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Microbial Quality of Drinking Water and Prevalence of Water-Related Diseases in Marigat Urban Centre, Kenya

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ABSTRACT

BACKGROUND: Accessibility to potable water is a fundamental right for dignity and well-being. Despite this observation, more than 1.1 billion people lack access to safe drinking water. This is particularly true in the Sub-Saharan Africa and South East Asia regions.

OBJECTIVE: The main aim of this study was to assess microbial quality of drinking water and prevalence of water-related diseases in Marigat town, Baringo County, Kenya.

METHODS: Samples of drinking water were collected from water sources (boreholes, rivers, and wells) and at the point of use (households) and analyzed for *Escherichia coli* and total coliform (TC) bacteria using the most probable number method. In situ measurements of pH and temperature were performed using a Wagtech International portable meter. Clinical health records from the local health centers were also reviewed to assess the prevalence rates of some of the water-related diseases.

RESULTS: There were significant differences among water sources during dry season for *E coli* ($F_{2,21} = 3.629$, $P < .05$) and TC ($F_{2,21} = 4.041$, $P < .05$). Similar observations were made during wet season for *E coli* ($F_{2,21} = 4.090$, $P < .05$) and TC ($F_{2,21} = 1.893$, $P < .05$). Furthermore, there were significant interactions between the water sources and season for *E coli* ($F_{2,42} = 7.66$, $P < .01$) and TC ($F_{2,42} = 5.494$, $P < .05$). Drinking water in large plastic storage containers (herein referred to as sky-plast) had the highest *E coli* and TC concentrations. Typhoid was the most prevalent water-related disease during the dry season (10%), whereas diarrhea (3%) was the most prevalent during the wet season.

CONCLUSIONS AND RECOMMENDATIONS: All drinking water at abstraction and point of use for Marigat residents are microbiologically contaminated and therefore pose serious health risks to consumers of such water. Thus, there is need for public health awareness campaigns on household water management to curb incidences of water-related diseases. Public health practitioners at county and national levels need to ensure that households have adequate access to potable water and improved sanitation.

KEYWORDS: Borehole, prevalence, microbial water quality, water-related diseases

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Introduction

According to a report on world development indicators by World Bank,[1] 1 billion people globally lack access to potable water with 2.5 billion people have inadequate sanitation facilities. Annually, 4 billion cases of water-related diseases cause 3.4 million deaths worldwide, which is a leading cause of deaths especially in children under 5 years who die of water-related diseases. The situation is much worse in the rural areas of many of the developing nations.[2] According to a report by World Health Organization (WHO) on drinking water in the year 2017, 159 million people depend on water from surface sources like rivers and 423 million take water from unprotected springs linked to transmission of water-related diseases.[3] Consumption of such microbiologically unsafe water leads to water-related diseases like typhoid, diarrhea, dysentery, and paratyphoid.[4]

According to a study by Futi et al on harvesting surface rainwater purification using *Moringa oleifera* seed extracts and aluminum sulfate, Kenya is among the countries experiencing water scarcity. Its water storage per capita has deteriorated with time to levels that are critical of 8 m^3, a majority of its population relies on communal water sources that are classified as unimproved.[5] A large portion of the population lives in arid and semi-arid lands (ASALs) where the provision of safe drinking water and sanitation is inadequate. Inadequate water and sanitation have been recognized as some of the significant developmental challenges Kenya is facing toward the realization of the vision 2030 and in meeting the United Nations Sustainable Development Goals 3 and 6, respectively.[5] According to a study conducted by Herrero et al[6] on climate variability and climate change and their impacts on the agricultural sector, about 40% of the urban population have access to piped water of which only 40% receive water throughout the day. The rest obtain water from vendors, and illegal connections that often expose consumers to water-related diseases.[6] According to a study by Gwimbi,[7] on microbial quality of drinking water, among the microorganisms of concern in water

