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The Occurrence of Waterborne Bacterial Disease and Water Quality in Higher Institution of Learning

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ABSTRACT

Waterborne diseases represent the substantial global burden of disease. There is the occurrence of waterborne disease as a result of the presence of a bacterial organism that spread in the Islamic University in Uganda (IUIU) community. This study aimed to determine the prevalence of waterborne bacterial diseases in IUIU from 2011 to 2014 and to assess the microbiological quality of water sources on the campus. Retrospective records from IUIU Health Centre were reviewed to determine the prevalence of waterborne bacterial diseases in the study area. A total of 48 water samples were collected and analyzed for TC (Total Coliform) and FC (Feacal Coliform) indicators. The results showed that typhoid is the most prevalent among all the waterborne bacterial diseases in the campus. So also the mean values of TC and FC of the water samples were above the World Health Organization (WHO) recommended guidelines. TC and FC count significantly varied among the water samples taken from different water sources at p=0.018 and p=0.010 for Total and Feacal Coliform respectively. The findings of this study points that water sourced from IUIU is safe for human consumption, but the long-stored water by the student is not safe.

Keywords: Bacteria, Total coliform, Feacal coliform, Waterborne diseases, Uganda

INTRODUCTION

This Water has a profound influence on human health since water is required for consumption on a daily basis for survival and therefore access to it is essential to life. However, water has much broader influences on health and well-being. Therefore the quantity and quality of the water supplied is important in the health of individuals and whole communities in both developing and developed countries (Clasen *et al.*, 2007; Pritchard *et al.*, 2008). Water contamination is induced by industrial effluents, sewerages, surface run-offs as well as other anthropogenic actions that may likely affect the physical (color, smell, and taste) and chemical composition of water (Malik *et al.*, 2012). Thus, contaminated and polluted water could be the basis of water-related diseases like cholera, typhoid, and dysentery (Bour, 2004; Mwendera, 2006). These diseases spread fast through ingestion of contaminated water or inorganic substances (Montgomery and Elimelech, 2007). Moreover, water can become contaminated in storage vessels, during transportation, or through inappropriate handling.

Water-related diseases have been a burden on the population and health services of many countries in the world, particularly the developing countries. According to the World Health Organization (WHO), every year more than 3 billion cases of water-related diseases caused at least 1.8 million deaths around the globe, making it one of the leading causes of morbidity and mortality. An estimated 99.8% of such deaths occur in developing countries (WHO 2005; UNICEF 2008b). Furthermore, inadequate water supply, poor sanitation, and hygiene have taken about 88% of the cause of these waterborne diseases (WHO, 2004). These diseases are commonly reported in low-income countries as the provision of safe

water, sanitation and hygiene are sub-optimal (Rana, 2009).

In the developing countries, accessibility to good and safe drinking water is still a problem. According to the Millennium Development Goals Report of United Nations (2010), 53 percent of the population in rural sub-Saharan Africa do not have access to a source of clean drinking water. Similarly, The World Health Statistics (2015) reported that 29 percent of the population in low-income countries lack access to better water sources; where 25 percent of the Ugandan population lacks access to improved water sources. This means that 1 in 3 Ugandans is forced to use available unimproved water sources. These water sources are often microbiologically unsafe, and as a result, the most well-known waterborne diseases (cholera, dysentery, and typhoid) are frequently reported in Uganda and almost all African countries particularly in tropical areas of the region (Chabalala and Mamo, 2001).

According to Gasana *et al*., (2002), there is a connection in poor infrastructure and commonness of water-related diseases; and publics that lacks infrastructure are more probable to high rates of water-related diseases and poverty (Manase *et al*., 2009). As such, rural communities suffer in the loss of economy due to sickness caused by waterborne diseases. In addition to the loss of work and labor due to the sickness, there is also cost implication of medical treatment and transport fee to a nearby medical facility. This is especially the case in less developed countries. Microbiological, physical and chemical properties of water determine its fitness for use. However, in the context of developing country such as Uganda, microbiological contamination is the most critical risk factor in drinking water, and these are caused by the microorganisms present in the environment and feces of warm-blooded animals (Gadgil, 1998; Gray, 2008; and Meinhardt, 2006).

