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Research Article

Keywords: water security, practices, sanitation, association, schools

Posted Date: October 5th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11240181/v1>

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Additional Declarations: The authors declare no competing interests.

The state of water security and sanitation practices in selected primary schools, Mzumbe Ward, Tanzania

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Abstract

This study aimed to determine the association between water security and sanitation practices in selected primary schools in Mzumbe ward through exploratory design. It was found that school communities faced water security issues like unreliability, and water inadequacy. Results show that water security has influence on sanitation practices in schools since availability of water influenced practices such as toilet cleanness. The r -value (0.77) and a scatter plot with an upward-sloping trend line indicate a strong positive correlation between water security and sanitation practices in the area. It is recommended that water infrastructure be improved, robust monitoring and maintenance systems to be established and water conservation strategies to be implemented in learning institutions to minimize water wastage. Other recommended actions are improvement of sanitation facilities, conducting hygiene education programs and behavior change campaigns.

Key words: water security, practices, sanitation, association, schools

1.0 Introduction

Improved sanitation and hygiene is a worldwide recognised way to control spread of infections as well as promote public health (Bartram & Cairncross, 2010, Mara & Evans, 2018; Mmbaga *et al.*, 2016). The United Nations Sustainable Development Goal (SDG 6- Clean water and sanitation), has emphasised access to sanitation and hygiene, safe and affordable drinking water, increase in water use efficiency, ensuring freshwater supplies as well as improved water quality (United Nations, 2018). Achievement of this goal will not only improve health but also alleviate poverty.

Globally, an estimated one in three people lacks access to safe drinking water (Rijsberman 2006; Nouri *et al.*, 2019), two in five lack basic handwashing facilities, and over 650 million people still practise open defecation (United Nations, 2021; Barnes, 2020). Sub-Saharan

Africa bears a disproportionate burden: by 2025, between 75 million and 250 million people in Africa are projected to be living under conditions of high-water stress (Beyene, 2012; UN-Water, 2014). In Tanzania specifically, only 47% of citizens have access to basic sanitation and only 23.5% can access basic handwashing facilities (WHO/UNICEF/JMP, 2018). A study on sanitation and hygiene practices in small towns in Tanzania by Mshida *et al* (2020) in Babati suggests that water insecurity provoked by various factors influence sanitation and hygiene practices. While the Tanzania Water Sector Development Programme (WSDP) has facilitated significant progress — including 72% rural water-point coverage and expansion of urban water networks — substantial gaps remain, particularly in peri-urban and rural learning institutions (URT, 2020).

Though there are several sources of water supplies in Mvomero district (Melchioli 2020)

where Mzumbe ward is situated including shallow wells, gravity, schemes, local wells and rainwater harvesting, only 53% of the Mvomero District population has access to clean and safe water (Mvomero DC, 2015). However, there are efforts to increase the size of population accessing safe and clean water such as emphasising community participation. Therefore, to achieve the SDG targets like target 6.1, multiple increases of the current trend are required.

1.1 Literature Review

Research at the global level consistently demonstrates that water insecurity in schools undermines sanitation outcomes. Cronk et al. (2017), in a study of South African schools, found that institutions with reliable water supply had significantly higher rates of good sanitation practices, including handwashing, compared to those without. Kabir et al. (2021), studying a public university in Bangladesh, identified irregular water supply as a key driver of poor hygiene behaviour among students. Similarly, Mshida et al. (2020), working in small towns in Tanzania, showed that water unavailability prevents handwashing at critical moments, results in smelly and dirty toilets, and leads students to hold urine or defecate in the open rather than use school facilities.

At the regional level across sub-Saharan Africa, studies have documented the compound effects of inadequate WASH in schools. Awoke et al. (2013), in Ethiopia, found that the latrine-to-student ratio was inadequate and that insufficient facilities contributed to poor hygiene conditions and increased risk of diarrhoeal disease. Curtis et al. (2000), studying Ghana, India and Zimbabwe, obtained similar findings. Ogunjobi et al. (2015), examining public primary schools in Lagos, Nigeria, reported widespread absence of functional handwashing stations and soap, identifying water scarcity as the primary constraint. These findings collectively establish that water access is a structural determinant of sanitation

practice in school settings.

Within Tanzania, Mmbaga et al. (2016) documented the inadequacy of safe water supply and sanitation facilities across primary schools in Kinondoni municipality, Dar es Salaam, and identified infrastructure deficits as the central barrier. The National Environment Policy (2021) explicitly lists lack of accessible good-quality water among the eight major national challenges, while the Mzumbe University Environmental Management Policy (2020) identifies unreliable water supply and questionable water quality as key local challenges. Despite this policy recognition, empirical evidence on how water security conditions translate into specific sanitation practices in primary school settings particularly at the ward level in rural Tanzania remains sparse.

This study fills that gap by providing quantitative evidence on the water security–sanitation relationship at two contrasting primary schools in Mzumbe Ward, Mvomero District, Tanzania.

1.2 Research Objectives

The main objective of this study was to examine the impact of water security on sanitation practices in selected primary schools in Mzumbe Ward. The specific objectives were:

- To examine the status of water security in the selected primary schools.
- To determine the association between water security and sanitation practices.
- To explore strategies for improving water security and sanitation in the study area.

1.3 Research Questions

- What is the status of water security in the selected primary schools?
- How is water security associated with sanitation practices?
- What are the strategies for improving water security and sanitation in the study area?

1.4 Significance of the Study

This study is relevant to the environmental, public health, and policy contexts of Tanzania. It contributes empirical evidence to fill the knowledge gap on how water insecurity affects sanitation practices in primary school settings — a setting type that has been understudied at the ward level. The findings will help to provide means to combat the problem of water insecurity and its impacts on sanitation in learning institutions. Implementation of the recommended actions will contribute to ensuring adequate availability of safe water for consumption throughout the year by addressing the water insecurities issues that arise thus contributing to improving water security and sanitation in learning institutions. Findings support the National Environment Policy (2021) challenge of accessible good-quality water and directly speak to the Mzumbe University Environmental Management Policy (2020). The study provides actionable recommendations for school administrators, local government, and WASH sector actors.

