https://rijournals.com/engineering-and-physical-sciences/

RESEARCH INVENTION JOURNAL OF ENGINEERING AND PHYSICAL SCIENCES 4(1):61-73, 2025

©RIJEP Publications

ONLINE ISSN: 1115-9057

PRINT ISSN: 1597-8885

https://doi.org/10.59298/RIJEP/2025/416173

Microbial Analysis of Domestic Water Sources in Namuwongo Slum of Kampala, Uganda

Mwesigwa Walter and Byaruhanga Ivan

Department of Physical Sciences, School of Natural and Applied Sciences, Kampala International University, Uganda

ABSTRACT

There is a dearth of information regarding the safety of the water in Namuwongo slum, despite claims of cholera, diarrhea and typhoid fever outbreaks. The purpose of this study was to ascertain the danger that Namuwongo people might face from waterborne diseases as a result of contaminating water sources. A sample of 50 respondents was questioned about the procedures used for gathering, treating, and storing water. In July2024, two distinct days were chosen to collect water samples in duplicate using sterile glass bottles from the tap water, spring and well. They were carried in a lightproof, insulated box with ice packs to the laboratory for investigation of the total and faecal coliform counts in less than two hours. For the well, the average Escherichia coli count was 43 ± 18 c.f.u/mL. The overall plate count level of the spring water was 76 ± 15 c.f.u/mL, however there was no detectable E. coli. Just 46% of those surveyed used boiling and filtration techniques to purify their drinking water. There were signs of poor hygiene and sanitation standards. Because so few people in Namuwongo treated their water, the total and faecal coliform levels of the water sources were unacceptable, placing the citizens at great risk of contracting waterborne diseases.

Keywords: High pH; Electrical conductivity; Eutrophication; Nutrients; Plant and human life