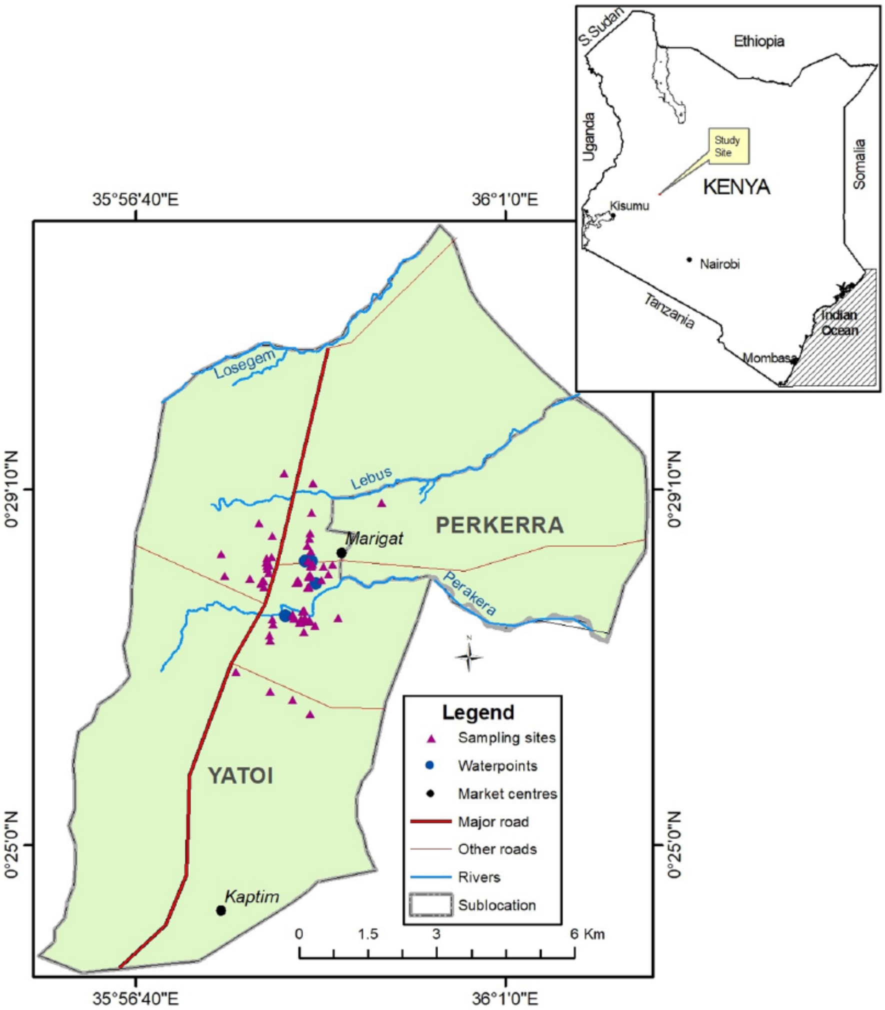

Figure 1. The area of study from topographic maps (Kenya) 1:50 000.

that make it not suitable for human consumption are total coliforms (TCs) and *Escherichia coli*. The 2 microbes are also used as indicators for fecal contamination that causes diarrhoeal diseases.[7] According to a report on drinking water by WHO,[8] water for human consumption should be free from any disease-causing microorganisms per 100 mL.

According to a report by National Drought Management Authority (NDMA, 2014), the main water sources in Baringo County are boreholes, dams (commonly referred to as water pans), natural rivers, traditional river wells, springs, and lakes.[9] The main water sources in the study area were mainly boreholes and traditional river wells. Water scarcity in the study area is rampant with 76.5% of the people relying on unimproved water sources.[10] It is against this background a study was conceived to assess the microbial drinking water quality and prevalence of water-related diseases in the study area.

Materials and methods

Study area. The study was conducted in Marigat town, Baringo County, Kenya (Figure 1). This town is located in the water-scarce ASALs of Kenya, in agro-ecological zones V and lies between latitude 0°12′ and 1°36′N, longitude 35° and 36′ and 36° and 30′E. The area experiences erratic rainfall with an annual average ranging from 150 to 450 mm and temperature between 25°C and 30°C.[11] According to a report by KNBS and SID,[11] Marigat town had a human population of 6661 and 1200 households. The wettest months are between April and July and driest months are between December and February. The town is about 1.678 km^2, and main economic activities include business and agriculture.

Study design

A cross-sectional survey design was used in this study. Ten percent of the households in the study area were sampled. Hence, a questionnaire was administered on 100 respondents drawn 10 strata. The stratification was based on drinking water sources for the households in the study area in which 10 households in each stratum was picked using random sampling technique.[12]

Water sample collection and processing

Ten replicate water samples were collected from the point of use (at the household level) and 4 replicate samples from water

Table 1. Physical parameters at the source and point of use.