2.0 Materials and Methods

2.1 Study area

The study was conducted in Mzumbe ward, Mvomero district in Morogoro region (Figure 1). The ward lies between latitude 6° 56' 0"

South and longitude 37° 34' 0" East. The selected schools were Masanze primary school which is geographically located 6° 53' 25" South and 37° 33' 31" East; and Vikenge Primary school which is geographically located 6° 54' 39" South and 37° 34' 24" East. Mzumbe ward in Mvomero district is still new administratively, its villages have implemented various water projects (Mostly funded by the World Bank) for the purpose of improving water services. For instance, in 2009 World Bank restored government's water projects in Mzumbe ward from Tangeni River; of which was later decentralised to water user association in Mvomero district in 2010. Despite these projects, Mzumbe Ward has been reported to experience water security and sanitation challenges that have implications for various aspects of the community, including educational facilities. Mzumbe ward is among the areas recently experiencing an emanating problem of occasional water insecurity in its various areas. High populated areas such as educational institutions, large markets, hospitals, face more difficulties of water insecurity since there is high-water demand in such places. Yet there is inadequate documentation about this scenario. Mzumbe Ward aligns closely with the research objectives of this study, which aim to investigate the relationship between water security, sanitation practices, and their implications

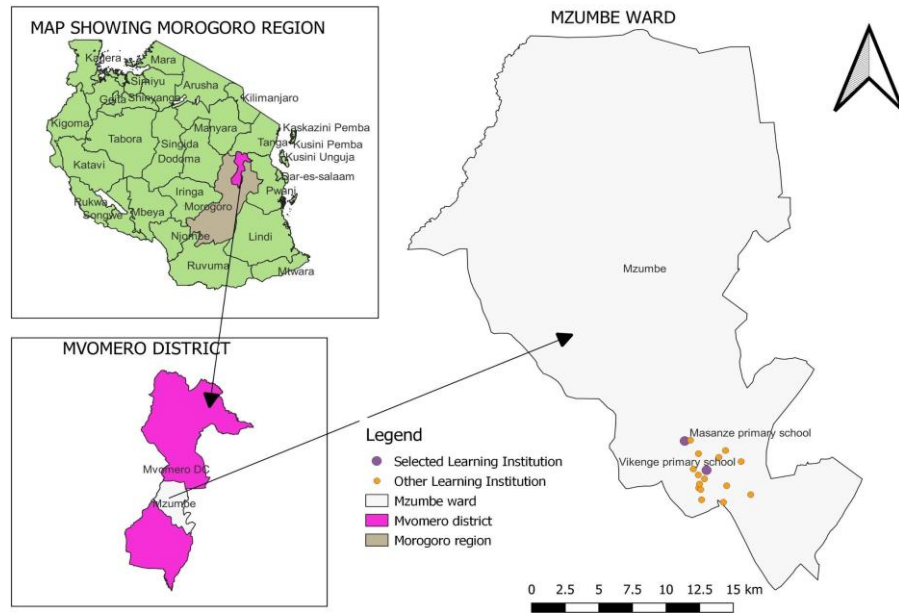


Figure 1 Map of the study area in Mvomero district, Tanzania (Source: Field data, 2023)

2.2 Research design

The study adopted an exploratory research design which helped to gain adequate information by addressing all types of research questions due to its flexible nature. The study used a mixed method design combining both qualitative and quantitative research methods. The research questions that guided data collection were

1. What is the status of water security in the selected primary schools?
2. How is water security associated with sanitation practices?
3. What are the strategies for improving water security and sanitation practices in the study area?

Furthermore, comparison of findings from the studied communities was done to explore the influence of water security on sanitation practices making this research a comparative study.

2.3 Sampling procedures

Stratified random sampling was used to select learning institutions for the study, whereas the population of learning institutions was divided into distinct strata based on the presence of water services. Specifically, two strata were formed: one comprising institutions with established water services, and the other consisting of institutions without such services. From each of these strata, one learning institution was randomly selected namely, Masanze Primary school and Vikenge Primary school. The sampling of participants was also executed using a stratified approach where stratification of school communities was based on two distinct strata: staff and students. Within the student population, the stratification was based on grade levels, taking into account cognitive capacity and participants were selected from grades five, six and seven (5, 6 & 7), acknowledging their cognitive development and capacity for meaningful responses. For other participant strata, a random selection process was employed. Purposive sampling, a

deliberate non-random method, was employed to select key informants including heads of schools, environmental teachers, personnel from the water office, and local government officials. Learning institutions were used as the sampling units and institutions studied were sampled from all institutions present in Mzumbe ward, Mvomero District.

2.4 Sample size, sampling and unit of inquiry

The sample size was computed using the study population and was obtained using Formula: $n = N / 1 + N(e)^2$ (Israel, 2013); where n stands for sample size, N stands for study population and e stands for marginal error. The sample size was computed using the Israel (2013) formula:

$$n = N / [1 + N(e^2)]$$

where n = sample size, N = study population, and e = margin of error. The total study population at the two selected schools was $N = 1,149$ (727 students at Masanze; 422 students at Vikenge, based on data obtained at the institutions). Assuming $e = (3,55\%)$, the computation obtained a sample size(n) used for this study to be four hundred sixty-nine (469). Furthermore, non proportional allocation was then applied to distribute the sample across the two schools, resulting to 260 participants at Masanze Primary School and 209 participants at Vikenge Primary School. This distribution helped to ensure adequate representation of both schools and to allow meaningful comparison between them., to ensure that the smaller Vikenge group had a sufficient number of respondents for reliable school-level analysis and reduced the risk of its views being underrepresented. Therefore, the sample distribution was based on the need for balanced analytical representation, adequate subgroup size, and meaningful comparison between the two schools, rather than strictly following their population proportions.

The sample was stratified by school community (staff and students), with students further stratified by grade level. Participants

from grades 5, 6, and 7 were included given their cognitive capacity for meaningful responses; staff were selected randomly within their stratum.

Purposive sampling was used to select six key informants: two school heads, two environmental teachers, one water office official, and one local government officer. These individuals were selected based on their direct roles and expertise relevant to water security and sanitation management.

Unit of inquiry included students and workers at the learning institutions. Government officials and experts (4 in number) were involved as key informants because they have enough information on climate variability, water insecurity and their effects on sanitation practices. The key informant provided information (qualitative data) on experiences, perceptions, institutional practices, challenges, and expert views regarding water security, and their influence on sanitation practices.