Many microorganisms have been used as an indicator organism to determine the microbiological quality of treated drinking water. The most commonly used indicators to determine the microbiological quality of domestic water supplies are the Total and Feacal coliform (Whitlock *et al*., 2002; Noble *et al.,* 2003). Coliform bacteria are described and clustered by their origin or features, as either Total Coliform (TC) or Feacal Coliform (FC). They are a group of organisms that are present in the environment and the feces of warm-blooded animals and humans. Their presence in drinking water indicates that disease-causing organism is present (Tallon *et al*., 2005; Meinhardt, 2006). The Total group includes FC bacteria such as Escherichia coli and other types of Coliform bacteria that are certainly found in the soil. The FC usually comprises E. coli, and the serotype Escherichia coli 0157: H7 known as a source of severe health disorders in humans. FC is an indicator of feacal contamination and is commonly used to evaluate microbiological quality of water and as a parameter to estimate disease risk (Abera *et al*., 2011). However, the absence of these indicator organisms in the water does not specify the absence of other disease-causing organisms such as viruses and protozoan (Potgieter, 2007).

The overall concepts adopted for microbiological quality is that water intended for drinking such as borehole water or the one supplied by National and Sewage Cooperation should contain zero FC and TC organisms per 100 ml (WHO, 1996). This study investigates the occurrence of waterborne bacterial disease at IUIU main campus and how it relates to the quality of water used on the campus. The university has made a tremendous effort to supply safe drinking water. Nevertheless, water-related diseases such as diarrhea, cholera, typhoid, and dysentery have a high prevalence in the campus. Also, a prevalence analysis of seven months records from the IUIU health Centre indicated that the most prevalent water-related diseases in the University are the bacterial infections which include diarrhea and typhoid fever. According to the records sourced from IUIU health Centre, out of the 59 cases reported, 52.5% were males while 47.5% were females. However, about 23 patients comprising of 56.5% males and 43.5% of females were diagnosed with typhoid disease.

Objectives of the Study

The main objective of the study was to investigate the occurrence of waterborne bacterial diseases at IUIU and how this relates to the quality of water used by staffs and students at the campus. Specifically, it will assess the occurrence of waterborne bacterial diseases from 2011 to 2014, and determine the bacterial species count from different water sources in IUIU main campus, Mbale.

MATERIALS AND METHODS

Study Design

The retrospective study design was used to collect data for objective one from the IUIU health center. Quantitative Cross-sectional study technique was used.

The abundance of Waterborne Diseases

Information regarding the prevalence of waterborne diseases was collected using retrospective records from the IUIU Health Centre, which services both students and the staffs. Retrospective data dated from January 2011 to December 2014 was collected. The clinic records were noted with focus on the patients from the study area. All the information was gathered using the clinic checklist. This was done under the supervision of the University doctor to ensure that patients' confidentiality was maintained.

Water Sampling

Samples of water from National Water and Sewage Cooperation (NWSC) (tap), borehole as well as student stored and drinking (boiled) water at both males and females hostel were aseptically collected during March 2015 in accordance to American Public Health Association (1992) guidelines. Water samples for microbiological analysis were collected in sterilized glass bottles of 250mls capacity and taken to the laboratory for the analysis. Two samples from student stored and drinking (boiled water) were collected from the male and female hostel with an interval of 1 week for four times, at the same time samples of tap and borehole were also collected for the analysis.

Laboratory Water Analysis Methods

The laboratory water analysis method was employed according to the procedure of American Public Health Association (1992) guidelines. Both TC and FC bacteria were enumerated on Lauryl sulfur broth medium prepared according to the manufacturer's instructions. Water samples were analyzed and repeated for four times to determine the presence of the Coliforms using the membrane filtration technique. The membrane filter method gives direct counts of the TC and FC present in a given sample of water. The method is based on filtration of a known volume of water through a membrane filter consisting of a cellulose compound with a uniform pore diameter of 0.45 µm; the bacteria are retained on the surface of the membrane filter. When the membrane containing the bacteria is incubated in a sterile container (Petri dishes), at an appropriate temperature 37ºC for TC and 44ºC for FC at 18 hours with a selective culture medium (membrane lauryl sulphur broth), characteristic yellow colonies of TC and FC developed which can be counted directly using a manual digital counter. The choice of the volume of sample depended on the type of water. As for the drinking water, the volume use is 100 ml. Results from the laboratory were organized in data-recording sheets and were compared to the standards set by the WHO (WHO, 2006).

