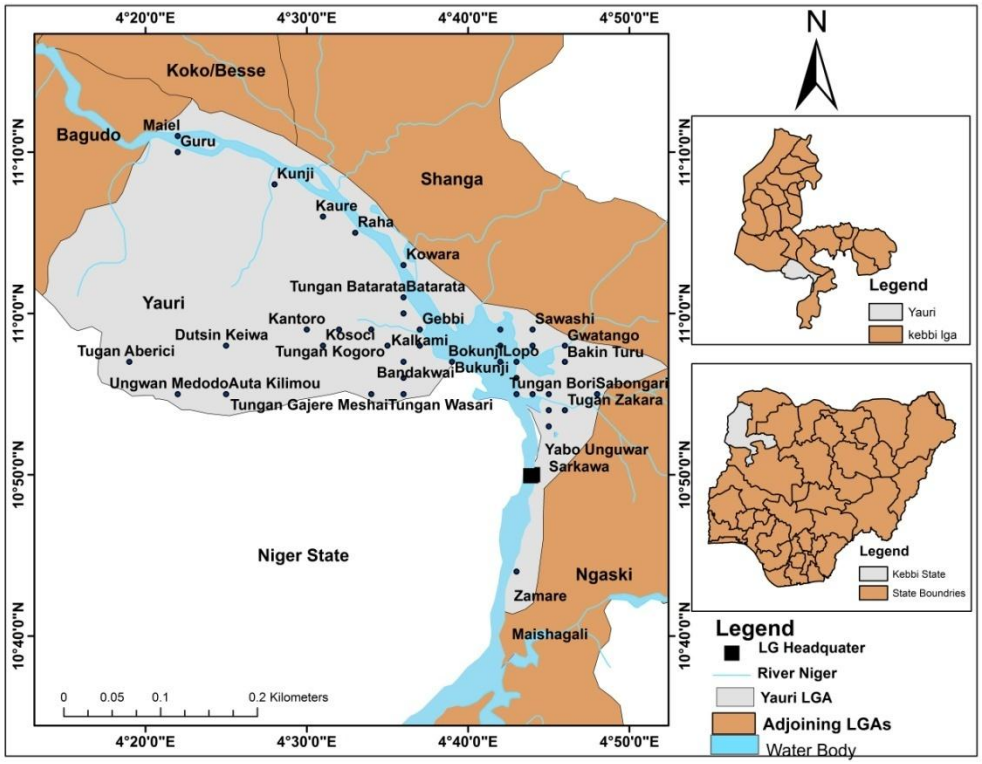

Figure 1: The Study Area.

Fishing, farming and animal husbandry are the occupations of most people. The presence of River Niger and the efficient fertile land have made Yauri a vibrant centre of economic activities and a transport hub serving as a gateway to many southern towns in the country and neighbouring Benin Republic. Thus, there are diverse and malleable groups of migrants. According to the National Population Commission (NPopC, 2006), it had a population of 13,234 people inhabiting an area of about 3,380 square kilometres.

MATERIALS AND METHODS

The study philosophy is the naturalist (or positivist) approach, where data collected are analyzed to uncover aetiological causes of diseases. Therefore, data on water-related diseases were collected from all healthcare facilities (both public and private) within Yauri town. Available records for the study period (2016-2018) are presented in form of tables and charts for visualization. Such data were also segregated into age-groups and gender so as to ascertain the proportions of each variable in the prevalence of water-related diseases..

Water samples were also collected from the River Niger, hand-dug wells and the public tap water supply (from the Water Board) and analyzed for the *Most Probable Number* (MPN) of coliforms so as to provide explanation for the prevalence of some of these diseases The

Multiple tube technique was used for microbial analysis (Bello and Fada, 2017). In this method, coliforms were detected in three stages, which include *Presumptive test*, *Confirm test* and *Completed test* (Fawola and Oso, 1995); and the number of coliforms was determined by a statistical estimation called Most-Probable-Number (MPN), which is expressed as MPN per 100 ml of water (Johnson and Case, 2010).

In the statistical analysis, the Spearman's Correlation analysis was carried out to show the relationships while the Independent *t*-test was carried out to show the significance of the prevalence.

