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The Occurrence of Waterborne Diseases in Drinking Water in Nakaloke Sub-County, Mbale District, Uganda

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Abstract: ***Waterborne diseases are the most prevalent infectious diseases in developing countries especially in the rural areas. This study aimed to investigate the occurrence of waterborne diseases in relation to the microbial water quality in Nakaloke sub county Mbale district eastern Uganda. Patient records were collected from Nakaloke health Centre III cover a period of five years (2010-2014). The results showed general distribution of selected waterborne diseases in Nakaloke Sub County. 3045 waterborne cases were reviewed and 1926 cases were found in the selected villages. Diarrhoea is the most common waterborne illness among the population in all villages accounting for 837 cases followed by skin infection with 453, gastroenteritis 258 and dysentery 213, typhoid 148 and cholera 17 respectively. Forty five water samples were collected from three protected springs well for the village of Nakaloke, Kireka and Nandala. The samples were monitored for microbial contamination. Children of age group 0-5 years were found more susceptible to all selected waterborne diseases. Women are more prone to waterborne diseases compared to men, Nakaloke village accounted for the highest incidence than other villages of the study.***

Keywords: Waterborne diseases, diarrhoea, gastroenteritis, dysentery, and water quality

1. Introduction

Water is indispensable for human health and well-being, and is crucial for achieving sustainable development. Although water is essential for life, it can also cause devastating effects as an effective carrier of pathogens, capable of transmitting diseases to a large amount of the population.[1] Waterborne diseases and death continue to be a worldwide burden in both developed and developing countries. Much of the world's population lacks access to sufficient and safe water supplies.[2] According to UNICEF and WHO [3] Worldwide, 780 million people do not have access to safe water, and an estimated 2.5 billion people in developing world lived without access to adequate sanitation. The WHO estimates 6.3% of all deaths are caused by limited access to safe drinking water, improved sanitation facilities and hygiene practices as well as water management that reduce transmission of waterborne illness. [4]

Waterborne diseases result from ingestion of water contaminated with microbial pathogens from human or animal waste. Swallowing of water in the river by swimmers may also result in infection although this is not a major pathway. [5] Pathogenic organisms of concern include bacteria, viruses, protozoans and some helminthes. A number of waterborne diseases such like diarrhoeal illness, cholera, typhoid skin infections etc. are known to cause health effects, varying in severity from mild gastroenteritis to dysentery, hepatitis and shigellosis [6]. A large number of people in developing countries mostly live in extreme conditions of poverty and poor sanitation services in public places as well as inadequate water supply and poor hygiene including hospitals, health centers and schools. [7]

In the context of Uganda, WBD have been reported to be among the major public health problems. This is mostly associated with poor hygiene and environmental sanitation as well as poor supply of safe water. [8] In Uganda most of the rural populations obtain their water supplies from unprotected water, underground water, streams, spring wells, ponds and lakes.[9] Developing countries have a huge burden of waterborne diseases, the heaviest being diarrhoeal diseases. Uganda as a tropical and developing country is frequently subjected to waterborne disease out breaks in many regions. [10]

2. Materials and Methods

Description of Study area

Nakaloke Sub County is located in Bungokho in Mbale District eastern Uganda and has a length of 13.8kilometres. Its geographical coordinates are 1° 9' 0" North, 30° 9 0" East. The climate is topographic with bimodal type of rainfall mainly during March to June and September to November with an average rainfall of 1500mm per annum [11] in figure 1.