Quality Assurance

All the equipment for the laboratory analysis of the water samples such as Petri-dishes, filter units were subjected to sterilization in an autoclave at a temperature of 121^0 C for 15 minutes to avoid contamination. Double distilled water was used in the analysis.

Statistical Analysis

The statistical analysis was performed using statistical package SPSS. Secondary data on the prevalence of waterborne diseases were analyzed using Kruskal-Wallis test to determine how the different diseases were varying across the different years. Man-Whitney test was also used to know how the TC and FC were varying in the different water samples, followed by descriptive statistics to evaluate how results are distributed around the mean, minimum, maximum and standard error values.

RESULTS AND DISCUSSION

The result of the prevalence of waterborne bacterial diseases between 2011 and 2014 are presented in figure 1. The most prevalent waterborne disease was typhoid while cholera was the least prevalent with no cases recorded between 2012 and 2014. Typhoid was prevalent in 2011 but slightly declined in 2012 and increased slightly in 2013. The number of cases in 2014 was relatively low, which may be due to some missing records.

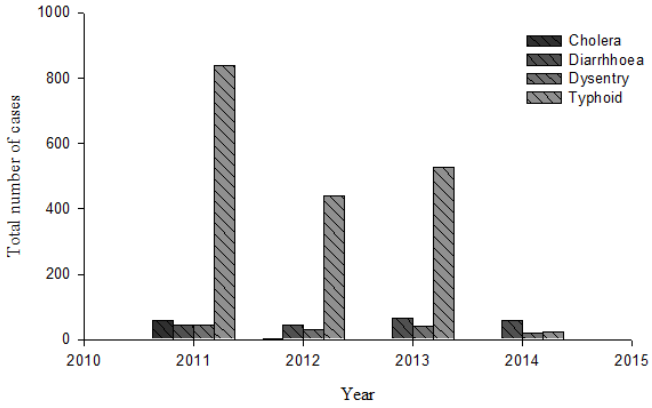

Fig. 1. Variation of water-related diseases across years in IUIU main campus

Monthly Variation in Prevalence of Water-borne Diseases at IUIU Campus

Temporal variations were observed in the prevalence of waterborne diseases, with the highest prevalence for each disease recorded in March and October (figure 2). These months are characterized by high rainfall that is probably aiding transmission of the diseases. At the beginning of the two semesters, January, February and August and September the prevalence are low. This suggests that the infection among the students occurs at the campus in March and October. The cases were limited in April, May, June, July, and December because of small amounts of raining and most of the students are off campus. These findings agree with Leclerc *et al*., (2001); Ako *et al*., (2009); Fares (2013) who concluded that the spread of waterborne infections depends on the season of the year. Although the relationship of seasonality and disease transmission is multifaceted, Fares (2013) attributed seasonality of human immune system, human activity, and pathogenic infectivity as some of the factors that contribute to the temporal variation in the prevalence of water-borne diseases.

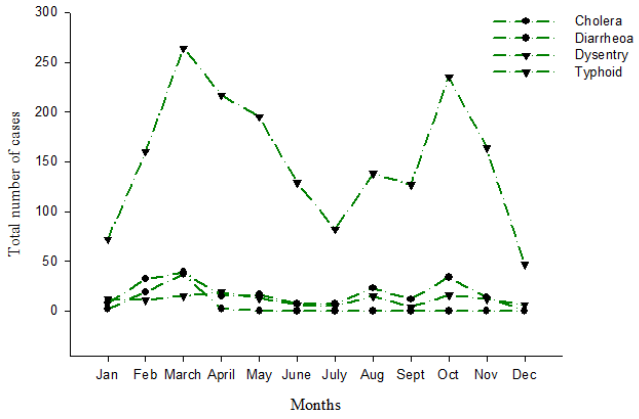

Fig. 2. Monthly variation in prevalence of water-related diseases at IUIU campus

Microbiological Quality of Water

Man-Whitney test was used to compare the TC and FC, and there was no significant difference at P=0.085. Kruskal-Wallis was also used to check how the different water sources were varying across the different water samples for both TC and FC and there's a significant difference at p=0.018 and p=0.010 for both TC and FC respectively.