RESULTS AND DISCUSSION

Table 1 shows the recorded water-related diseases in all the healthcare facilities in Yauri town during the study period. It also shows the gender of the affected patients and their age groups for the three-year period of study. The most prevalent among the diseases appears to be malaria within the years of study and across all gender with males having an edge over the females in 2017 and 2018. The reasons for this may be attributed to the level of exposure. The males are more exposed to mosquito bite because of the longer hour they spend on the farms and the river. The cultural setting makes them more free to participate in water-related activities such as fishing, water vending, irrigation farming, boat driving and therefore more prone to water-related diseases than their female counterparts who are, in most cases, confined to houses due to the purdah system. However, the independent *t* test applied failed to discover a significant difference (p = 0.93) in the prevalence of water related diseases among the two gender groups (males and females) in the study area (Table 2). This means that malaria is common among people in respective of their gender inclination.

Similarly, findings indicate that the prevalence of malaria is highest among children aged 15 years and below. This is also true with typhoid and diarrhoea. This is confirmed by the Spearman's correlation coefficient, which prevails an inversed relationship between diseases prevalence and age of patients (r= -0.289; $p<0.01$) Table 3. This is attributable to their lower immunity than the adults.

Other diseases of high prevalence include typhoid and diarrhoea, followed by yellow fever, schistosomiasis and gastroenteritis in 2016, but the their prevalence got reduced drastically in 2017 and 2018, probably due to improved water supply and sanitation or perhaps poor

records keeping in the healthcare facilities. Tables 3 & 4 and Figures 1&2 show more vividly the pattern of the prevalence.

Table 1: Gender difference in diseases prevalence.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Diseases	Equal variances assumed	.097	.758	.086	24	.932	27.769	322.665	-638.178	693.716
	Equal variances not assumed			.086	23.042	.932	27.769	322.665	-639.646	695.184

Table 2: Prevalence of Water-related Diseases by Healthcare Facility (2015-2018).

Disease	**Health Facilities**																				
	Nakowa Clinic, Yauri		Nasara Clinic, Yauri		MCH Yauri		GH Yauri		Yelwa Hosp. Yauri		Tondi Disp.		Rotal Clinic & Maternity		U/Malamai		Rafin Kuka		Town Disp. Yauri		**Total**		**Grand Total**
2018	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
Malaria	-	-	150	100	-	300	310	24	100	50	150	50	200	180					120	80	1030	774	1804
G/Worm	150	200	-	-	280	300	-	-	-	-	-	-	-	-							430	500	930
Typhoid	150	100	25	25	-	-	-	-	8	2	15	5	20	80					35	65	253	397	530
Diarrhoea	10	-	=	=	10	60	-	-	10	10	9	11	20	30							59	111	170
Gastroentr.	10	-	-	-	-	-	-	-	-	-	-	-	-	-							10	-	10
Cholera	-	-	10	-	-	150	115	17	2	3	5	-	-	-							132	170	302
Salmonell.	-	-	-	-	-	5	-	-	-	-	3	1	-	-							5	6	11
Amebiosis	-	-	-	-	-	-	-	-	-	-	-	-	170	70							170	70	240
2017																							
Malaria	200	250	140	60			156	114	250	150	120	-			130	103	250	200			1246	877	2123
G/Worm																			30	64			94
Typhoid	200	400	20	40			50	34	50	100	8	2			2	8	10	10			340	594	934
Diarrhoea	75	15	12	8			14	8	100	50					20	40	10				231	121	352
Gastroentr.	50	20	4	2			2	1							2	4					58	27	85
Cholera									5	15					2	8					7	23	30
Salmonell.							3	1													3	1	6
Bilharziasis	20		5				4														29	-	29
Yellow Fev.							2	1							40	20			9	11	51	32	83
Filariasis							94	62										20	39	61	133	143	276
2016																							
Malaria			200	160	250	300	240	160	180	120			14	11	160	240			35	25	1079	1016	2095
Typhoid			12	10			190	14					18	21	140	160			8	2	368	207	575
Diarrhoea			40	20	70	53	80	40	120	44				1	100	150			5	3	415	311	726
Gastroentr.			10	2			45	45	60	180			5	8					2		119	238	357
Cholera														1					5	5	5	6	11