INTRODUCTION

Water is an essential natural resource since life cannot survive without it. Water is necessary for numerous purposes, but it also carries a significant risk of contamination [1, 2]. This makes it necessary to guarantee that there is high-quality water available. According to estimates, drinking contaminated water accounts for one-third of mortality in underdeveloped nations [3, 4]. Even though it is regarded as a human right, many poor nations, including Uganda, still struggle to provide their citizens with access to clean drinking water. Slums represent a significant global danger to the availability of clean water. This is due to the fact that they are typified by excessive crowding, improper technology and poor sanitation facilities. Diarrhea is a major contributor to under-five mortality, and poor sanitation and hygiene contribute to the contamination of 85% of protected spring water sources [5, 6]. In Uganda, the Namuwongo slum which is located in Makindye division of Kampala city, with a population of 30,000 residents, faces challenges in accessing safe drinking water due to inadequate information about water sources and household hygiene practices [7]. Namuwongo, a busy slum in the center of Kampala, Uganda, has several obstacles in its quest for dependable and clean water supplies. Namuwongo, Kampala's biggest informal settlement, is home to a varied population, the majority of whom are poor and have limited access to essential amenities like clean water [8]. The slum's overcrowding and shoddy construction, poor sanitary facilities, and improper drainage systems are its defining characteristics. Due to the fact that the accessible water sources are frequently contaminated, unstable, and insufficient to meet the needs of the population, these factors make the problems associated with water delivery worse [9]. The National Water and Sewerage Corporation's (NWSC) communal taps are one of Namuwongo's main water sources. One of the most pressing problems arising from inadequate water supply in Namuwongo is the prevalence of waterborne diseases [10]. Residents often rely on contaminated water sources, such as wells, and springs and communal taps, which are prone to contamination from human waste, industrial pollutants, and garbage due to poor sanitation and waste management practices [11]. This leads to diseases such as cholera, typhoid, and dysentery which disproportionately affect children, pregnant women, and the elderly, leading to high morbidity (unhealthy conditions) and mortality rates in the community [12]. The economic impact of inadequate water supply is profound, as many residents are forced to purchase water from private vendors, placing a significant financial burden on poor households [13]. This practice also affects the proper maintenance of latrines and toilets, leading to unsanitary conditions and the spread of infections [14]. The lack of reliable water supply has severe consequences for education, as schools in the slum often lack sufficient water for drinking, cooking, and sanitation purposes, affecting the health and hygiene of students and teachers, leading to frequent absenteeism and lower academic performance [15]. Social inequalities are exacerbated (worsened) by the inadequate water supply in Namuwongo, with vulnerable populations facing greater challenges in accessing sufficient and safe water. Addressing these inequalities requires a comprehensive approach that ensures equitable access to water for all residents, regardless of their socio-economic status or physical abilities [16]. Namuwongo's water sources are contaminated with microbiological, chemical, and physical pollutants. Microbiological contaminants include bacteria, viruses, and protozoa, which can cause waterborne diseases like cholera, typhoid, and dysentery[16]. The primary sources of microbiological contamination in Namuwongo's water supply are human waste, open defecation, and inadequate sanitation facilities [17]. Chemical contaminants in Namuwongo's water sources arise from a combination of anthropogenic activities (human activities), such as industrial discharges, agricultural runoff, and improper use of chemicals in household settings [18]. These pollutants can have long-term health effects on residents, including chronic illnesses and developmental disorders. Physical contaminants, such as sediments, suspended solids, and debris, are common due to poor environmental management and inadequate infrastructure. Sedimentation and erosion contribute to the contamination of water sources, while solid waste and debris accumulate in drainage channels, open spaces, and near water sources[18]. Natural contaminants also affect water quality in Namuwongo, including naturally occurring minerals, organic matter, and biological organisms [19]. Elevated levels of these minerals can pose health risks and affect the taste, odor, and color of water. Natural organic matter, such as plant debris and decaying vegetation, can serve as a food source for bacteria and other microorganisms, leading to the growth of biofilms and the proliferation of harmful pathogens [20]. Environmental factors contributing to contamination in Namuwongo include the area's topography, climate, and hydrological conditions. Topography and drainage are poor, making the slum susceptible to flooding during heavy rains [20, 21]. Inadequate drainage infrastructure leads to the accumulation of surface water and the mixing of contaminants from various sources. Heavy metals like lead, mercury, cadmium, and arsenic are common contaminants in domestic water sources within the slum, posing serious health risks to the community, including neurological damage, kidney disease, and cancer [21]. The presence of heavy metals in Namuwongo's water sources results from various channels, including industrial waste, poor waste management practices [22], and runoff from construction sites. Industrial waste discharge, poor waste management practices, soil and sediment runoff are major sources of heavy metal contamination in Namuwongo's water sources [22]. Industrial waste discharges containing heavy metals like lead, mercury, and cadmium into nearby drainage systems or directly into water bodies, often lacking adequate treatment due to weak enforcement of environmental regulations [23]. Poor waste management practices also contribute to the accumulation of heavy metals in the water[23]. Soil and sediment runoff from contaminated areas can carry heavy metals into surface water and groundwater sources, exposing residents to harmful levels of heavy metals [24]. Construction activities in and around Namuwongo often disturb the soil, which may already be contaminated with heavy metals from previous industrial activities or vehicle emissions [24]. This sediment runoff increases the levels of heavy metals in the water, posing a direct threat to the health of those who use these water sources for drinking and other domestic purposes. Long-term exposure to arsenic in drinking water can lead to skin lesions, cardiovascular diseases, and various forms of cancer. Addressing heavy metal contamination requires a multi-faceted approach involving community engagement, government intervention, and support from non-governmental organizations (NGOs) [24]. Residents have developed various methods of water collection, often relying on informal and improvised sources [25]. Nature-based sources include rainwater harvesting, swamps and natural springs, communal water taps and standpipes, boreholes and wells, private water vendors, and storage tanks [25]. Rainwater harvesting is a relatively reliable and accessible source, but it can be contaminated if collection surfaces are dirty or storage containers are not properly covered and maintained. Swamps and natural springs provide another source of water, but they are not entirely safe and are often used out of necessity due to the lack of better alternatives [26]. Communal water taps and standpipes are common in Namuwongo, serving as a primary source of water for many households. Wells are crucial sources, but they face challenges such as contamination from nearby latrines, waste dumps, and industrial pollutants. Regular maintenance and water quality testing are often lacking, making it difficult to ensure the safety of the water drawn from these sources [26]. Private water sources, such as storage tanks, allow residents to have greater control over their water supply, reducing their dependence on communal taps or water vendors. However, the cost of installing and maintaining private wells or tanks can be prohibitive for most residents, limiting their use to those who can afford the investment [27]. Water quality issues are a major challenge in Namuwongo, as many water sources are susceptible to contamination from human activities, industrial waste, and poor sanitation practices. The lack of regular water quality testing and treatment exacerbates these issues. Namuwongo, like many other informal settlements in Kampala, has no formal waste management system. The majority of the community's trash, including domestic, industrial, and commercial waste, is disposed of in open spaces, along roadsides, drainage channels, or in poorly managed dump sites. These disposal sites are frequently unregulated, and garbage is rarely separated, resulting in a combination of organic, inorganic, and toxic materials. The closeness of these facilities to residential areas heightens the danger of exposure, since trash decomposes and releases toxic compounds into the environment. Examples of dumping sites in Namuwongo include the Nakivubo channel, which serves as a major drainage system but is also extensively polluted with solid garbage. Other informal dumpsites are spread across the slum, where inhabitants dump rubbish. Namuwongo's waste disposal sites are divided into three types: open dumps, drainage channels, and makeshift disposal sites. Open dumps are often located along roadsides, vacant plots, or near residential areas, leading to environmental contamination and health risks. They also attract vermin and complicate sanitation efforts. Drainage channels are another prevalent type of waste disposal site in Namuwongo, with the Nakivubo channel heavily polluted due to illegal dumping. The accumulation of waste in these channels can block water flow, leading to flooding during heavy rains and further contamination of surface water sources.

Efforts to mitigate water contamination in Namuwongo require a multi-faceted approach involving community engagement, improved waste management practices, and government intervention. Community initiatives can help reduce water contamination by promoting proper waste disposal practices, improving sanitation, and raising awareness about the impact of economic activities on water quality [28]. Namuwongo's drainage system is informal and inadequate, with many areas dependent on open ditches and poorly maintained infrastructure. Due to a lack of a comprehensive and official network, rainwater and wastewater flow through homemade channels and open ditches, contributing to localized flooding [28]. The microbiological investigation of residential water sources in the Namuwongo slum is crucial for public health, environmental management, and policy formulation. Contaminated water sources can spread waterborne diseases. Identifying microbiological contamination in residential water sources will give critical information about the potential health dangers to inhabitants. The study will aid in determining the presence of microorganisms that could cause disease outbreaks, allowing for the development of targeted interventions to reduce morbidity and death from waterborne infections. The study will help to better understand the environmental health conditions in Namuwongo, specifically the contamination sources that affect water quality. It will highlight the relationship between sanitation practices, waste management, and water contamination, providing insights into environmental improvement initiatives. By communicating the findings, the study will encourage the community to adopt better water usage and management habits, ultimately lowering the prevalence of waterborne diseases.