The result from the table below shows that borehole water and tap water have better water quality with no feacal contamination while the drinking and stored water from both male and female hostels were grossly contaminated. The contamination could be as a result of the poor hygienic behavior of the students from both hostels. For instance, a student may use any available mug to withdraw water from the storage container. Apart from using a mug to withdraw water, the water could be left open; thus becoming susceptible in getting contaminated. This is in line with the findings of Seino *et al*., (2008) which shows that dipping a cup in a storage container was the major cause of contamination of most drinking water accessed in such manner. Trevett *et al*., (2005) also reported that contact of stored drinking water with the hands is a possible cause of contamination.

The results also indicated that all the parameters assessed for microbiological quality for all samples collected in the study area exceeded the WHO recommended guideline value of 0 cfu/100 ml for TC and FC bacteria counts in drinking water. Mean counts of TC and FC varied widely between the minimal and maximal values (descriptive statistics) (Table 1).

Table 1. Mean Values for Microbiological Indicators for Water Samples

Water samples	Total coliforms			Feacal coliforms		
	Mean ± SE	Minimum value	Maximum value	Mean± SE	Minimum value	Maximum value
Borehole	43.00± 27.33	0	114	0.00± 0.00	0	0
Tap water	23.00± 23.00	0	92	0.00± 0.00	0	0
Female drinking water	8.00± 4.69	0	18	0.50± 0.50	0	2
Male drinking water	2210.00 ±1010.29	0	4200	577.50 ± 577.50	0	2310
Female stored water	8430.00± 3430.97	720	16000	4025.0 0 ±1410. 89	600	75000
Male stored water	304.00± 178.89	0	820	6.50± 6.50	0	26

CONCLUSION

The most prevalent disease among the resident students at IUIU main campus was typhoid over the last four years. Prevalence is always high in mid-semester, and thus the infection occurs while the students are on campus not at home. Cholera is no longer a threat, as no cases were recorded from 2012 to date. Microbiological assessment of the raw water from different sources used by the student's community indicated that the water had unacceptable counts for TC and FC bacteria and therefore unsafe for human consumption. Ingestion of such water may increase health risk associated with waterborne diseases. The stored water in both the hostels had significantly higher counts of coliform bacteria than freshly collected water from the source. The results of this study indicated that although the community is provided with clean water from the tap and borehole, it is contaminated during storage to levels that are unsafe for drinking.

RECOMMENDATIONS

The study recommended that adequate water should consistently be supply by the management so that students should not be using long stored water. Additionally, the university management should have routine

sensitization programs that inform students and staff about the significance of having a better water storage system and avoidance of contamination.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

REFERENCES

Abera, S., Zeyinudin, A., Kebede, B., Deribew, A., Ali, S., & Zemene, E. (2011). Bacteriological analysis of drinking water sources. African Journal of Microbiology Research, 5(18), 2638-2641.

Ako, A. A., Nkeng, G. E., & Takem, G. E. E. (2009). Water quality and occurrence of water-borne diseases in the Douala 4th District, Cameroon. Water science and technology, 59(12), 2321-2329.

Buor, D. (2004). Water needs and women's health in the Kumasi metropolitan area, Ghana. Health & Place, 10(1), 85-103.

Greenberg, A., Clesceri, L., & Eaton, A. (1992). Standard methods for the examination of water and wastewater (18th ed.). Washington, D.C.: American Public Health Association.

Chabalala, H. P., & Mamo, H. (2001). Prevalence of water-borne diseases within the health facilities in Nakuru district, Kenya. Kenya: University of Nairobi. Available: http://www.doh.gov.za/docs/misc/keniawaterdisease.pdf. Accessed: [March 28, 2018].

Clasen, T., Schmidt, W. P., Rabie, T., Roberts, I., & Cairncross, S. (2007). Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis. British Medical Journal, 334(7597), 782.

Fares, A. (2013). Factors influencing the seasonal patterns of infectious diseases. International journal of preventive medicine, 4(2), 128.

Gadgil, A. (1998). Drinking water in developing countries. Annual Review of Energy and the Environment, 23(1), 253-286.

Gasana, J., Morin, J., Ndikuyeze, A., & Kamoso, P. (2002). Impact of water supply and sanitation on diarrheal morbidity among young children in the socioeconomic and cultural context of Rwanda (Africa). Environmental Research, 90(2), 76-88.

Gray, N. (2008). Drinking water quality: problems and solutions (2nd ed., pp. 225 -235). New York: Cambridge University Press.