Quantitative and qualitative methods were combined to provide a more comprehensive understanding of the study problem. Quantitative data provided measurable patterns and relationships, while qualitative information from key informants helped explain and provide context to the quantitative findings. The two sets of findings were therefore integrated during interpretation, with qualitative responses used to complement and explain the quantitative results.

2.5 Data collection

A diverse range of methods were employed to gather data, each method being carefully selected to capture different aspects of the research objectives, providing a well-rounded understanding of the complex relationship between water security and sanitation practices. A mixed-methods approach was employed, combining quantitative and qualitative data collection to enable

triangulation — that is, the corroboration of findings across multiple sources to enhance credibility and validity (Creswell & Plano Clark, 2018). Methods used were survey conducted through questionnaire allocation; semi-structured interview; observation in hand with use of checklist; a focus group discussion (FGD) comprising four members and documentary review.

2.6 Data analysis and presentation of findings

Data analysis comprised both qualitative and quantitative analysis. Obtained data was organised using research questions and then grouped. Data obtained from interviews with key informants was qualitatively analysed through organisation into concepts and then connecting the concepts so as to show how they influence one another. Descriptive analysis and thematic analysis were used as methods to analyse quantitative and qualitative data respectively. The collected quantitative data was compiled, edited and coded. Afterwards the data was entered in analysis software to be analysed. IBM SPSS 23 software (of 2015) was used to analyse the quantitative data while NVivo 12 Software (of 2018) was used to organize, code, categorize, and analyse interview responses. The interview data were analysed thematically by identifying recurring ideas, patterns, and themes related to climate variability, water insecurity, and sanitation practices. The qualitative findings were then used to complement and provide explanations for the quantitative results.

2.7 Operationalization of variables

To measure water security, five indicators were assessed through questionnaire items and backed up by researcher's computations and observations were applicable. The indicators were, presence of water service (present/not present) within the premises, water reliability (very reliable/somewhat reliable/not reliable), water accessibility (very accessible/somewhat

accessible/not accessible), water adequacy and utilization (0-9l per day/10-18l per day/ 19l and above), as well as perception on water quality (very clean and safe/ somewhat clean and safe/not clean and safe).

On the other hand, to measure sanitation practices, the indicators assessed through questionnaires items asked up by researchers' computation and observation where applicable include toilet cleanness (clean/somewhat clean/not clean), hand washing and hand-washing facilities (present/not present), Cases of open defecation, open urination and unflushed excreta (Yes/no), presence of water and soap in the toilets (present/not present), and latrines student ratio.

Study results have been presented using text, figures, tables and plates so as to simplify interpretation and discussion of the study findings.

2.8 Ethical consideration

Ethical considerations were practised in the planning and carrying out of this study. The well-being and rights of participants throughout all stages of the research process were highly prioritised by carrying ethical measures including: informed Consent, confidentiality, voluntary participation and transparency in research practices including publication.

Prior to data collection, an ethical approval data collection letter was obtained from Directorate of Research and Postgraduate Studies, as a formal ethical practice.

Informed consent was obtained from all participants, including local government officials, school heads, teachers, non-teaching staff and students. There was clear communication about the purpose of the study and the voluntary nature of participation. Participants were assured that their involvement would not affect their relationship with the institution.

Confidentiality of all data collected was strictly

maintained. Data was securely stored and accessible only to the researcher. To ensure the privacy and confidentiality of the study participants, the practice of using participant identifiers rather than real names or positions was adopted. In this context, identifiers such as "Key Informant One" have been used as a participant identifier to refer to a specific individual who provided valuable information during research. This was done so as to safeguard the anonymity of participants, maintain the trust and confidence of participants while presenting the findings accurately and ethically.

Participation in the study was voluntary whereas participants were free to withdraw without facing any ramifications. This was emphasised during the informed consent process, ensuring that no one felt obligated to participate. The purpose, methods, and intended use of the collected data were openly discussed with participants. This transparency helped build trust and ensured that participants understood the study's objectives.

3.0 Results and Discussion

3.1 Status of water security

3.1.1 Water supply services

Table 1: Water supply service within premises

Water service	Masanze (%)	Vikenge (%)
Present	40.2	73.3
Not present	59.8	26.7
Total	100	100
P value	.001 hence significant	

Source: Field data, 2023

As presented in table 1, It was found that Masanze Primary school had no water supply service as reported by approximately sixty percent (59.8%) of the respondents. Hence relied on unreliable and unaffordable alternative water sources such as buying from water vendors and carrying them from home causing the school community to face water insecurity. On the other hand Vikenge Primary school had an intermittent water supply service as reported by

seventy three percent of respondents. Thus making it in a better situation of water security as compared to Masanze Primary school but still having lower than the recommended water consumption quantity of 19 -26 litres per student per day. This is supported by findings from the focus group discussion conducted at the Mzumbe ward offices that revealed that Masanze Primary school was the only school in Mzumbe ward known to have no water supply services.

3.1.2 Water reliability

Table 2: Water reliability

Water reliability	Masanze (%)	Vikenge (%)
Very reliable	1.3	11.6
Somewhat reliable	34.7	51.8
Not reliable	64	36.6
Total	100	100
P value	.001 hence significant	

Source: Field data, 2023

Regarding reliability (see table 2) it was found that at Masanze Primary School water is not reliable as reported by sixty-four percent (64 %) of respondents. All the key informants responded that water was not reliable as most of the time, they didn't get water when they wanted or needed it. Some reasons for this are mentioned that when they order for water, they get the water at later hours due to jams for buying water or long-distance travel of water vendors to fetch the water. When water is not available in nearby areas, water vendors travel long distances to fetch the water then sell it to the school community. For the case of Vikenge Primary school, the majority of the respondents replied that water is somewhat reliable as responded to by the majority of questionnaire respondents (51.8 %). Only thirty seven percent replied that water was not reliable while the remaining eleven percent of the respondents replied that water was very reliable as presented. Results of chi square test indicate that there is strong association between school and water reliability, hence te

difference between the schools in terms of water reliability is significant ($p < 0.001$)