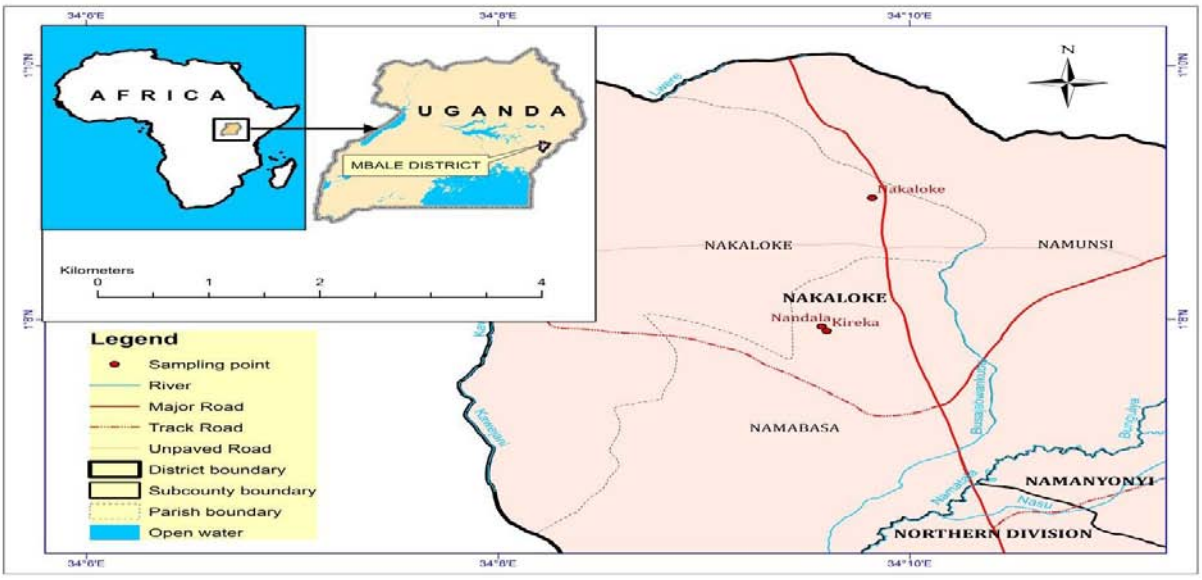

Figure 1: Study Area

Study Population

The study was conducted in Nakaloke Sub County in three different villages, to make a comparative study in the villages. Nakaloke Sub County has thirty two villages but about twenty one villages were found in the reviewed health records collected from Nakaloke health Centre III. Nakaloke, Kireka and Nandala were selected as target area of the study due to high and low incidence of waterborne cases in the villages.

Determining prevalence of water borne diseases

Document review technique was used [12] and determined the type and frequency of distribution of water borne diseases in Nakaloke, Kireka and Nandala villages. Information for the period of 60 months from January to December of 2010 to 2014 for the period of five years from out patient record register in Nakaloke Health Centre III was reviewed. 3045 cases were reviewed. Based on the aggregation of hospital data, two villages that recorded high incidence of waterborne diseases (Nakaloke and Kireka) and one village with low incidence (Nandala) were randomly selected as study sites for water collection and sanitary inspection.

Determination of microbial water quality of the wells

Water samples were collected from 3 randomly selected wells for the villages Nakaloke, Kireka and Nandala. In each village, only one well was selected and monitored for a period of three weeks. For each well, 15 water samples were collected i.e. 5 samples per week for three weeks (n= 15). The water samples for bacteriological analysis were collected in sterile bottles from protected springs under sterile condition using labeled sterile glass bottles (250ml) and transported to the Directorate of Water Resources Mbale regional laboratories in a cool box at 4^{o}C for analysis that same day. At springs, the cap of a 250 ml sterile bottle was removed aseptically. The bottles were filled from the water outflow pipe at protected springs. About one inch of space was left at the top of full bottles. The cap was replaced aseptically. The samples were analyzed for *E. coli* using the membrane filtration technique according to the standard methods. [13]

Data analysis

Descriptive statistic through cross tabulation was used for analysis of distribution of waterborne diseases. While an independent t-test was used to test if there was significance seasonal difference between the numbers of cases infected with waterborne diseases. One way ANOVA was used to test for differences in the number of infected cases among age groups and villages at significance level of p= 0.05.

3. Results and Discussions

Prevalence and distribution of waterborne diseases in Nakaloke Sub-county

The investigation of prevalence and distribution of waterborne diseases in Nakaloke Sub County was conducted through review of documents from Nakaloke health center III for a period of 2010 to 2014. A total of 1926 cases were reviewed and analyzed. The results for the distribution and variation of waterborne diseases in Nakaloke Sub County in general are shown in Figure 2.