Leclerc, H. D. A. A., Mossel, D. A. A., Edberg, S. C., & Struijk, C. B. (2001). Advances in the bacteriology of the coliform group: their suitability as markers of microbial water safety. Annual Reviews in Microbiology, 55(1), 201-234.

Malik, A., Yasar, A., Tabinda, A. B., & Abubakar, M. (2012). Water-borne diseases, cost of illness and willingness to pay for diseases interventions in rural communities in developing countries. Iranian Journal of Public Health, 41(6), 39.

Manase, G., Nkuna, Z., & Ngorima, E. (2009). Using water and sanitation as an entry point to fight poverty and respond to HIV/AIDS: The case of Isulabasha Small Medium Enterprise. Physics and Chemistry of the Earth, Parts A/B/C, 34(13-16), 866-873.

Meinhardt, P. L. (2006). Recognizing waterborne disease and the health effects of water contamination: a review of the challenges facing the medical community in the United States. Journal of Water and Health, 4(S1), 27-34.

Montgomery, M. A., & Elimelech, M. (2007). Water and sanitation in developing countries: including health in the equation. Environmental Science and Technology, 41:17-24.

Mwendera, E. J. (2006). Rural water supply and sanitation (RWSS) coverage in Swaziland: Toward achieving millennium development goals. Physics and Chemistry of the Earth, Parts A/B/C, 31(15-16), 681-689.

Noble, R. T., Moore, D. F., Leecaster, M. K., McGee, C. D., & Weisberg, S. B. (2003). Comparison of total

coliform, Feacal coliform, and enterococcus bacterial indicator response for ocean recreational water quality testing. Water Research, 37(7), 1637-1643.

Potgieter, N. (2007). Water storage in rural households: intervention strategies prevent waterborne diseases (Doctoral dissertation, University of Pretoria).

Pritchard, M., Mkandawire, T., & O'neill, J. G. (2008). Assessment of groundwater quality in shallow wells within the southern districts of Malawi. Physics and Chemistry of the Earth, Parts A/B/C, 33(8-13), 812-823.

Rana, A. K. M. M. (2009). Effect of water, sanitation and hygiene Intervention in reducing self-reported waterborne diseases in rural Bangladesh. RED research report: Online. Available: https://pdfs.semanticscholar.org/9e9c/5081ee290f2ebce79669c97390f7bcc60258.pdf. Accessed: [March 28, 2018].

Seino, K., Takano, T., Quang, N. K., Watanabe, M., Inose, T., & Nakamura, K. (2008). Bacterial quality of drinking water stored in containers by boat households in Hue City, Vietnam. Environmental Health and Preventive Medicine, 13(4), 198.

Tallon, P., Magajna, B., Lofranco, C., & Leung, K. T. (2005). Microbial indicators of feacal contamination in water: a current perspective. Water, air, and soil pollution, 166(1-4), 139-166.

Trevett, A. F., Carter, R. C., & Tyrrel, S. F. (2005). Mechanisms leading to post-supply water quality deterioration in rural Honduran communities. International journal of hygiene and environmental health, 208(3), 153-161.

United Nations. (2010). Goal 7. The Millennium Development Goals Report, 58-65.

United Nations International Children's Emergency Fund. (2008a). UNICEF handbook on water quality. United Nations Children's Fund, New York/USA.

United Nations International Children's Emergency Fund. (2008b). Promotion of household water treatment and safe storage in UNICEF WASH programmes. Washington D.C.

Whitlock, J. E., Jones, D. T., & Harwood, V. J. (2002). Identification of the sources of Feacal coliforms in an urban watershed using antibiotic resistance analysis. Water Research, 36(17), 4273-4282.

World Health Organization (1996). Guidelines for drinking-water quality (2nd ed). Delhi: A.I.T.B.S. Publishers & Distributors.

World Health Organization. (2004). Draft research agenda: International network to promote safe household water treatment and storage. Geneva: World Health Organization

World Health Organization. (2005). The World Health Report 2005: Make every mother and child count. World Health Organization.

World Health Organization. (2006). Guidelines for drinking-water quality [electronic resource]: incorporating first addendum. Vol. 1, Recommendations.

World Health Organization. (2010). World health statistics. Geneva: World Health Organization Press. Available: http://www.who.int/gho/publications/world_health_statistics/EN_WHS10_Full.pdf. Accessed: [March 28, 2018].

World Health Organization. (2015). Progress on sanitation and drinking water: 2015 update and MDG assessment. World Health Organization.