Water unreliability holds broad definitions, but it holds major features which are “the physical absence of water flowing from the tap, water unavailability at a consumption point (public or household standpipe or protected spring) for 24/7/365, it is not provided in time, and with the quality and quantity required”. This implies the continuity and predictability if there is non-continuity and functionality of water supply (Majuru et al., 2011). With these broad definitions of water unreliability, based on the findings obtained from both schools, it can be argued that water is unreliable and this has divergent implication

3.1.3 Accessibility of water

Table 3: Water accessibility

Water accessibility	Masanze (%)	Vikenge (%)
Very accessible	15.2	22
Somewhat accessible	62.5	68
Not accessible	22.3	10.
Total	100	100
P value	.049 hence significant	

Source: Field data, 2023

Concerning accessibility of water to the special group, the majority (62.5 %) of the respondents showed that water was somewhat accessible at Masanze, while only fifteen percent responded that water is very accessible to the special group, specifically younger children (see table 3) . Similar findings were obtained at Vikenge Primary school where majority (sixty-eight percent) of respondents replied that water was somewhat accessible to the special group followed by twenty-two percent who replied that water was very accessible. To determine status of water accessibility in the schools, the conducted survey was backed up by researcher's quick infrastructure evaluation, source and storage assessment. In infrastructure

evaluation, number, functionality and easy reach of water points available in the school premises were determined. In source assessment, proximity and reliability of the water sources were also determined. Furthermore, capacity, condition of water storage facilities was examined. It was found that in both schools, water was somewhat accessible.

3.1.4 Perception of water quality

Based on the study conducted, (as presented in table 4) only nineteen- point six percent (19.6 %) of the respondents replied that the drinking water used in the premises was very clean and safe. Majority of the Masanze respondents perceive that water is somewhat clean and safe. The remaining twenty-three-point two percent (23.2 %) replied that it is not clean and safe. For the case of Vikenge Primary School, 68 % of the respondents show that water was very clean and safe. Only 8 % replied that water was not clean and safe.

Table 4: Perception on water quality

Water quality perception	Masanze (%)	Vikenge (%)
Very clean & safe	19.6	68
Somewhat clean&safe	57.2	24
Not clean & safe	23.2	8
Total	100	100
P value	.001 hence significant	

Source: Field data, 2023

To determine the cleanliness and safety of water without laboratory tests can be challenging since it is known that lab tests provide the most accurate information about water quality. However, it is possible to make an educated guess about the safety and cleanliness of water by considering the factors and some indicators that can provide useful information on the quality of water. These factors include information if local water sources are known to be heavily polluted, Water appearance and taste if it is known to be

cloudy, discoloured, having a strange taste or odour and if water source is protected from waste contamination, chemicals and other pollutants (United States Environmental Protection Agency, 2022, World Health Organization, 2021; United States Geological Survey, 2022). From these factors, the quality of water can be perceived

3.1.5 Water adequacy and utilisation

Table 5: Water adequacy and utilisation

Water utilization	Masanze (%)	Vikenge (%)
0-9l/day/student	76.7	18
10-18l/day/student	11.6	54.1
19l/day/student&above	11.6	27.8
Total	100	100
P value	0.001	

Source: Field data, 2023

Concerning water adequacy and utilisation (see table 5), it was found that the majority at Masanze consume 0 to 9 litres of water per day. Only eleven-point six percent (11.6 %) utilise 10- 18 litres of water. Also, only eleven percent (11.6 %) utilise 19 and above litres of water per day when at school. These findings obtained can be backed up by researchers' computation based on the data on water utilisation obtained from school. Ten water containers of 20 litres each are bought per day for school consumption. This makes a total of 200 litres of water provided for drinking purposes. Therefore, each student has a share of 0.3 litres per day provided by the school for drinking as computed in the equation i. (obtained from the total amount of water divided by the total number of students that is 200/727).

Share of water = Total amount of water/total number of students

$$=200/727$$

$$=0.3 \text{ litres per student for drinking purpose}$$

The fact that each student carries water (3 to 5

litres) from home for cleaning purposes. Water consumption per student per day when at school can be roughly computed by taking the largest volume of water that can be carried by a student from home which is 5 Litres of water adding the average drinking water used by each student which is 0.3Litres The approximate total consumption per student per day at Masanze Primary School becomes

5.3 and falls within the range of 0-9 litres consumption.

For the case of Vikenge Primary School, the major response was 10-18 litres as reported by 54 % of the respondents. Eighteen percent (18 %) replied that they consume 0-9 litres and the remaining 28 % (more than quarter) replied that they use 19 litres and above when at school. Water consumption at Vikenge appears to be higher compared to that of Masanze Primary school as it was found that the majority utilise 10-18 litres of water and more than quarter utilise 19 and above litres of water

As a general rule, it is recommended that day schools provide a minimum of 5-7 gallons which is equivalent to 19 -26 litres of water per student per day for drinking and sanitation purposes as provided on guidelines set by the Environmental Protection Agency (EPA, 2007). This includes water for drinking fountains, hand washing, and toilet flushing. In addition, schools should also consider the water demand for other activities such as irrigation of school gardens and lawns, cleaning of facilities, and other non-potable uses.

The average utilised amount (0-9 litres) at Masanze Primary School is low compared to the average utilised amount (of 10-18 litres) at Vikenge Primary School and very low compared to the recommended amount of 19 to 26 litres Utilisation at Vikenge Primary school appears to be higher and better than that of Masanze primary school as at least more than a quarter utilise the recommended amount of 19 and above litres. More than half of the respondents utilise less than the recommended amount but higher than the

average amount utilised at Masanze primary school.

The very low consumption at Masanze Primary school is due to absence of a safely managed drinking water service within the school premises. A safely managed drinking water service implies utilising water from a source that is within premises hence easily accessible, reliable implying that it is available whenever needed and of good quality that is free from chemical or faecal contamination. Had there been a safely managed water service, the water utilisation figures would be higher than the reported ones as seen for the case of Vikenge Primary school.

Being below the recommended water demand for schools has various impacts on the health and well-being of students and staff such as dehydration and sanitation issues. Due to inadequate amounts of water, students and staff are not able to meet their hydration needs and become dehydrated.