POINT OF USE	TEMPERATURE	PH	SOURCE	TEMPERATURE	PH	WHO (PH)
Borehole	25.75 ± 0.94	6.42 ± 0.49	Borehole	27.7 ± 1.4	6.95 ± 0.4	6.5-8.5
River	28.37 ± 0.37	7.25 ± 0.17	River	27.6 ± 0.6	7.47 ± 0.3	
Well	30.9 ± 0.1	7.38 ± 0.05	Well	24.6 ± 3.6	7.29 ± 0.1	

Abbreviation: WHO, World Health Organization.

sources during the wet and dry seasons using sterilized 250-mL glass sampling bottles. The bottles were first washed in dilute hydrochloric acid and then thoroughly rinsed with distilled water and finally autoclaved. Sampling was performed during the wet and dry seasons. At the water sampling site, each bottle was rinsed 3 times with sampled water before it was finally filled, capped, labeled, and placed in a cool box. The samples were stored at 4°C then transported to Egerton University Biological Science Department Laboratory for analysis that commenced immediately within 24 hours of sampling.

In the Laboratory, *E coli* and TC concentrations were determined using the most probable number method that uses the Chromocult broth media. This media is a selective chromogenic medium for simultaneous determination of *E coli* and TC, 27 g of the media was dissolved in 1000 mL distilled water and then gently heated to dissolve the media completely. The media was sterilized by autoclaving at 121°C for 15 minutes, cooled to 40°C to 50°C in a water bath, then mixed gently, and 1 mL was poured in the Petri dishes. Serial dilutions were performed up to 10^{-3}, by picking 1 mL of the sample into 9 mL of distilled water. 1 mL of the aliquot from each of the dilutions was inoculated into 5 mL of media. The Petri dishes were inverted and then incubated at 35°C for 24 hours. After the set time, the Petri dishes were removed from the incubator and examined for bacteria colony growth. A 10 to 15× magnifier microscope was used to count the colonies. The colonies which indicated a red color was enumerated as positive colonies for TC and dark blue colonies were enumerated as positive colonies for *E coli*, and both were reported as colony-forming units (CFU) per 100 mL.[13] In situ measurement of physical parameters for pH and temperature were performed using a Wagtech International portable meter. Clinical health records from Marigat Health Centres were reviewed to identify the most prevalent water-related diseases (period prevalence) 1 year before the study period. Data were acquired from 2 governmental health centers; Marigat sub-county health center and Marigat mission health center. The information on disease prevalence included age, sex (male and female), and the name of the disease the patient suffered from during dry and wet periods. The prevalence rates of water-related diseases were calculated using the equation below:

$$\text{Prevalence rate} = \frac{\text{All persons with a specific condition at one point in time}}{\text{Total population}} \times 100$$

Data analysis

The data were managed using SPSS version 22. Data were analyzed using both descriptive and inferential statistics at alpha = 0.05. Inferential statistics, that is (1-way analysis of variance [ANOVA]) was used to compare the mean concentration of microorganisms among the water sources and points of use. Furthermore, a 2-way ANOVA was performed to examine whether there existed any significant interactions among water sources, the point of use and season on microbial density. Prevalence rates were used to calculate the most prevalent water-related diseases in the study area.

Results

The physical and chemical parameters results on mean values at the source and point of use during the dry and wet seasons as compared with standards acceptable by WHO are shown in Table 1. Temperature and pH were within the range recommended by WHO during the dry and wet seasons.

Spatial and seasonal variation in microbial drinking water quality at the point of use and water sources

In Marigat town, the main sources of water for human consumption were borehole, river, and well. Of 10 households that were sampled during the wet season, 50% relied on borehole water, 40% on well, and the rest relied on river. Among the sources of water used at the household level during the wet season, 90% were faecally contaminated. During the dry season, 60% of the households used borehole as a source of water and 40% on river water. All these samples from these households were faecally contaminated. During the dry season at the point of use, *E coli* and TC for borehole and well water were below 1000 cfu/100 mL, whereas river water was above 1000 cfu/100 mL as shown in Figure 2. One-way ANOVA indicated that there was a significant difference in CFUs among the point of water use for *E coli* ($F_{2,21} = 3.629$, $P < .05$) and TC ($F_{2,21} = 4.041$, $P < .05$).

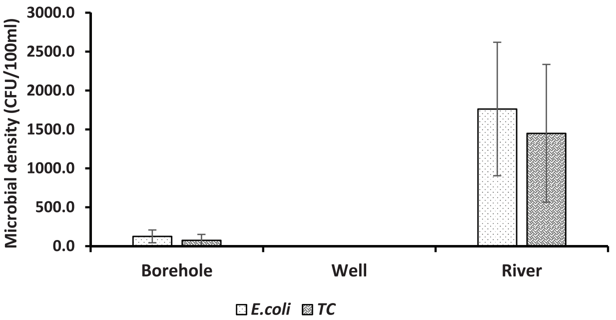

Figure 2. Concentration of *E coli* and TC at the household level during the dry season. TC indicates total coliform.