Materials and Methods

Description of study area

The study was carried out in the Namuwongo slum, which is in Kampala, the capital of Uganda. Namuwongo is bordered by Lugogo to the north, Nakawa to the northeast, Kiswa and Bugoloobi to the east, Muyenga to the southeast, Kisugu and Kabalagala to the south, Kibuli to the west and Kololo to the northwest. Namuwongo is situated alongside a defective railroad in the industrial area of Kampala.

Figure 1: Appearance of Namuwongo Slum

Research Design

The study was a cross-sectional descriptive survey conducted in the Namuwongo slum's water sources which where my sampling sites. Water samples were taken from spring, tap and well located within Namuwongo slum. 500ml of water where taken from each source. Sampling point 1 (SP1) – spring, was 75m away from SP2 – tap, which was also 55m away from SP3 – well. The experimental setup comprised of 12 samples. A microbiological evaluation of the water quality was done at National Water and Sewerage Corporation (NWSC).

Sampling design

Sampling Area

All sampling points are located in Namuwongo slum in Kampala, Uganda. The high pace of informal settlement expansion and the documented cases of water borne related diseases led to the selection of Namuwongo as a sampling area. Since Namuwongo slum is said to contain the most households in Makindye division, samples of its domestic water were taken. Additionally, there is a dearth of information regarding the water, sanitation, and hygiene practices of Namuwongo residents. However, due to the substandard living circumstances common to slum areas in Kampala, Namuwongo residents are extremely susceptible to waterborne disease infections. Using a methodical random selection technique, 50 households were selected and interviewed.

Sampling Units

The sampling matrices involved water samples collected from spring, tap and well.

Sampling technique

The samples will be collected during July of 2024. Data on hygiene and sanitation practices, water sources, techniques for collecting, treating, and storing water, and knowledge regarding water treatment will be gathered using self-administered, semi-structured, closed-ended questionnaires. Questionnaires will be pretested in Kampala's Kisugu slum before the data collection effort. The conditions in this slum are nearly identical to those in the study region. After that, the tool will be adjusted and validated once again. The data will be gathered by skilled research assistants who are NWSC student trainees of research.

Sample collection

Bottles with a 100 mL capacity were meticulously cleaned and carefully rinsed before being sterilized for 30 minutes at 121 °C, using American electric pressure steam sterilizers model 25×, prior to the collection of water samples. Even though there were sporadic showers throughout the dry season in July 2024, the water samples were taken in just two days. Water samples were collected in duplicate from every chosen water source by grasping the bottle by its base with one hand and letting the sample enter the container through its mouth. To ensure that the sample bottle could be shaken effectively, 20 to 30 mm of space was allowed before it was completely filled. To enable quick cooling, each sample was delivered to the lab in an insulated, light-proof box with ice packs inside. In order to prevent unforeseen fluctuations in the microbial population, the microbiological examination of water samples was initiated within two hours of collection. The samples were examined in the microbiology laboratory at NWSC for total and faecal coliform counts, which are the primary markers of microbial contamination. Using a digital pH meter that had been calibrated, samples of water were taken at each of the water sources as soon as possible. Two pH buffers (4.01 and 7.01) and standard calibration solutions were used to calibrate the pH meter. The pH was measured again in the lab to see if there were any changes after the samples were transported.

Justification for determining the study's overall plate count

The purpose of the total plate count test was to identify coliform organisms, which are a good microbiological indicator of the quality of drinking water since they are simple to find and count in water. The water source and distribution system's integrity is determined by the results of the coliform test. Additionally, helpful for keeping an eye on the microbiological quality of treated piped water sources is the coliform test.

Total number of plates

The membrane filtration method produced a typical total coliform count. Nine milliliters of sterile peptone water solution (oxoid) were used to homogenize one milliliter of water, and more diluting water was added as needed. On the previously dried surfaces of plate count agar, one milliliter subsamples of the relevant dilutions were dispersed in duplicate and incubated for twenty-four hours at 37 °C. Duplicate plates with fewer than 300 colonies were used to count the quantity of microorganisms in the sample after incubation. A colony counter (Quebel Colony Counter) was used for counting. The number of colony forming units per milliliter of diluents × dilution factor = number of bacteria c.f.u/milliliter of sample was the formula used to calculate the colony count in milliliters of water.

Counting coliform bacteria in water

The multiple-tube approach, also known as the most probable number (MPN) method, was used to count the coliforms in water samples. The MPN of the microorganisms present in the original sample is determined by using statistical tables to quantify the microbial density in the water sample indirectly. Nine milliliters of sterile peptone water solution (oxoid) were used to homogenize one milliliter of water, and more diluting was added as needed. After pipetting one milliliter (1 mL) of the decimal dilutions' water into each of the three distinct MacConkey broth (Oxoid 5a) tubes using inverted Durham tubes, the tubes were incubated at 37 °C. Following a 24-hour period, the tubes that tested positive for coliforms were identified, and the MPN value was recorded using MPN tables.