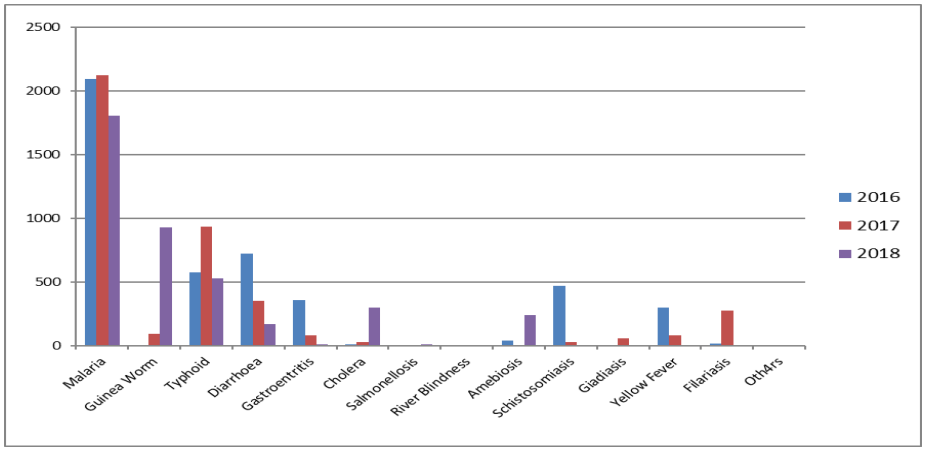

Figure 1: Disease Prevalence by Year of Reporting.

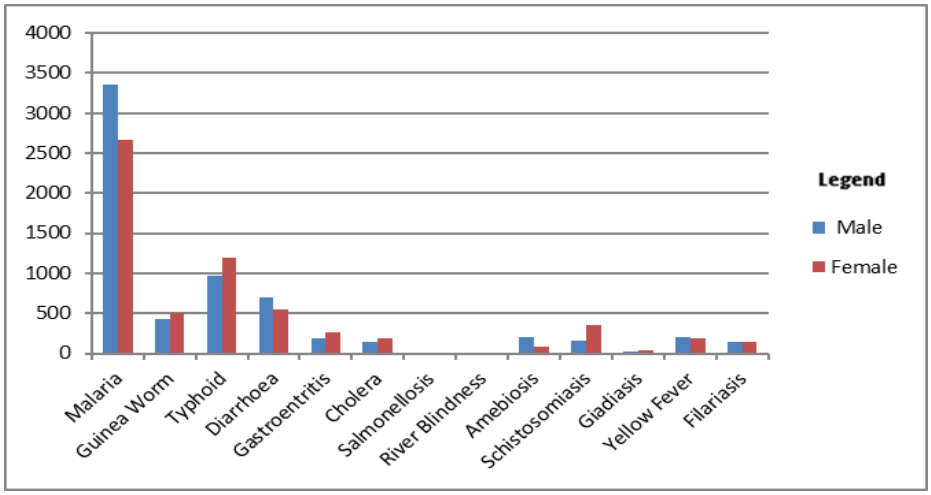

Figure 2: Total Disease Prevalence by Gender.

Table 3 Disease – Age relationship.

			Disease	Age
Spearman's rho	Disease	Correlation Coefficient	1.000	-.289**
		Sig. (2-tailed)	.	.004
		N	96	96
	Age	Correlation Coefficient	-.289**	1.000
		Sig. (2-tailed)	.004	.
		N	96	96

**. Correlation is significant at the 0.01 level (2-tailed).

The Nigerian Centre for Disease Control (NCDC) reports that Nigeria usually experiences an increase in suspected disease cases, particularly cholera, diarrhoea and typhoid, during the rainy season, when floods occur with attendant increased risk of transmission (NCDC, 2016: 18) and according to Wendy *et al* (2015: 11), seasonality in outbreak [of water-related diseases] occurrence may be the result of increased pathogen prevalence in source waters,

coupled with contributing weather events such as heavy rains or drought, but it may also reflect the seasonal use of the water. Diarrhoea is more common when there is a shortage of clean water for drinking, cooking and cleaning and basic hygiene is important in prevention as diarrhea can spread from person to person, aggravated by poor personal hygiene. Similarly, water-borne microbial infections such as *Giardia*, *Shigella*, *Salmonella*, and *Cryptosporidium*, *Campylobacter*, *Schistosoma* have been reported elsewhere due to exposure to contaminated water (Maleke *et al*, 2003; Ejaz *et al*, 2011; Adeyinka *et al*, 2014 and Ozioma *et al*, 2016). It is thus obvious that most of these diseases are related to poor domestic water quality.