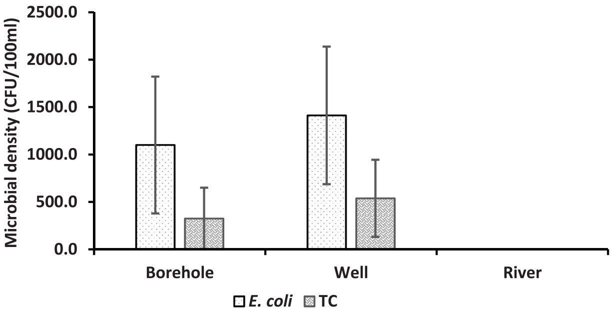

Figure 3. Concentration of *E coli* and TC at the household level during the wet season. TC indicates total coliform.

During the wet season at the household level concentrations of *E coli* and TC for Borehole and well water was above 1000 cfu/100 mL, whereas river water was below 1000 cfu/100 mL as shown in Figure 3. A 1-way ANOVA indicated that there were significant differences among the water sources in CFUs for *E coli* ($F_{2,21} = 4.090$, $P < .05$), TC ($F_{2,21} = 1.893$, $P < .05$). A 2-way ANOVA indicated that there was a significant interaction between the point of water and season for *E coli* ($F_{2,42} = 7.66$, $P < .01$) and TC ($F_{2,42} = 5.494$, $P < .05$) as shown in Table 2.

The concentrations of the selected of microorganisms in borehole and well water were below 500 cfu/100 mL but not for *E coli* in river water (Figure 4). One-way ANOVA indicated that there was no significant difference among the water sources in terms *E coli* concentrations ($F_{2,9} = 0.020$, $P > .05$) and TC ($F_{2,9} = 1.196$, $P > .05$).

During the wet season, concentrations of *E coli* and TC varied minimally (Figure 5). A 1-way ANOVA indicated that there were no significant differences among the water sources in terms *E coli* concentrations ($F_{2,9} = 0.055$, $P > .05$) and TC ($F_{2,9} = 0.002$, $P > .05$). Two-way ANOVA indicated that there were no significant interactions between source of water and season for *E coli* ($F_{2,18} = 0.016$, $P > .05$) and TC ($F_{2,18} = 0.402$, $P > .05$) as shown in Table 2.

Microbial quality of water from households water storage containers

Drinking water storage containers varied widely in capacity and type. The most common types of storage containers were plastics followed by clay pots. For capacity, the most common one was sky-plast that were relatively larger than jerrycans. The former was preferred during the dry and wet seasons compared with the other storage containers. During the wet season, sky-plast and clay pots recorded the highest amount of *E coli* concentrations in both borehole and well water (Figure 6).

In the dry season, sky-plast storage containers for river water had the highest amount *E coli* concentrations, whereas jerrycans and clay pots had the same amount of *E coli* concentrations in borehole water (Figure 7).

During the wet season, sky-plast and clay pots had the highest amount of TC in both borehole and well water (Figure 8).

During the dry season, sky-plast had the highest amount of TC in borehole water, whereas in river water, jerrycans had a higher amount of TC (Figure 9).

Water-related disease prevalence

The prevalence rates of water-related diseases based on season is presented in Figures 10 to 11. Typhoid recorded 669 (10%) cases, and this was the most prevalent water-related disease during the dry season (Figure 10).

There were 194 cases of diarrhea cases recorded in the study area, thus the most prevalent during the wet season (Figure 11).

Discussions

Microbial quality of household drinking water at the source and point of use

According to a report on drinking water quality guidelines by WHO,[14] access to safe drinking water is essential for human health as well as a basic human right. According to the United Nations third World Water Development Report, more than 600 million people in most parts globally are forced to live without safe water and sanitation services. Our study findings indicate that the residents of Marigat are among this global statistic of persons with inadequate access to potable water. Inadequate access to safe drinking water can result in water-related illnesses to health illnesses among consumers of such contaminated water. Based on this study findings, *E coli* concentrations and TC exceeded the WHO drinking water guidelines of 0 cfu/100 mL.[14]

Among the sources of water used at the household level during the wet season, 90% were faecally contaminated thus higher prevalence of water-related diseases. During the dry season, most of water samples drawn from households irrespective of the water source were faecally contaminated. This, therefore, indicates that drinking water used in these households was not suitable for human consumption and thus higher chances of contraction of water-related diseases. According to a study by Addo et al[15] on water handling and hygiene practices on the transmission of diarrhoeal diseases and soil-transmitted helminthic infections, water may become contaminated at the time between collection and storage where handling and hygienic practices matter most. This study is consistent with

Table 2. Summary of 2-way ANOVA on the relationship between the source of water, the point of use, and season.