List of Escherichia coli organisms

Nine milliliters of sterile peptone water solution (oxoid) were combined with one liter of water, and more diluting was added as needed. This was well combined, and each sample was subjected to five subsequent dilutions. Three tubes of sterile MacConkey broth (oxoid CM5a) equipped with a Durham tube received one milliliter of each dilution pipetted aseptically. The tubes were then incubated at 44.5 °C for twenty-four hours. At the conclusion of the incubation period, positive tubes and their corresponding dilutions were noted, and counts were calculated using MPN tables.

pH and Electrical Conductivity Borehole, spring and Tap water

I measured 250ml of each water sample respectively one at a time and poured in a beaker. I then dipped the pH and Electrical conductivity electrodes into each of the solutions respectively. I then pressed the read button on the multi-parameter meter.

Turbidity

Borehole, spring and Tap water

I measured 100ml of each water sample respectively one at a time and poured in a glass bottle. I then placed the bottle into the turbidity meter and read.

Temperature

Borehole, spring and Tap water

Exactly, 300mL of each water sample respectively one at a time was measured and poured in a glass bottle. Then dipped the temperature electrode into the solution and read. Total suspended solids Borehole, spring and Tap water was measured 10ml of each sample respectively one at a time and poured into the cuvette, I then placed the cuvette into the spectrophotometer and read it using the spectrophotometer calibration for total suspended solids.

Alkalinity

Borehole, spring and Tap water

I measured 100ml of each water sample respectively one at the time and then poured it into a conical flask. To each of the solutions, I added 4 drops of the mixed indicator. I then titrated using 0.02N hydrochloric acid solution until end point and read the results.

Sulphates

Borehole, spring and Tap water

We measured 20ml of each water sample respectively one at a time and poured it into a measuring cylinder. To each I added 2ml of sulphate buffer followed by 2g of barium chloride. I shook gently each of the cylinders to dissolve the barium chloride powder. I then poured 10ml of each samples respectively one at the time into a cuvette and then placed into the spectrophotometer and read according to the spectrophotometer calibration.

Nitrates

Borehole, spring and Tap water

We measure 20ml of each water sample respectively one at the time and poured it into a glass bottle. we then added one nitrate test tablet respectively into each of the solution and shook until it dissolved. And then added 2g of nitrate test powder to each of the solutions respectively and shook to dissolve. We later decanted off the solution and poured 20ml of each into a measuring cylinder and added 0ne nitrite 100 test pack table to each of the solutions respectively. We then reacted for 15 minutes. We later poured 10ml each of the solutions one at the time into the cuvette and read using the spectrophotometer.

RESULTS

Water quality obtained from the water sources

There was a significant difference seen in the mean total plate count of the water samples obtained from the three sources, which varied between 76 ± 43 and 230 ± 100 c.f.u/ 100mL of water sample. (c.f.u - colony forming units)

Table 1: Colony forming units per 100mL of water sample (c.f.u/100mL)

Water sample	Total plate count (c.f.u/100mL)
Well	246
Tap	78
Spring	43

The average coliform count in the water samples varied significantly between the various water sources, with values ranging from 46 ± 10 to 76 ± 15 c.f.u/100mL. Water samples obtained from the well exhibited the greatest level of coliforms, tap water exhibited the lowest amount of coliforms, while there was no E. coli found in any of the spring water samples. There was a significant variation in the mean E. coli counts across all investigated water sources, with values ranging from 0 to 43 ± 18 c.f.u/100mL of sample.

Table 2: Microbial counts (c.f.u/mL) of water samples taken from 3 different Namuwongo slum water sources

Water sample	colony forming units/100mL	
	Total coliforms	E.coli
Well	76	44
Spring	55	0
Tap	33	39

Table 3: pH

WATER SAMPLE	VOLUME TAKEN(mL)	INSTRUMENT READING
BOREHOLE	250	7.80
TAP	250	8.78
SPRING	250	4.95

Table 4: ELECTRICAL CONDUCTIVITY

WATER SAMPLE	VOLUME TAKEN(mL)	INSTRUMENT READING(mS/cm)
BOREHOLE	250	1225
TAP	250	1499
SPRING	250	1325

Table 5: TURBIDITY

WATER SAMPLE	VOLUME TAKEN(mL)	READING at 860nm(NTU)
BOREHOLE	100	10.91
TAP	100	4.61
SPRING	100	77.8

Table 6: TEMPERATURE

WATER SAMPLE	VOLUME TAKEN(mL)	INSTRUMENT READING(°C)
BOREHOLE	300	24.3
TAP	300	25.5
SPRING	300	37.8

Table 7: TOTAL SUSPENDED SOLIDS

WATER SAMPLE	VOLUME TAKEN(mL)	INSTRUMENT READING(mg/L)
BOREHOLE	10	50
TAP	10	45
SPRING	10	63

Table 8: ALKALINITY

WATER SAMPLE	VOLUME TAKEN(ml)	BURETTE READING	
		INITIAL(mL)	FINAL(mL)
BOREHOLE	100	0.00	100.90
TAP	100	0.00	50.00
SPRING	100	0.00	270.80