Dehydration occurs when the body loses more fluids than it takes in, which lead to a variety of negative symptomatic health effects such as fatigue and weakness, which makes it difficult for students and staff to concentrate and perform well in school; decreased cognitive function leading to impaired memory, attention, and decision-making skills as it was reported in the studies conducted by Armstrong and his colleagues in 2012, by Edmonds and Burford in 2013 and by Hobin in 2018. Dehydration also causes headaches and dizziness, which is particularly problematic for students and staff who need to focus on schoolwork or other tasks (Kenney, Robinson and Isaacs, 2011; Crow and Row, 2004; Hobin *et al.*, 2018). Furthermore, dehydration also lead to dry skin, dry mouth, decreased ability to regulate temperature as well as decreased urine output, which are uncomfortable and lead to other health problems like heat exhaustion and kidney stones (Armstrong *et al.*, 2012; Edmonds and Burford, 2013; Hobin *et al.*, 2018; Kenney,

Robinson and Isaacs, 2011).

Another impact of having an inadequate amount of water in schools is sanitation issues since insufficient water prevents students and staff from washing their hands properly and flushing toilets adequately, which are important hygiene practices to prevent the transmission of diseases. Handwashing is one of the most effective ways to prevent the transmission of germs and bacteria that cause illnesses such as colds, flu, and gastrointestinal infections (Sampath *et al.*, 2014; UNICEF, 2015, World Health Organization, 2018). Inadequate water supply leads to insufficient hand washing, which increases the risk of these illnesses spreading within the school. Proper hand washing requires enough running water, soap, and enough time to thoroughly wash and rinse hands. (Sampath *et al.*, 2014; UNICEF, 2015).

Similarly, inadequate water supply leads to insufficient flushing of toilets, which results in unsanitary conditions and unpleasant odours (Sampath *et al.*, 2014; UNICEF, 2015, WHO, 2018). This creates an unhealthy environment for students and staff, as well as increases the risk of disease transmission. Proper flushing requires enough water to thoroughly rinse away waste and ensure that the toilet bowl is clean. Furthermore, insufficient water supply also affects the overall cleanliness of the school facilities, including classrooms, kitchens, and other common areas. Without enough water, it becomes difficult to properly clean and sanitise surfaces, which leads to the growth of bacteria and other harmful microorganisms.

Assessment of factors affecting water security in the study area revealed the causes being absence of water sources, infrastructure issues such as absence of pipes, damaged, old and worn out infrastructure. Also, high cost of water, environmental and climate factors such as lack of rainfall, cutting down of trees, environmental pollution. Other causes include lack of cooperation and regional

discrimination, deteriorated quality of water, unreliable water supply as well as water inadequacy.

During this study, infrastructure issues was a cause mentioned by forty-four percent (44 %) of the respondents of questionnaires administered at Masanze Primary and thirty-eight percent (38 %) of those at Vikenge Primary school. Similar information was also obtained from interviews with key informants where it was further claimed that the previously existing infrastructure was damaged by some villagers around Masanze Primary school. It was further informed that the infrastructure in Vikenge Primary school was worn out, water infrastructure in toilet buildings were no longer functioning hence when students feel the urge, they carry water buckets from storage tanks to the toilets (more than 15 metres apart) for flushing and cleansing purposes.

From physical observation at Masanze, it was found that the infrastructure of previously functioning water service was damaged and there was no running water. There was one existing water consumption point and there were no further networks to other points. On the other hand of Vikenge, the standpipe was broken, a water pipe surfacing from the ground was directed into the tank. There were further pipe networks towards the toilets but they were not functioning (no sign of running water)

Water infrastructure comprises the physical systems, facilities, and structures that are necessary for the collection, storage, treatment, distribution, and management of water resources (Gupta *et al.*, 1999; Clark *et al.*, 2004). They include dams, reservoirs, pumping stations, treatment plants, water storage tanks and pipeline networks. Water infrastructure is vital to enhance that communities have access to clean and safe water for various uses such as drinking, sanitation and irrigation.

Water infrastructure may be limited due to ageing especially for the supply systems

established a long time ago, damage or being insufficient. These lead to water shortages during periods of high demand or drought or complete inaccessibility of the water supply service.

Cost of water is one of the mentioned causes of water insecurity as mentioned by nine percent of the Masanze respondents. The community currently faces water scarcity and relies on water distributed by local vendors

which may be not affordable to many. The high cost therefore triggers some to opt for unsafe sources such as surface ponds which are dangerous to their health. For the case of Vikenge primary school, the water bill charged currently is Ten thousand Tanzanian shillings (Tshs 10000/=) per month which seems cheaper than costs incurred at Masanze Primary school which is three hundred Tanzanian shillings (Tshs 300/=) for every 20 litres of water.

3.1.6 Chi square test summary 1

Table 6 : Summary of chi square test results of to establish difference between the two schools in terms of water security

Association of variables	Pearson Chi square value	Df	P value (0.05)	Association
School * water presence in premises	22.154	1	.001	Significant
School* water reliability	20.470	2	.001	Significant
School * water accessibility	6.015	2	.049	significant
School * perception on water quality	46.884	2	.001	significant
School * water adequacy and utilization	70.780	2	.001	Significant

Source: Field data, 2023

From results shown in table 6, Masanze Primary school can therefore be termed to be less water secured compared to Vikenge Primary school.

3.2 Status of Sanitation practices within school communities

3.2.1 Toilet cleanness

Table 7: Toilet cleanness

Toilet cleanness	Masanze (%)	Vikenge (%)
Very clean	19.6	25.4
Somewhat clean	64.3	73.2
Not clean	16.1	1.4
Total	100	100

P value	
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Source: Field data, 2023

At Masanze, it was found that toilets were somewhat clean as responded by the majority (64.3 %); only nineteen point six percent (19.6 %) replied that toilets were clean as presented in table 7. Information obtained from key informants revealed toilets are cleaned once per day. The findings at Vikenge Primary School were a bit different from that of Masanze Primary school.

Only one point four percent (1.4 %) responded that the toilets were not clean. Seventy-three percent (73.2 %) replied that the toilets were somewhat clean and the remaining twenty-six percent (25.4 %) replied that the toilets were

clean.