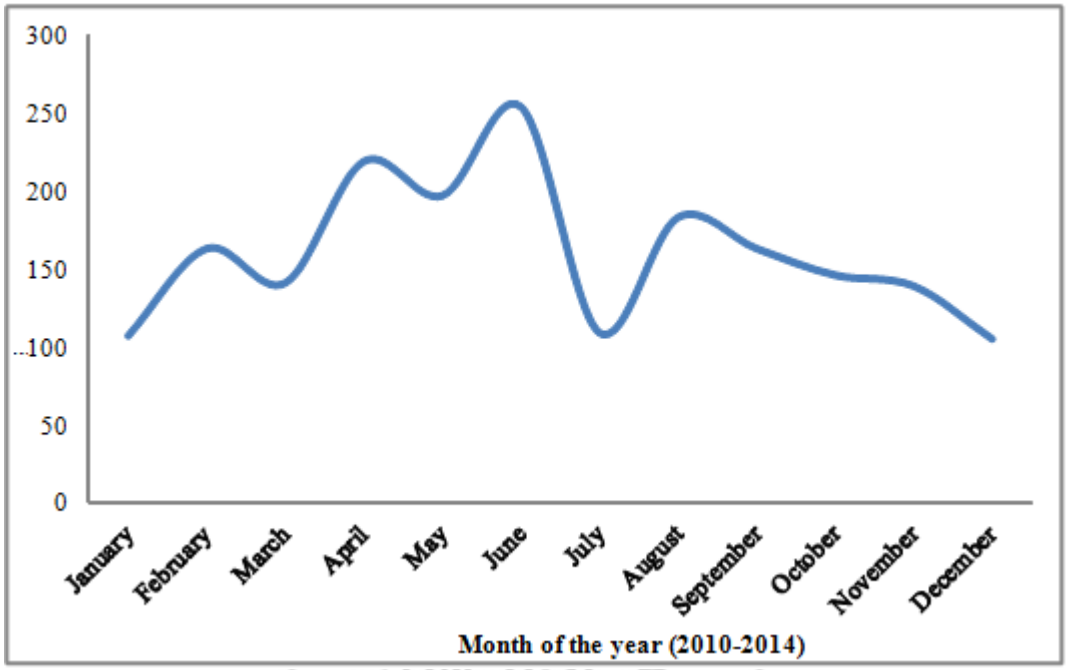

Figure 2: General distribution of the number of patients recorded suffering from waterborne related diseases in Nakaloke Sub County diseases in Nakaloke Sub County (2010-2014)

Generally, the month of June showed the highest number cases while the month of July and January registered the lowest number of cases. The trend of the diseases shows a dual cyclic pattern, with the first cycle increasing from January and peaking in April, it then falls to the lowest in July and begins a second cyclic increase from May to November. The month of February, April, June and September have high occurrence of cases suffering from waterborne diseases. This is probably due to contamination of sources by rural runoff after a heavy rainfall which carries pathogens into water sources. This is in line with finding of Harper [14] runoff is capable of transporting pathogens into water sources, increasing the risk of human exposure and infection. This pattern is very important for planning in the health center in terms of budgeting and allocation of resources.

Top most common contributors of waterborne diseases in Nakaloke Sub County are diarrhoea (837 cases), skin infection (453 cases) and gastroenteritis (258 cases) in that order. The distributions of these diseases with time are shown in Figure 3.

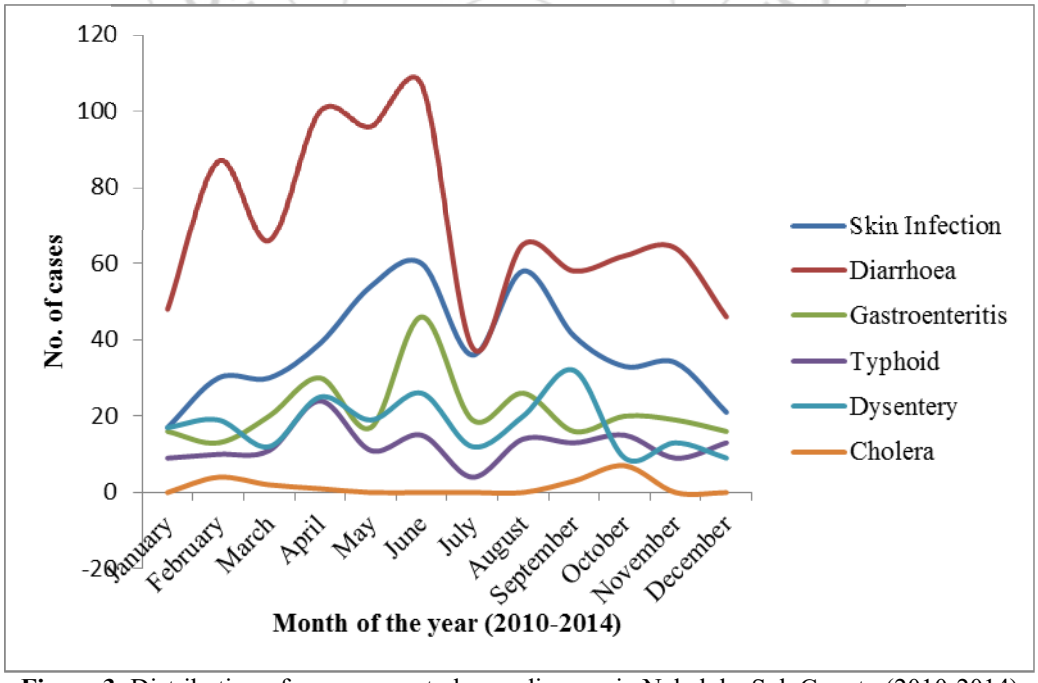

Figure 3: Distribution of common waterborne diseases in Nakaloke Sub County (2010-2014)

The three most contagious diseases are typhoid (148), dysentery (213) and cholera (17) which fortunately contributes least to the total number of waterborne diseases in Nakaloke Sub County. These diseases can spread and affect large mass of the population within a short time causing drastic impacts. The results of these studies seem to point out that highest cases all the waterborne diseases in Nakaloke Sub County occur during the wet season e.g. March - June and August – November.