Table 9: NITRATES

WATER SAMPLE	VOLUME TAKEN(ml)	INSTRUMENT READING(mg/L)
BOREHOLE	10	36
TAP	10	21
SPRING	10	67

Table 10: SULPHATES

WATER SAMPLE	VOLUME TAKEN(ml)	READING at 420nm(mg/L)
BOREHOLE	10	55
TAP	10	20
SPRING	10	600

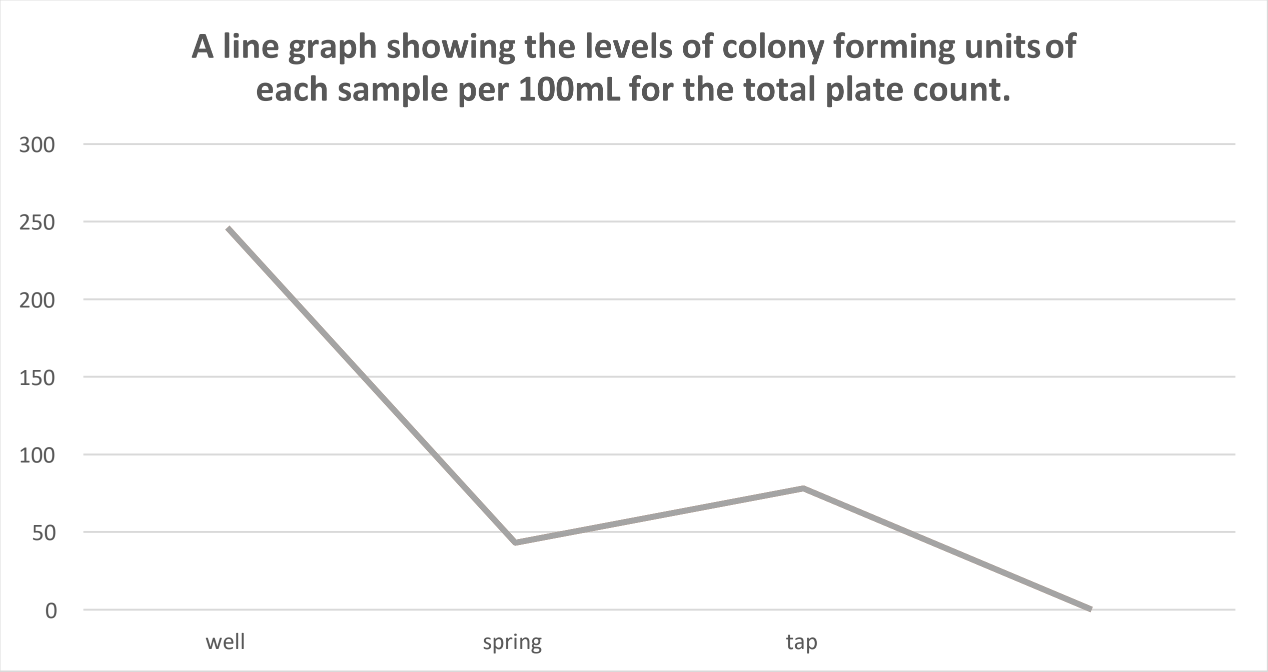

Figure 2: Colony forming units per 100mL of water sample (c.f.u/100mL)

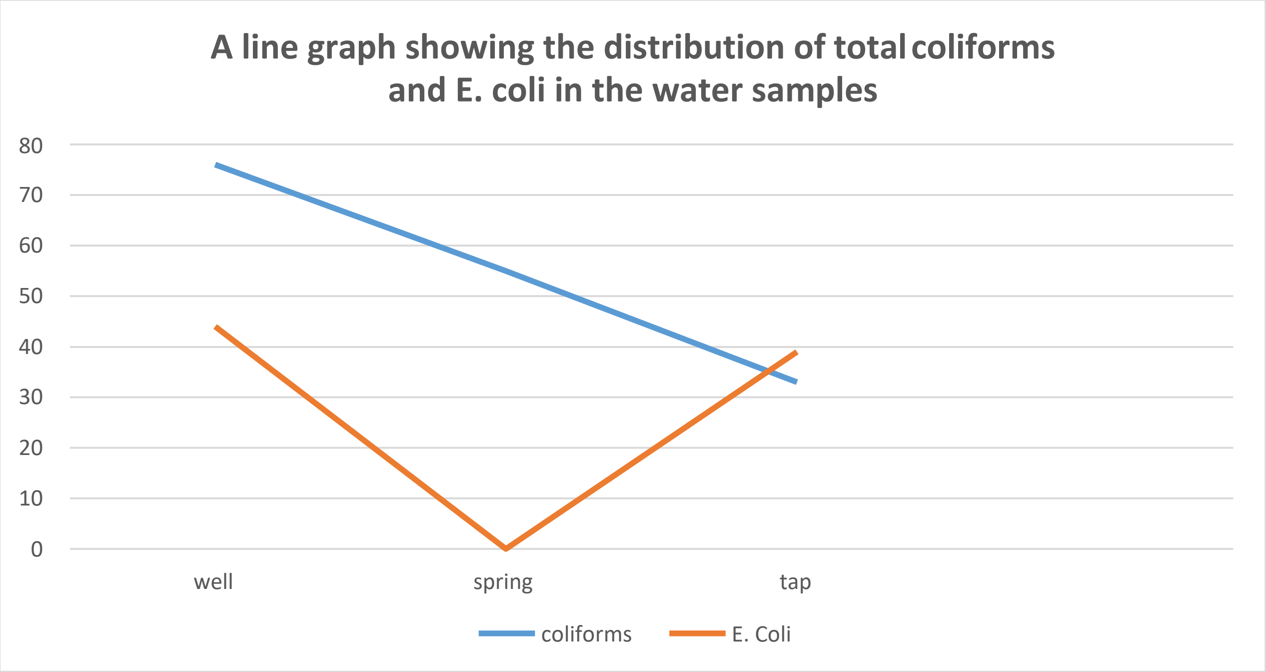

Figure 3: Microbial counts (c.f.u/mL) of water samples taken from 3 different Namuwongo slum water sources