3.2.2. Hand Washing

Table 8: Presence of handwashing facilities withing school premises

Hand washing facilities	Masanze (%)	Vikenge (%)
Present	12	29
Not present	88	71
Total	100	100
P value	.003 hence significant	

Source: Field data, 2023

From questionnaires administered at Masanze Primary School, it was found that there was no presence of handwashing facilities as responded by approximately eighty-eight percent of respondents. More than a quarter of respondents at Vikenge primary school responded that there is a presence of handwashing facilities (see table 8)

It was found that regular hand washing, for instance before and after eating or after encountering dirt is not a common practice within the schools premises as indicated by the absence and non-functionality of handwashing facilities around the school premises. The causes of absence and non-functionality of hand washing facilities is lack of funding to enhance installation and maintenance of the handwashing facilities, inadequate infrastructure to support hand washing facilities, poor maintenance that makes handwashing facilities unusable after damage and water inadequacy. Another cause is lack of awareness on the importance of having handwashing facilities in the school as well as cultural barriers where handwashing is not a common practice hence installation of handwashing facilities appears to be of little importance.

Despite these causative reasons, availability of hand washing facilities remains to be an important item that need to be emphasised so to promote good hygiene practices and prevent

spread of disease-causing organisms and their respective diseases, protect the health and well-being of the school community.

3.2.3 Soap and water in the toilets

Table 9: presence of soap and water in toilets

Soap and water in toilets	Masanze (%)	Vikenge (%)
Present	17.8	22
Not present	82.2	78
Total	100	100
P value	.372 hence not significant	

Source: Field data, 2023

As presented in table 9, results show that there is no presence of water and soap in the toilet buildings as responded by eighty-two and seventy-eight percent in Masanze and Vikenge Primary schools respectively. This finding reveals that hand washing after visiting the toilet is not a common practice among members of school. Providing soap and water in school toilets is essential for promoting good hygiene practices and preventing the spread of illness. Students use school toilets regularly throughout the day, and it is important that they have access to soap and water to wash their hands effectively. Soap and water should be available and accessible in every toilet stall in the school by installing soap dispensers at the sinks enough to accommodate the number of students in the school.

Regular maintenance and refilling are necessary to ensure that they are in good working order and that they are always enough to serve all. Furthermore, students and staff should be educated on the importance of washing their hands regularly with soap and water, and the proper technique for doing so. This can be done through classroom instruction, posters in the toilets, and other educational materials.

3.2.4 Cases of left open human wastes

Table 10: presence of left open feaces

Left open human faeces	Masanze (%)	Vikenge (%)
YES	72	43
NO	28	57
Total	100	100
P value	<.001 hence significant	

Source: Field data, 2023

Table 11: presence of left open urine

Left open human urine	Masanze (%)	Vikenge (%)
YES	39.3	27
NO	60.7	73
Total	100	100
P value	.071 hence not significant	

Source: Field data, 2023

Based on the information provided by one of the key informants there were cases of open defecation, open urination and unflushed

toilets. The key informant added that some students openly defecate behind the toilet buildings. Mentioned reasons for these cases are some children's habits and unclean toilets. The toilets are cleaned in the morning but a few hours afterwards they become so dirty that other students opt to defecate in the open rather than inside toilets buildings. As compared to a YES response (72 % for Masanze and 43 % for Vikenge) to the presence of left open fecal excreta, a YES response on left open urine was lower (39.3 % for Masanze and 27 % for Vikenge) as seen in table 10 and 11. This is explained by the facts that; first, urine requires small water quantity to be flushed away compared to fecal excreta and second, signs of open urination are not so easy to spot as compared to open defecation since urine dries away easily and may be flushed away easily by rain as compared to fecal excreta.

3.3.5 Chi square test results summary

Table 12: Summary of chi square test results of to establish difference between the two schools in terms of sanitation practices

Association of variables	Pearson Chi square value	df	P value (0.05)	Association
School * toilet cleanness	15.902	2	<.001	Significant
School* handwashing	8.866	1	<.003	Significant
School * handwashing in toilets	0.796	1	.372	Not significant
School * cases of open urine	3.256	1	.071	Not significant
School * cases of open faeces	17.207	1	<.001	Significant

Source: Field data, 2023

Table 12 presents the summary of association of variables indicating the difference between the schools being significant in toilet cleanness, handwashing within school premises and cases of open faeces, while not being significant in handwashing in toilets and cases of open urine.

3.3 Association between water security and sanitation practices

To assess the association between two sets of variables that are water security indicators and sanitation practices, correlation analysis was done using correlation coefficients(r). The correlation coefficient is a value between -1 and 1, representing the strength and direction of the correlation of variables. Positive coefficients indicate that as one variable increases another variable also tends to

increase while negative coefficients suggest the opposite. Detailed results of the correlation analysis are presented in table 13.

All correlation coefficients (r) were found to be positive indicating that as water security improves, sanitation practices also improve. (see table 13). The obtained r value for water accessibility correlation with toilet cleanness (0.85) indicates a very strong positive correlation, with the rest values being moderate to strong correlation, only one set) water accessibility * left open urine) was found to have a weak positive correlation

(0.368).

Interpretation of coefficient values (r)

0.00-0.19	Very weak
0.20-0.39	Weak
0.40-0.59	Moderate
0.60- 0.79	Strong
0.80-1.00	Very strong