SOURCE OF WATER	*DF*	F	*P*
TC	(2, 18)	0.016	>.05
E coli	(2, 18)	0.402	>.05
POINT OF USE			
TC	(2, 42)	7.66	**<.01**
E coli	(2, 42)	5.494	**<.05**

Abbreviation: ANOVA, analysis of variance; TC, total coliform.
Significant *P* values are in bold.

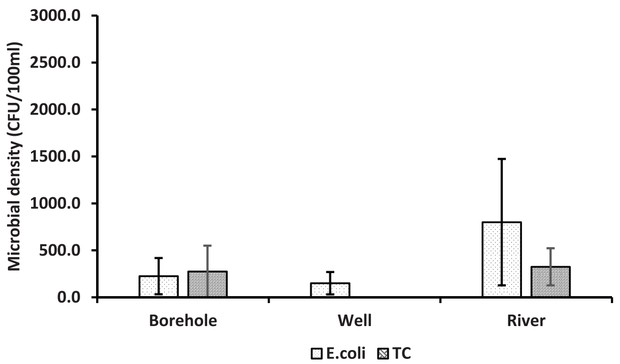

Figure 4. Concentrations of *E coli* and TC at water sources during the dry season. TC indicates total coliform.

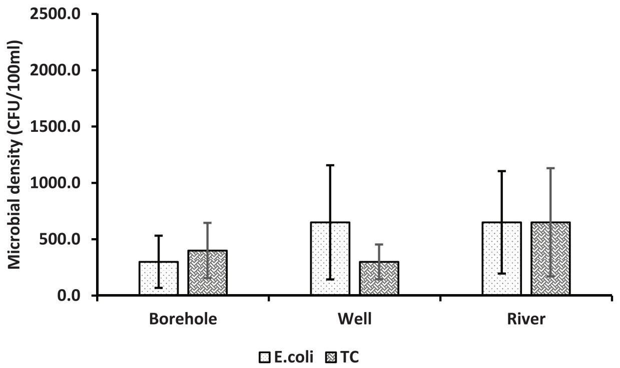

Figure 5. Concentrations of *E coli* and TC at the water sources during the wet season. TC indicates total coliform.

other studies by Addo et al, on sanitation and its impact on the bacteriological quality of water. In a study by Addo et al,[16] of the 30 water samples, all the TC values recorded were significantly higher than the WHO-recommended guidelines for drinking water. In Sub-Saharan Africa where most of the people practice open defecation, fecal contamination of surface water is a major issue of concern.[17]

With increasing poor sanitation conditions, fecal contamination of the water samples can also be attributed to unsanitary handling of the water during collection and distribution in various households.[17] Besides, studies have indicated poor storage conditions and inadequate water storage containers as factors contributing to increased microbial contamination compared with the source of water. In this study, higher levels of microbial contamination were associated with storage vessels having wide openings (eg, sky-plast and pots), vulnerability to introduction of hands, cups, and dippers that can carry fecal contamination, and lack of a narrow opening for dispensing water similar observations have been made in another study by Seino et al,[18] on bacterial quality of drinking water stored in containers by boat households. The concentrations of *E coli* and TC were much higher in the households that relied on sky-plasts and clay pots as their main water storage containers. Consequently, biofilm formation inside the household's water storage containers could, due to improper cleaning practices, facilitate the survival and the growth of potential pathogenic disease-causing microorganisms.[19] A study, however, looking at the impact of tank material on water quality in household water storage systems in Bolivia indicated that cleaning frequency might contribute to microbial water quality. Although there was no statistically significant association, storage containers that were reported to be cleaned 3 or more times per year have less *E coli* than containers cleaned less frequently ($P = .102$).[20]

Prevalence of water-related diseases

Water-related diseases account for 4.1% estimated cases of global disease burden and cause about 1.8 million deaths annually with 88% attributed to unsafe water supply, sanitation, and poor personal hygiene.[4] According to a report on drinking water by the WHO, 884 million people lack access to even basic drinking water service, including 159 million people who are dependent on surface water such as rivers.[3] The latter group is therefore at a higher health risk of contracting water-related diseases and more so if they live in places where people practice open defecation.[21]