DISCUSSION

According to this study inadequate sanitation facilities have posed a problem even in Namuwongo slum. The poor garbage disposal around the spring and we will have led to an increase in the presence of waterborne microbes into the waters. Despite the fact that Namuwongo spring had no E. coli, the presence of coliforms in the water makes infection a possibility. Contrary to the findings, many households opted to consume the tap water provided by the National Water and Sewerage Corporation because they believed it to be safe. This means that since all of the community's sources of water are susceptible to contamination, it is imperative that residents be made aware of the requirement of treating their water. In addition to the significant danger of water in this slum coming into touch with sewage or other contaminating agents, the high counts of E. coli and coliforms in the samples taken can be linked to the widespread leaks in the plumbing systems of transmission and distribution of water [29, 30]. As per the criteria set forth by the World Health Organization, the existence of coliforms in treated water supplies indicates insufficient treatment, contamination after treatment, or an overabundance of nutrients. The high pH and electrical conductivity levels can be attributed to eutrophication. This refers to the rise in the levels of nutrients in water. Nutrients are needed by the body and for plant growth but increased levels of these nutrients can pose a great danger to plant and human life[31]. The poor garbage disposal and poor waste drainage system has increased the levels of such nutrients in the waters. Despite the scarce information available about the pH and E.C (electrical conductivity) of this water, people have continuously used the water yet it's unsafe. The high levels have been attributed by the continuous disposal of wastes in the water. The spring water has got a thick orange color, which indicates the high level of waste disposal[32]. Due to the poor topography of Namuwongo, the spring constantly experiences siltation especially during the rainy days. This leads to the accumulation of other dissolved particles hence increasing the turbidity and making water unsafe for usage. The hot sunshine has also increased the temperaturs of the body and hence it has also slightly reduced the water usage capability. The constant siltation, poor garbage disposal and channeling of sewer pipes into the springs and surrounding areas of the well have led to the increase in the levels of the total dissolved solids in the waters. This has made the water unsafe as such dissolved solids can be a composition of hazardous metals which dissolve in water to release dangerous chemicals.[33] According to the survey, people carry their clothes and move closer to the water bodies where they wash from. As they wash, such soapy detergents enter the water and affect its alkalinity. The increased alkalinity levels have largely been attributed to the small scale detergent companies made by people who pour their residues in the water and also the people who wash from the water sources hence affecting the alkalinity of the water. The high levels of nitrates and sulphates in the water have been largely contributed by the steel and tube industry located in Namuwongo. It was found out that there is an effluent line that is connected directly to Lake Victoria from the industry but however this line was found with various leakages on its pipes[34]. The water that leaks from this pipe was discovered to be flowing to the spring and the nearby areas of the well. The composition of the water from the effluent leakages was found with a high level of these nutrients and since the leakage is not controlled, the deposition has been high which has led to the high levels of contamination. Hence the water was found not safe for usage.

CONCLUSION

The Namuwongo water sources have an unacceptably high level of microbial contamination. This is mostly because of E. Coli and coliform infection brought on by the unsanitary conditions in the Namuwongo slum. The problem is made worse by improper water treatment, improper collection and storage of water, and other factors. According to National Water and Sewerage Corporation standards of E. Coli, Faecal coliforms, Total coliforms and other physicochemical parameters that govern the usage of portable waters as seen below; The available water is not safe as per the standards. This is because the microbial count of all the three water sources is high and it contradicts with the available standards for safe portable water. He there is a high risk of water born infections to the Namuwongo people which can lead to high mortality rates. According to the standards of portable water, it shows that the physicochemical parameters of water are relatively high which pose a great risk to the usage of the water. Therefore, the available water from the three different water sources is not safe at all. The water has got a high level of nutrients, dissolved solids and oxidizable matter content making it unsafe for the people.

RECOMMENDATION

Raising public awareness of the risks associated with drinking contaminated water and the necessity for coordinated action to guarantee clean water is available from the point of collection to the point of consumption are important. There should be training sessions conducted to teach people about clean water treatment practices and collection habits. There should be construction of a better structure where people can effectively dispose off their rubbish rather than leaving it hanging everywhere in the community. Construction of more toilets to ensure that people do not defecate anywhere in the community which can increase the risk of spread of water borne pathogens.