The possible causes for this observation could be due to contamination of water sources during a heavy rainfall. The results is supported by Curriero *et al* [15] found out that floods can transport faecal matter from the ground or sewers that have through flowed and contaminate wells, boreholes and surface waters. Most of the population in the sub county use pit latrines it is more likely the fecal material finds its way into water sources. [16] Identified pit latrines as sources of bacteria to groundwater. It was reported by Howard Guy *et al* [17] that in Mbale, the location of a latrine uphill within 10m shows the greatest positive association with contamination. Distance of contaminating sources such as pit latrines to water points has been an important estimator in indicating the possible source of bacterial contamination of groundwater.

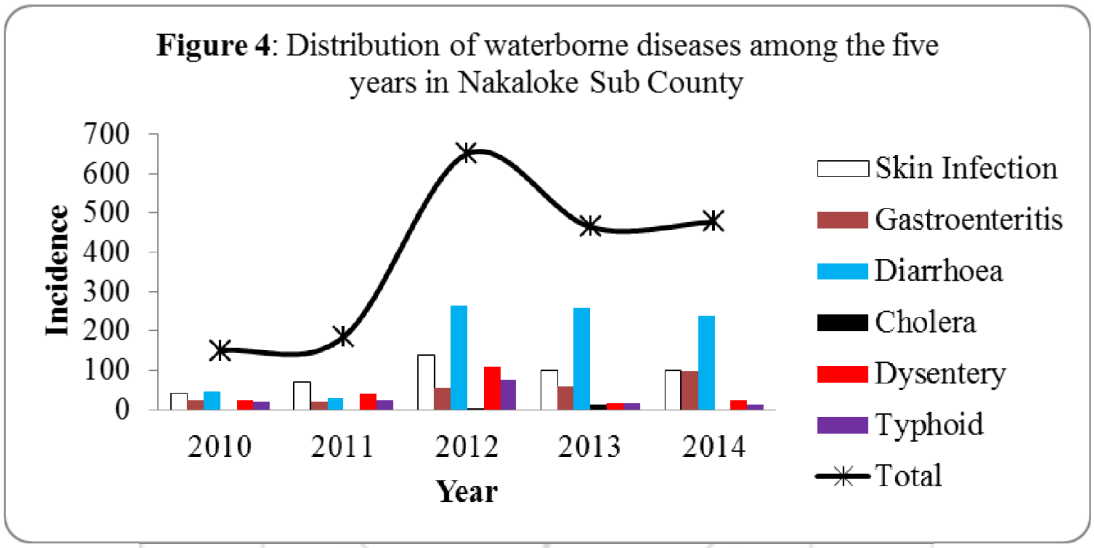

Figure 4: Distribution of waterborne diseases among the five years in Nakaloke Sub County

Figure 4 above shows yearly distribution of waterborne diseases, the trends of the diseases are increasing over years from 2010 to 2014. There is steady progression of the diseases burden from waterborne stating with the year 2010 and peak in 2012 it then falls down in 2013 and rose up in 2014. Year 2012 accounting with high incidence of waterborne due to lacks of access to adequate sanitation and contamination of water sources. Waterborne outbreak had been occurred in Nakaloke Sub County during the year of 2012. In eastern region of Uganda three districts have been reported with an outbreak of cholera including Mbale. Nakaloke sub-county is one of the Sub Counties affected. It was reported by DREF[10]. The one way ANOVA of the monthly distribution of waterborne diseases revealed significant differences in monthly waterborne diseases at 95% significance level. This indicates that there is variation in monthly distribution of waterborne diseases in Nakaloke Sub County.