Source: Witte and Witte, 2017

Sanitation practice vs. Water security

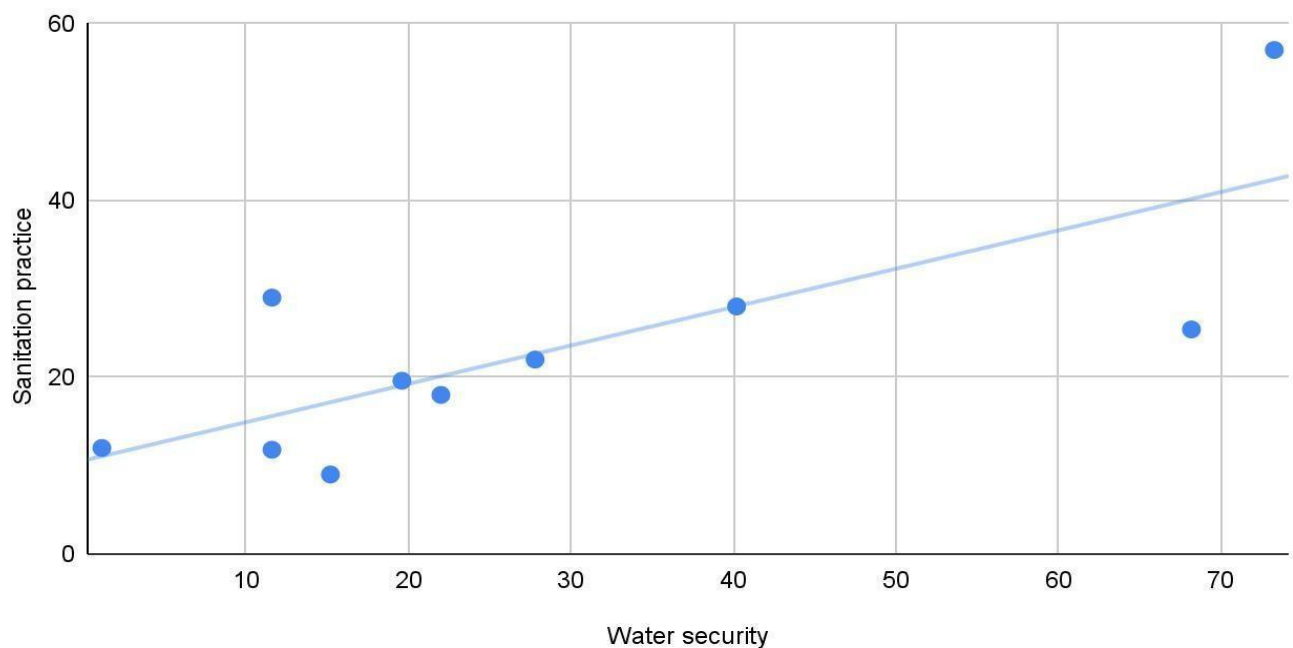


Figure 2 A positive slope of linear regression analysis

Furthermore results of regression analysis produced a scatter plot with an upward-sloping trendline that is, a positive slope as presented in Figure 2. This finding indicates a strong positive correlation between water security and sanitation practices. The R-squared value which is 0.59 is a measure of how well the trendline fits the data points whereas the closer the value is to 1, the better the fit. The scatter plot with a trendline has helped to visually identify the general trend between

the two variables and reinforces the correlation coefficient's interpretation. It provided a clear way to understand the relationship between water security and sanitation practices in the selected learning institutions. The results of the R-squared value correspond to the correlation coefficient that is $R^2=0.59$, $r = R = 0.77$.

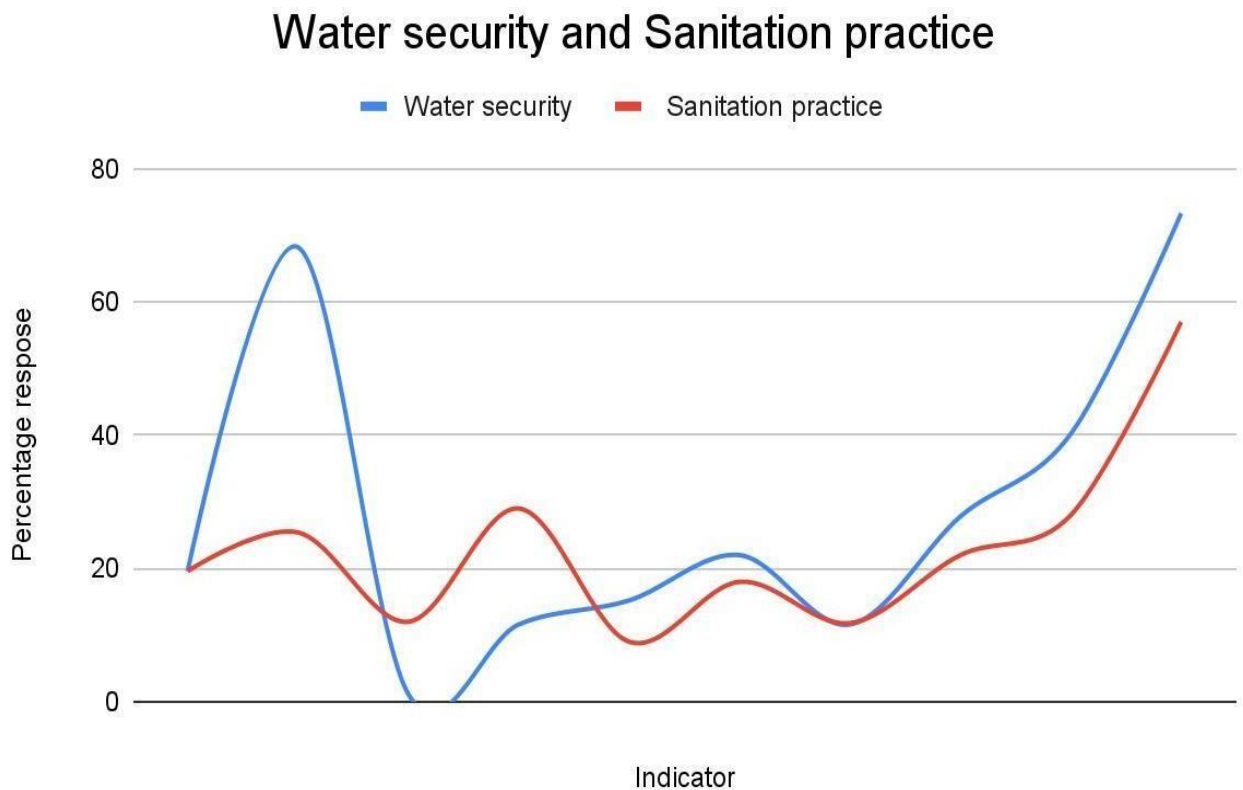


Figure 3 Trend of the relationship between water security and sanitation practices

Table 13: Correlation analysis of water security indicators and sanitation practices