Cholera diarrhea and typhoid are among the most widely known illnesses that are linked to the consumption of faecally contaminated food and water. The results on water quality results from this study agree with the clinical data drawn from local health centers that showed the prevalence of water-related diseases. Typhoid was the most prevalent water-related disease during the dry season, and diarrhea was most prevalent during the wet season. Poor personal hygiene at the household level and poor household water handling practices could explain the high prevalence of diarrhoeal and typhoid diseases in the study area. According to the study findings of Mazari-Hiriart et al[22] on a longitudinal study of microbial diversity and seasonality, the intensity and effects of water-related diseases depend on the volume of contaminated water ingested by an individual and the individual's immune status, with the children being the most susceptible. The result of this study are consistent with those of Adeyinka et al,[23] on review on the prevalence of waterborne diseases, revealed that diarrhea is the most prevalent waterborne disease in communities located along River Ase in

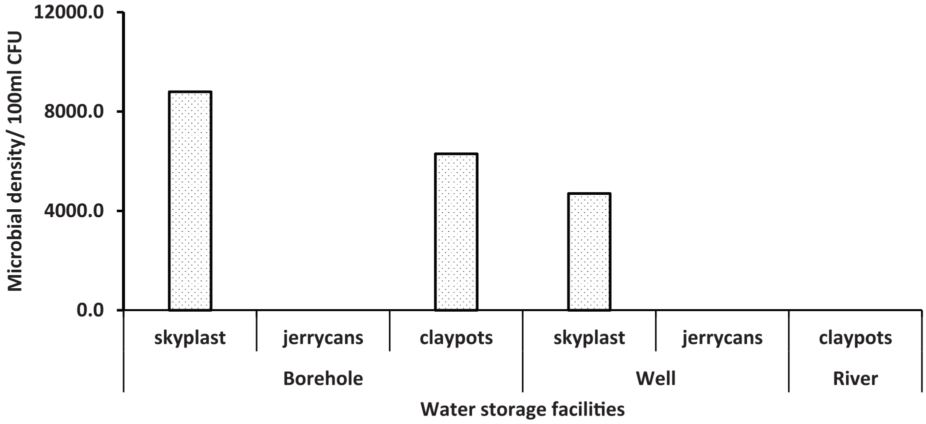

Figure 6. Concentration of *E coli* in the household water storage containers in the wet season.

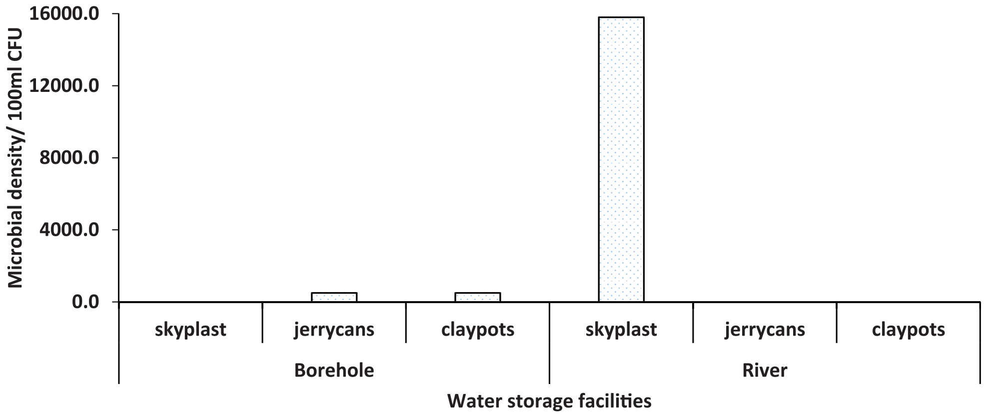

Figure 7. Concentration of *E coli* in the household water storage containers in the dry season.