Table 4: Prevalence of Water-related Diseases by Age Group (2016-2018).

Diseases	<5 Years	5-10 Years	11-15 Years	16-20 Years	21-30 Years	31-40 Years	41-50 Years	>50 years
Malaria	1206	1143	834	539	377	296	336	148
G/Worm	160	100	30	40	40	60	100	10
Typhoid Fever	153	62	292	152	241	413	162	188
Diarrhoea	538	336	130	112	60	46	13	0
Gastroentr.	69	37	37	12	2	10	11	2
Cholera	54	82	18	14	16	20	3	0
Salmonell.	0	12	19	5	10	23	0	0

In order to determine the possible sources of infection, water used by locales from different sources and the transportation media used were analyzed so as to determine the probable number of coliforms. Table 5 shows that the highest number of coliforms was recorded in water fetched directly from the river either by individuals using jerry cans, wheel barrows or tankers, or from hand dug wells (1,100 coliforms). Conversely, water fetched directly from bore holes had no coliforms, an indication that the contamination was from the surface,, whilst that directly from Water Board had the least number of coliforms (48), which also shows that the water is either poorly treated, got contaminated on transit or the transportation media where infected before fetching. Samples of water from tankers and wheel barrows fetched from the Water Board had slightly higher number of coliforms (400), which also shows the handlers may be responsible for the contamination. It can then be surmised that the primary sources of infection are most likely the river and hand dug wells whilst the secondary sources are the tankers and wheel barrows or their handlers. This can be deduced from the fact that even the supposedly safe water from the Water Board gets polluted when transported by wheel barrows and tankers. It is probable that these wheel barrows and tankers

also fetch from both the Water Board and the river (which is the main source of infection, thereby further contaminating water from the Water Board. The hand-dug wells are also a major source of infection as these are not only open, but also shallow, allowing seepage of sewage from toilet and othepolluted sources.

Table 5: Determination of Most Probable Number of coliform (MPN) in various water samples in Yauri town.

S/No	Water Source	Number of sample tubes showing positive reaction			MPN Index Coli form
		3 of 10ml each	3 of 1ml each	3 of 0.1ml each	
1	River	03	03	02	1,100
2	Wheel Barrow from Water Board	03	03	01	400
3	Tanker from River	03	03	03	1,100
4	Bore hole	00	00	00	00
5	Water Board	03	01	00	48
6	Tanker from Water Board	03	03	01	400
7	Wheel Barrow from River	03	03	02	1,100
8	Hand dug Well	03	03	02	1,100

Source: Author's Fieldwork, 2018

CONCLUSION AND RECOMMENDATIONS

The study has shown that by virtue of their location along the River Niger, people of Yauri town and its environs are prone to water-related diseases, particularly those due to faecal contaminants. This is evident from the number and types of water-related diseases reported in the different healthcare facilities, although malaria (a water-based disease) appears to be an all-season and most prevalent disease. Similarly, the probable number of coliforms in the sampled water is indicative of mostly faecal contamination, although water transported by tankers, wheel barrows and the river water itself, as well as the hand-dug wells appear to be most contaminated. The four sources might be the major sources of contamination. The only source with no coliforms detection is the Bore hole, which goes to show that all surface sources and the media of transportation are prone to infection. This is even as the Water Board has recorded a minimum number of coliforms. Conversely, this situation explains the occurrence of the diseases particularly because they are water-related. Therefore, although water is readily available and accessible in the study area, it is not potable or safe enough for human consumption. In this light, it is recommended as follows:

1) In so far as water gets contaminated in transit, sanitary inspectors should ensure cleanliness or disinfection of all jerry cans in wheel barrows or tankers that transport the water to households;
2) Government should ensure that containers and tankers do not fetch water from multiple sources, particularly, those from the Water Board should abstain from fetching from the river;
3) The public should be enlightened on possible routes of water-related diseases so as to minimize the scourge and possibly abstain from some water-related activities; and
4) Yauri Water Board should improve on its water treatment.

Study Limitations

Reporting bias may have resulted in under-reporting of cases in the healthcare facilities perhaps due to poor recording system or variations in the start of records keeping. So also the records might have captured other patients who might have come from outside Yauri town itself. Again, detailed analysis of data was limited by the large amount of missing data in many of the healthcare facilities's records.

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