Distribution of waterborne disease according to seasons

Table 1: Seasonal Distribution of Waterborne Diseases

		Waterborne diseases						Total
		Skin Infection	Diarrhoea	Gastroenteritis	Dysentery	Typhoid	Cholera	
Seasons	Wet season	349	616	194	156	112	13	1440
	Dry season	104	221	64	57	36	4	486
Total		**453**	**837**	**258**	**213**	**148**	**17**	**1926**

Table 1shows that villages are more susceptible to waterborne diseases during rainy seasons this is due to increase in precipitation and risk of flood into the water sources. Increased precipitation will increase the risk of flooding in many areas of the world. Floods can increase human exposure to pathogens, as contaminants are spread by floodwaters[15]. Infection with waterborne pathogens has been shown to be higher during the wet season, this is happen due to blocked drains, flooding sewer and compromised systems during extreme rainfall which can cause an increased in diseases. The high risk of water-borne diseases during the period of heavy rains is an index of higher water pollution. Going by the finding of Oguntole olegun *et al* [18] cholera cases in Ibadan were more common during the rainy season.

Floods can contaminate water sources more especially wells as it washes away the top soils carries faecal matter, chemicals and diseases agents. This presents a health risk to the communities depending on water points. The results for independent t-test of mean of the season's shows statistical significant differences at 0.05% level of confidence rainy

seasons had higher prevalence of waterborne diseases than its counterpart dry seasons.

Distribution of waterborne diseases per villages

Table 2: Distribution of waterborne diseases per villages

	Waterborne diseases						Total
	Skin Infection	Diarrhoea	Gastroenteritis	Dysentery	Typhoid	Cholera	
Nakaloke	253	468	167	131	96	10	1125
Kireka	174	302	73	61	37	5	652
Nandala	26	67	18	21	15	2	149
Total	**453**	**837**	**258**	**213**	**148**	**17**	**1926**

Table 2 shows the results for distribution of waterborne diseases among villages show that Nakaloke and Kireka villages are more susceptible to diseases with 1125 and 652 cases respectively. This is due to high number of population in villages compared to Nandala which had 149 cases with the lowest population. In all the selected villages in the sub-county diarrhoea is the most prevalent with 468 cases due to distribution of its infective agent followed by skin infection with 253 cases. This may be due to direct contact of communities during collection of water for domestic used. Gastroenteritis, typhoid and dysentery are the most contagious waterborne diseases accounting less for distribution of 167, 96 and 131 cases respectively, followed by cholera with the least number of cases (10). According to USAID [19] diarrhoeal diseases are largely caused by unsafe water, inadequate sanitation and poor hygiene. And this could be attributed to contaminated food, poor water quantity and quality and due to bad sanitation and hygiene. The main reason for transmission is the high probability the wastewater contamination from Nakaloke Sub County. [20]

Determination of microbial pollution of some selected spring wells in Nakaloke Sub-county

The microbial contamination of water sources have been identified through collection of sampling from the sources. The samples were investigated for the presence of *E. coli.* The results for microbial contamination of protected springs in Nakaloke, Kireka and Nandala villages were shown below:

Table 3: Results for Microbial contamination of some selected spring wells in Nakaloke Sub County

E. coli (CFU/100ml)			
Source Name	Average (CFU/100ml)	WHO/100ml	DWRMU/100ml
Nakaloke Spring	970	0	50
	613.33	0	50
	100.33	0	50
	100.33	0	50
	855	0	50
Kireka Spring	130	0	50
	171.66	0	50
	73.33	0	50
	106.66	0	50
	115	0	50
Nandala Spring	233.33	0	50
	93.33	0	50
	150	0	50
	110	0	50
	196.67	0	50

Results from microbiological water quality for Nakaloke, Kireka and Nandala are shown in Table 3. The results showed that spring sources are contaminated with *E. coli*. This indicate a clear evidence that all the sampling point are contaminated and water from the sources are unfit for consumption when compared to world health organization's standard (WHO) which is 0cfu/100ml and Directorate of water resource management Uganda (DWRMU), which is 0 per 100ml but the acceptable range is 50cfu/100ml of water in rural. Howard Guy [21] reported that the water quality data for protected springs in Mbale indicates that, in general water quality is much poorer than from boreholes. Contamination is more commonly found in Mbale. All samples from boreholes from all the towns except Mbale comply with the Uganda guideline for untreated supplies (<50cfu/100ml), whilst in Mbale a compliance rate of 80% is found. The presence of *E. coli* in drinking water is unacceptable as it is an indication that the water supply has become contaminated with human or animal waste. The contamination of the three popular sources of water indicates that most residents in Nakaloke, Kireka and Nandala are at risk of waterborne diseases.

4. Conclusions

There is a high prevalence of waterborne diseases in the study area and this is probably due to poor sanitation and hygienic conditions that include poor siting of sanitary facilities and closeness of pit latrines near water sources. The study revealed that the presence of the *Escherichia coli* in protected spring source used for drinking and domestic purposes in different villages of the study area in concentration above world health organization standard and directorate of water resources Uganda guidelines.

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