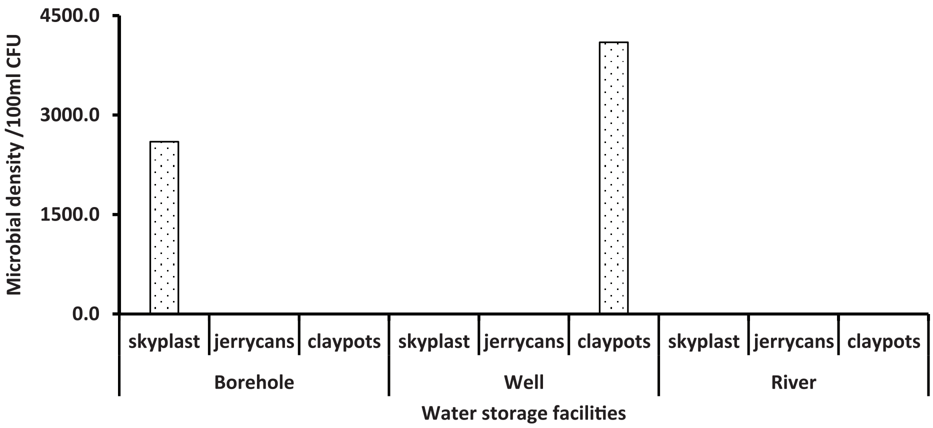

Figure 8. Concentration of TC in the household water storage containers in the wet season. TC indicates total coliform.

Southern Nigeria. The high incidence of diarrhoeal diseases during the wet season could be attributed to high level of microbial contamination caused by surface run-off as much fecal matter is washed into ponds and rivers.[24]

Conclusions and Recommendations

Based on the findings of this study, it is concluded that all drinking water at abstraction and point of use for Marigat residents are microbiologically contaminated and therefore pose serious health risks to consumers of such water. The levels of selected microbes (*E coli* and TCs) exceed the WHO-recommended guidelines for drinking water. Therefore, there is need for intensive public health awareness campaigns on household water management to curb incidences of water-related diseases. Public health practitioners at county and national levels need to ensure that households have adequate access to potable water and improved sanitation. There is need for households to practice conventional household water treatment methods before consumption to reduce incidences of water-related diseases.

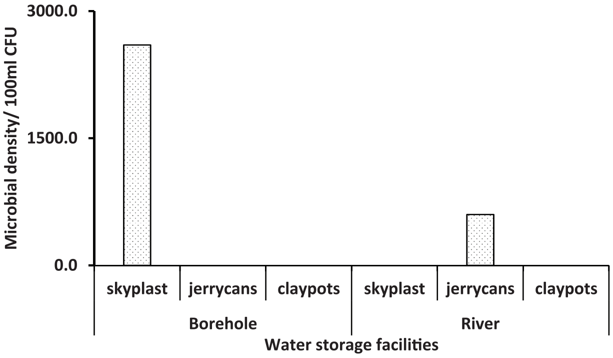

Figure 9. Concentration of TC in the household water storage containers in the dry season. TC indicates total coliform.

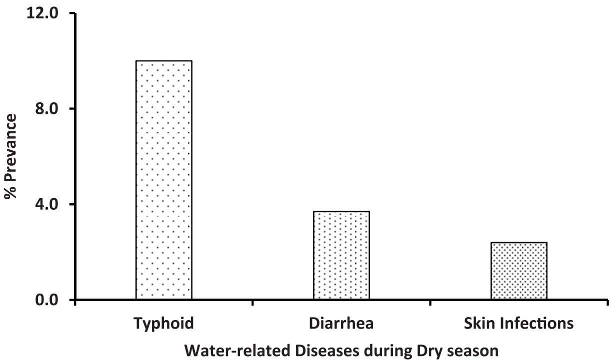

Figure 10. Prevalence of water-related diseases during the dry season.

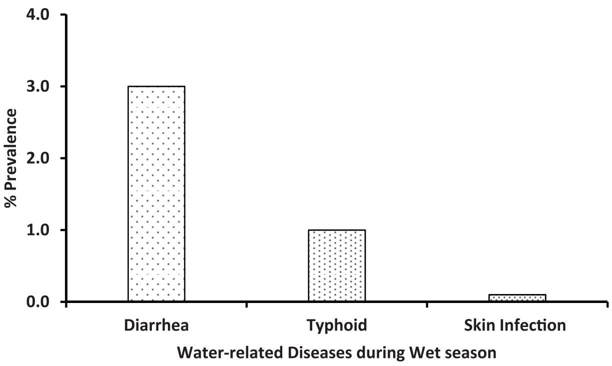

Figure 11. Prevalence of water-related diseases during the wet season.

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Author Contributions

MMO, GMO, and CMM conceived and designed the experiments, collected and analyzed the data, jointly developed the structure and arguments for the paper, wrote the manuscript, made critical revisions, and agreed on the final version of the manuscript. All the authors reviewed the final manuscript and approved it for submission.