		Water presence within premises	reliability of water	accessibility of water	Perception on water quality	Water adequacy and utilisation	how clean the toilets are	Handwashing in school premises	presence of left open urine	Hand washing in toilets	presence of left open faeces
Water presence within premises	Pearson Correlation	1	.809**	.587**	.785**	.333**	.551**	.446**	.616**	.432**	.368**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000
reliability of water	Pearson Correlation	.809**	1	.656**	.737**	.375**	.640**	.623**	.671**	.617**	.446**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000
accessibility of water	Pearson Correlation	.587**	.656**	1	.779**	.583**	.850**	.696**	.641**	.775**	.588**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000
Perception on water quality	Pearson Correlation	.785**	.737**	.779**	1	.372**	.708**	.507**	.418**	.491**	.427**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000
Water adequacy and utilisation	Pearson Correlation	.333**	.375**	.583**	.372**	1	.494**	.298**	.533**	.395**	.760**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000
how clean the toilets are	Pearson Correlation	.551**	.640**	.850**	.708**	.494**	1	.738**	.704**	.781**	.547**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000
Presence of handwashing facilities withing school premises	Pearson Correlation	.446**	.623**	.696**	.507**	.298**	.738**	1	.671**	.813**	.437**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000
presence of left open urine	Pearson Correlation	.616**	.671**	.641**	.418**	.533**	.704**	.671**	1	.701**	.603**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.000
presence of soap and water in toilets	Pearson Correlation	.432**	.617**	.775**	.491**	.395**	.781**	.813**	.701**	1	.423**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000		.000
presence of left open faeces	Pearson Correlation	.368**	.446**	.588**	.427**	.760**	.547**	.437**	.603**	.423**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	

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

Source: Field data, 2023

Figure 3 shows a simple line graph presentation of how the values for the two variables relate. This depicts the trend of the relationship between water security and sanitation practices in the selected learning institutions. As water security improves sanitation practice improves and as water security worsens also sanitation practices worsens. Water insecurity has influenced sanitation practices in schools since it influenced toilet cleanliness, place of excretion, toilet flushing, hand washing and overall water utilisation in quantity.

It was found that poor sanitation and sanitation practices are influenced by water insecurities like absence/unavailability of water among other factors. The obtained r value (0.77) and results of regression analysis that gave a scatter plot with an upward- sloping trendline indicate a strong positive correlation between water security and sanitation practices in the selected learning institutions. The r value not being 1, suggests the small contribution of other factors (compounding factors such as latrine to student ratio and behaviours on sanitation practices. Vikenge Primary school appears to be in a better situation compared to Masanze Primary school in terms of toilet cleanliness as contributed by the presence of a water service. The presence of water within Vikenge premises has influenced the sanitation practice of toilet cleaning and flushing hence making the school in a better position than Masanze primary school where water supply service is not within the premises.

Water security and sanitation practices in schools are closely linked and can highly affect the health and well-being of students. This is because, first, proper functionality and maintenance of sanitation facilities highly depend on water availability. Adequate water supply is necessary for maintaining proper sanitation facilities in schools. Absence of an accessible and reliable water source makes the effective operation of toilets and handwashing facilities difficult. Water insecurity also affects the functionality and cleanliness of facilities,

undermining their purpose and increasing health risks. Second, water is crucial for proper sanitation practices. Most sanitation practices in schools such as flushing toilets, cleaning and maintaining cleanliness thoroughly rely on water. In the absence of sufficient water, sanitation facilities may not be properly cleaned or maintained, leading to unhygienic conditions. Unhygienic conditions may result in the spread of diseases and negatively impact the overall health of students and staff. Handwashing with soap is a critical hygiene practice that helps prevent the transmission of diseases. However, without access to clean water, students may face challenges in practising proper handwashing. Water insecurity limits the availability of water for handwashing, challenging maintenance of good hand hygiene and increasing the risk of infections.

4. Conclusion

It can be concluded that water security highly contributed to the status of sanitation that signifies the status of sanitation practices in the school communities. Availability, reliability, quality and quantity of water influenced toilet cleanliness, place of excretion, toilet flushing, hand washing and overall water utilisation in quantity. In addition, the association between water insecurity and poor sanitation practices in schools has significant implications for health and educational outcomes. Insufficient access to water and sanitation facilities increases the risk of waterborne diseases, resulting in increased absenteeism among students and teachers. Illnesses caused by inadequate sanitation practices can lead to decreased concentration, poor academic performance, and overall educational setbacks. Water insecurity and inadequate sanitation practices can also have psychological effects on students. The lack of clean water and sanitation facilities can create stress, discomfort, and a sense of insecurity. Students may feel embarrassed or stigmatised,

particularly in cases where privacy is compromised due to insufficient facilities. These psychological impacts can further hinder students' well-being and their ability to focus on their studies

5. Recommendations

To address water insecurity and sanitation problems, the following need to be done Water infrastructure in learning institutions should be installed and/or upgraded to ensure reliable access to clean and safe water which in turn address water insecurity issues, improve hygiene practices, and contribute to the overall health and well-being of students and staff. Robust monitoring and maintenance systems should be established to ensure the continuous functionality of water and sanitation facilities. Water conservation strategies should be implemented in learning institutions to minimise water wastage. The sanitation facilities in learning institutions should be improved by constructing and maintaining functional toilets, handwashing stations, and waste management systems. Facilities should be accessible, of the recommended latrine ratio which is 1: 25 for girls and 1:30 for boys in schools, gender-sensitive, and promote good hygiene practices. Hygiene education programs should be integrated into the curriculum to educate students about proper handwashing techniques, personal hygiene, and sanitation practices. Community engagement and participation should be fostered to address water insecurity and improve sanitation practices in learning institutions.

6. Conflict of Interest

There is no financial or non-financial conflict of interest.

7. Acknowledgement

I express my gratitude to the participants of this study, whose cooperation and involvement have provided the foundation for the empirical

findings of this study and to Dr. Norbert Ngowi for his supervision. No funds were obtained for this research.

8. Declarations of AI assisted tools

During preparation of this manuscript, ChatGPT (OpenAI) was used to assist with language editing, improving clarity, readability and refining the presentations of some sections. The author reviewed and verified all AI assisted content and take full responsibility for the accuracy, originality and interpretation and final content of the manuscript. No AI tool was used to generate, fabricate or manipulate research data, results or references.

9. Data availability

The datasets generated and analysed during current study are available from the author.

10. Author contribution declaration

The author (Msangi G.S) conceived and designed the work. The author performed data collection, analysis and interpretation of findings. The manuscript was drafted and critically revised by the author. The author approves the final version of the manuscript and accepts responsibility for the work.

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