REFERENCES

1. Hoff, H.: Global water resources and their management. Curr. Opin. Environ. Sustain. 1, 141–147 (2009). https://doi.org/10.1016/j.cosust.2009.10.001
2. Miller, J.D., Workman, C.L., Panchang, S.V., Sneegas, G., Adams, E.A., Young, S.L., Thompson, A.L.: Water Security and Nutrition: Current Knowledge and Research Opportunities. Adv. Nutr. 12, 2525–2539 (2021). https://doi.org/10.1093/advances/nmab075

3. Okafor, C.O., Ude, U.I., Okoh, F.N., Eromonsele, B.O., Okafor, C.O., Ude, U.I., Okoh, F.N., Eromonsele, B.O.: Safe Drinking Water: The Need and Challenges in Developing Countries. In: Water Quality - New Perspectives. IntechOpen (2024)
4. du Plessis, A.: Persistent degradation: Global water quality challenges and required actions. One Earth. 5, 129–131 (2022). https://doi.org/10.1016/j.oneear.2022.01.005
5. Essuman, M.A., Storph, R.P., Ahinkorah, B.O., Budu, E., Yaya, S.: Hygienic Disposal of Children's Stools Practices Among Women of Children With Diarrhoea in Sub-Saharan Africa. Environ. Health Insights. 17, 11786302231204764 (2023). https://doi.org/10.1177/11786302231204764
6. Wasiq, A.N., Saw, Y.M., Jawid, S., Kariya, T., Yamamoto, E., Hamajima, N.: Determinants of diarrhea in children under the age of five in Afghanistan: a secondary analysis of the Afghanistan Demographic and Health Survey 2015. Nagoya J. Med. Sci. 82, 545–556 (2020). https://doi.org/10.18999/nagjms.82.3.545
7. Merid, M.W., Alem, A.Z., Chilot, D., Belay, D.G., Kibret, A.A., Asratie, M.H., Shibabaw, Y.Y., Aragaw, F.M.: Impact of access to improved water and sanitation on diarrhea reduction among rural under-five children in low and middle-income countries: a propensity score matched analysis. Trop. Med. Health. 51, 36 (2023). https://doi.org/10.1186/s41182-023-00525-9
8. Azanaw, J., Malede, A., Yalew, H.F., Worede, E.A.: Determinants of diarrhoeal diseases among under-five children in Africa (2013–2023): a comprehensive systematic review highlighting geographic variances, socioeconomic influences, and environmental factors. BMC Public Health. 24, 2399 (2024). https://doi.org/10.1186/s12889-024-19962-0
9. Boschi-Pinto, C., Velebit, L., Shibuya, K.: Estimating child mortality due to diarrhoea in developing countries. Bull. World Health Organ. 86, 710–717 (2008). https://doi.org/10.2471/blt.07.050054
10. Mutono, N., Wright, J.A., Mutembei, H., Muema, J., Thomas, M.L.H., Mutunga, M., Thumbi, S.M.: The nexus between improved water supply and water-borne diseases in urban areas in Africa: a scoping review. AAS Open Res. 4, 27 (2021). https://doi.org/10.12688/aasopenres.13225.1
11. Dickson-Gomez, J., Nyabigambo, A., Rudd, A., Ssentongo, J., Kiconco, A., Mayega, R.W.: Water, Sanitation, and Hygiene Challenges in Informal Settlements in Kampala, Uganda: A Qualitative Study. Int. J. Environ. Res. Public. Health. 20, 6181 (2023). https://doi.org/10.3390/ijerph20126181
12. Sadik, N.J., Uprety, S., Nalweyiso, A., Kiggundu, N., Banadda, N.E., Shisler, J.L., Nguyen, T.H.: Quantification of multiple waterborne pathogens in drinking water, drainage channels, and surface water in Kampala, Uganda, during seasonal variation. GeoHealth. 1, 258–269 (2017). https://doi.org/10.1002/2017GH000081
13. Dickson-Gomez, J., Nyabigambo, A., Rudd, A., Ssentongo, J., Kiconco, A., Mayega, R.W.: Water, Sanitation, and Hygiene Challenges in Informal Settlements in Kampala, Uganda: A Qualitative Study. Int. J. Environ. Res. Public. Health. 20, 6181 (2023). https://doi.org/10.3390/ijerph20126181
14. Fogang, R.L.-, Payne, V.K., Cedric, S.F., Tsafack, H.N., Bamou, R.: A Cross-sectional Epidemiological Survey on Drinking Water, Sanitation and Hygiene amongst Residents of Bamboutos Division, West Region Cameroon: A Knowledge, Attitude and Practice (KAP) Study. Int. J. Trop. Dis. Health. 1–14 (2020). https://doi.org/10.9734/ijtdh/2020/v41i1630359
15. Dickson-Gomez, J., Nyabigambo, A., Rudd, A., Ssentongo, J., Kiconco, A., Mayega, R.W.: Water, Sanitation, and Hygiene Challenges in Informal Settlements in Kampala, Uganda: A Qualitative Study. Int. J. Environ. Res. Public. Health. 20, 6181 (2023). https://doi.org/10.3390/ijerph20126181
16. Sinharoy, S.S., Pittluck, R., Clasen, T.: Review of drivers and barriers of water and sanitation policies for urban informal settlements in low-income and middle-income countries. Util. Policy. 60, 100957 (2019). https://doi.org/10.1016/j.jup.2019.100957
17. Wamyil, J.F., Chukwuanugo Nkemakonam, O., Adewale, O.S., Nabona, J., Ntulume, I., Wamyil, F.B.: Microbiological quality of water samples obtained from water sources in Ishaka, Uganda. SAGE Open Med. 11, 20503121231194239 (2023). https://doi.org/10.1177/20503121231194239
18. Gwimbi, P., George, M., Ramphalile, M.: Bacterial contamination of drinking water sources in rural villages of Mohale Basin, Lesotho: exposures through neighbourhood sanitation and hygiene practices. Environ. Health Prev. Med. 24, 33 (2019). https://doi.org/10.1186/s12199-019-0790-z
19. Nalumenya, B., Rubinato, M., Catterson, J., Kennedy, M., Bakamwesiga, H., Wabwire, D.: Assessing the Potential Impacts of Contaminants on the Water Quality of Lake Victoria: Two Case Studies in Uganda. Sustainability. 16, 9128 (2024). https://doi.org/10.3390/su16209128
20. Krsmanovic, M., Biswas, D., Ali, H., Kumar, A., Ghosh, R., Dickerson, A.K.: Hydrodynamics and surface properties influence biofilm proliferation. Adv. Colloid Interface Sci. 288, 102336 (2021). https://doi.org/10.1016/j.cis.2020.102336
21. Riyadh, A., Peleato, N.M.: Natural Organic Matter Character in Drinking Water Distribution Systems: A Review of Impacts on Water Quality and Characterization Techniques. Water. 16, 446 (2024). https://doi.org/10.3390/w16030446
22. Novak Babič, M., Gunde-Cimerman, N., Vargha, M., Tischner, Z., Magyar, D., Veríssimo, C., Sabino, R., Viegas, C., Meyer, W., Brandão, J.: Fungal Contaminants in Drinking Water Regulation? A Tale of Ecology, Exposure, Purification and Clinical Relevance. Int. J. Environ. Res. Public. Health. 14, 636 (2017). https://doi.org/10.3390/ijerph14060636