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REFERENCES

1. World Bank. *World Development Indicators 2015*. Washington, DC: World Bank Publications; 2015.
2. World Health Organization (WHO). *Global Report on Drowning: Preventing a Leading Killer*. Geneva, Switzerland: WHO; 2014.
3. World Health Organization (WHO). Drinking water fact sheets. www.who.int/mediacentre/factsheets/fs391/en/.Up-dated2017. Accessed July 2017.
4. Vaziri M, Tolouei R. Urban water resources sustainable development: a global comparative appraisal. *Iran J Sci Technol*. 2010 34::93–106.
5. Futi A, Otieno WS, Acholla OJ, Otieno WA, Ochieng OS, Mukisira MC. Harvesting surface rainwater purification using *Moringa oleifera* seed extracts and aluminium sulfate. *Kenya J Agric Ext Rural Dev*. 2011 3::102–112.
6. Herrero M, Ringler C, Van de Steeg J, et al. Climate variability and climate change and their impacts on the agricultural sector (ILRI report to the World Bank for the project Adaptation to Climate Change of Smallholder Agriculture in Kenya). https://cgspace.cgiar.org/handle/10568/3840.Up-dated2010.
7. Gwimbi P. The microbial quality of drinking water in Manonyane community: Maseru District. *Afr Health Sci*. 2011; 11: 474–480.
8. World Health Organization (WHO). Drinking water fact sheets, reviewed November 2016. https://reliefweb.int/report/world/drinking-water-fact-sheet-reviewed-november-2016.
9. NDMA. *Drought Monitoring and Early Warning Bulleting April*. Baringo, Kenya: National Drought Management Authority (NDMA); 2014.
10. UNDP. *Combating Desertification in Kenya: Emerging Lessons from Empowering Local Communities*. Nairobi, Kenya: United Nations Development Programme (UNDP); 2013.
11. National Bureau of Statistics (KNBS) and Society for International Development (SID). *Exploring Kenya's Inequalities, Pulling Apart or Pooling Together; Water and Sanitation*. Nairobi, Kenya: KNBS and SID; 2013.
12. Mugenda M. *Research Methods Quantitative and Qualitative Approaches*. Nairobi, Kenya: ACTS Press; 2003.
13. APHA. *Standard Methods for the Examination of Water and Wastewater*. 21st ed. Washington, DC: APHA; 2017.
14. World Health Organization (WHO). *Guidelines for Drinking Water Quality*. 4th ed. Geneva, Switzerland: WHO; 2011.
15. Addo H, Addo K, Bimi L. Water Handling and Hygiene Practices on the Transmission of diarrhoeal diseases and soil-transmitted helminthic infections in Rural Ghana. *J Civ Environ Res*. 2014; 6. https://www.iiste.org/Journals/index.php/CER/article/view/10314.
16. Addo HO, Addo KK, Langbong B. Sanitation and its impact on the bacteriological quality of water: a study in three communities in Ghana. *African J Food Agric Nutr Dev*. 2013;13:8258–8272.
17. World Health Organization (WHO). *Progress on Sanitation and Drinking Water*. Geneva, Switzerland: WHO; 2013.
18. Seino K, Takano T, Quang NKL, Inose T, Nakamura K. Bacterial quality of drinking water stored in containers by boat households in Hue City, Vietnam. *Environ Health Prev Med*. 2007;13:198–206.
19. Potgieter N. *Water Storage in Rural Households: Intervention Strategies to Prevent Waterborne Diseases* [PhD thesis]. https://repository.up.ac.za/handle/2263/30323.Up-dated2007.
20. Schafer CA. Impact of tank material on water quality in household water storage systems in Cochabamba. https://scholarcommons.usf.edu/etd/3596/.Up-dated2010.
21. Vidal J. Water and sanitation still not top priorities for African governments. https://www.theguardian.com/global-development/2012/aug/30/water-sanitation-priorities-african-governments.Up-dated2012.
22. Mazari-Hiriart M, Lopez-Vidal Y, Ponce-de-Leon S, Calva JJ, Rojo-Callejas F, Castillo-Rojas G. Longitudinal study of microbial diversity and seasonality in the Mexico City Metropolitan area water supply system. *Appl Environ Microbiol*. 2005;71:5129–5137.
23. Adeyinka S, Wasiu J, Akintayo C. Review on the prevalence of waterborne diseases in Nigeria. *J Adv Med Life Sci*. 2014;1:1–3.
24. Onyango D, Angienda P. Epidemiology of waterborne diarrhoeal diseases among children aged 6-36 months old in Busia—Western Kenya. *Int J Biol Life Sci*. 2010;6:2.