23. Zhang, P., Yang, M., Lan, J., Huang, Y., Zhang, J., Huang, S., Yang, Y., Ru, J.: Water Quality Degradation Due to Heavy Metal Contamination: Health Impacts and Eco-Friendly Approaches for Heavy Metal Remediation. Toxics. 11, 828 (2023). https://doi.org/10.3390/toxics11100828
24. Saravanan, P., Saravanan, V., Rajeshkannan, R., Arnica, G., Rajasimman, M., Baskar, G., Pugazhendhi, A.: Comprehensive review on toxic heavy metals in the aquatic system: sources, identification, treatment strategies, and health risk assessment. Environ. Res. 258, 119440 (2024). https://doi.org/10.1016/j.envres.2024.119440
25. Dickson-Gomez, J., Nyabigambo, A., Rudd, A., Ssentongo, J., Kiconco, A., Mayega, R.W.: Water, Sanitation, and Hygiene Challenges in Informal Settlements in Kampala, Uganda: A Qualitative Study. Int. J. Environ. Res. Public. Health. 20, 6181 (2023). https://doi.org/10.3390/ijerph20126181
26. Qi, Q., Marwa, J., Mwamila, T.B., Gwenzi, W., Noubactep, C.: Making Rainwater Harvesting a Key Solution for Water Management: The Universality of the Kilimanjaro Concept. Sustainability. 11, 5606 (2019). https://doi.org/10.3390/su11205606
27. Sridhar, M.K.C., Adejumo, M.: Chapter 7 - Water, sanitation and hygiene (WASH) disease prevention and control in low resource countries. In: Charlesworth, S. (ed.) Sustainable Water Engineering. pp. 99–120. Elsevier (2020)
28. Nelson, S., Drabarek, D., Jenkins, A., Negin, J., Abimbola, S.: How community participation in water and sanitation interventions impacts human health, WASH infrastructure and service longevity in low-income and middle-income countries: a realist review. BMJ Open. 11, e053320 (2021). https://doi.org/10.1136/bmjopen-2021-053320
29. Ssemugabo, C., Wafula, S.T., Ndejjo, R., Oporia, F., Osuret, J., Musoke, D., Halage, A.A.: Knowledge and practices of households on safe water chain maintenance in a slum community in Kampala City, Uganda. Environ. Health Prev. Med. 24, 45 (2019). https://doi.org/10.1186/s12199-019-0799-3
30. Obaideen, K., Shehata, N., Sayed, E.T., Abdelkareem, M.A., Mahmoud, M.S., Olabi, A.G.: The role of wastewater treatment in achieving sustainable development goals (SDGs) and sustainability guideline. Energy Nexus. 7, 100112 (2022). https://doi.org/10.1016/j.nexus.2022.100112
31. Akinnawo, S.O.: Eutrophication: Causes, consequences, physical, chemical and biological techniques for mitigation strategies. Environ. Chall. 12, 100733 (2023). https://doi.org/10.1016/j.envc.2023.100733
32. Lukhele, T., Msagati, T.A.M.: Eutrophication of Inland Surface Waters in South Africa: An Overview. Int. J. Environ. Res. 18, 27 (2024). https://doi.org/10.1007/s41742-024-00568-8
33. Zill, J., Perujo, N., Fink, P., Mallast, U., Siebert, C., Weitere, M.: Contribution of groundwater-borne nutrients to eutrophication potential and the share of benthic algae in a large lowland river. Sci. Total Environ. 951, 175617 (2024). https://doi.org/10.1016/j.scitotenv.2024.175617
34. Lan, J., Liu, P., Hu, X., Zhu, S.: Harmful Algal Blooms in Eutrophic Marine Environments: Causes, Monitoring, and Treatment. Water. 16, 2525 (2024). https://doi.org/10.3390/w16172525

CITE AS: Mwesigwa Walter and Byaruhanga Ivan (2025). Microbial Analysis of Domestic Water Sources in Namuwongo Slum of Kampala, Uganda. RESEARCH INVENTION JOURNAL OF ENGINEERING AND PHYSICAL SCIENCES 4(1):61-73. https://doi.org/10.59298/RIJEP/2025/416173