ASSOCIATION BETWEEN WATER QUALITY, SANITATION AND HYGIENE ON DIARRHOEA CASES IN KOROGWE DISTRICT, TANGA, TANZANIA

Halfan R. Mkongo, (BscES)

Master of Public Health

Muhimbili University of Health and Allied Sciences

October, 2021

Muhimbili University of Health and Allied Sciences

Development of Development Studies

School of Public Health and Social Sciences

ASSOCIATION BETWEEN WATER QUALITY, SANITATION AND HYGIENE ON DIARRHOEA CASES IN KOROGWE DISTRICT, TANGA, TANZANIA

By

Halfan R. Mkongo, (BscES)

A dissertation Submitted in (Partial) Fulfilment of the Requirements for the Degree of Master of Public Health of
Muhimbili University of Health and Allied Sciences
October, 2021

CERTIFICATION

The undersigned certify that has read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences thesis/dissertation entitled, ***"Association between water quality, sanitation and hygiene on diarrhoea cases in Korogwe District, Tanga, Tanzania"*** in fulfilment of the requirements for the degree of Master of Public Health (Regular Track) of Muhimbili University of Health and Allied Sciences

_____

Dr. Hussein Mohamed

(Supervisor)

_____

Date

DECLARATION AND COPYRIGHT

I, Halfan Mkongo, declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award

Signature……. **Date**……

ACKNOWLEDGEMENTS

I thank God for giving me good health and strength to accomplish this research work. I would like to thank all academic staff of the School of Public Health and Social Sciences; their contribution and assistance was wonderful in making this dissertation possible.

Special thanks go to Dr. Hussein Mohamed, my supervisor for his tireless support in providing constructive guidance and encouragement from the preparation to the final stage of dissertation.

I am also grateful to my entire colleagues MPH cohort (2020/2021) with special recognition of Dr, Samwel Daniel who in one way or another supported and inspired me throughout the year of study.

Endless gratitude to my family who made this academic journey possible, their support can never be explained. Also, I lastly thank The Director Korogwe Town Council together with his team for a wonderful cooperation during the field work.

DEDICATION

This dissertation is dedicated to my loving family for the kind and support. My parents Mr. Ramadhan Yahya Mkongo and Mrs. Hidaya Mohamed. My brothers Dr. Mohamed Mkongo, Adnan Mkongo and Yahya Mkongo. Without you all this could have not been completed, Thank you so much.

ABSTRACT

Introduction: High risk water, sanitation, and hygiene (WASH) are still prevailing in most low-income countries and globally. Limited access to WASH and low knowledge on their proper practice within households and in the societies highly expose people especially children under five years to diarrheal diseases.

Objectives: This study determined water quality, sanitation and hygiene in selected households in Korogwe urban district and their association to diarrhea cases among children under five years.

Methodology: A cross sectional study focused mainly on under-fives in selected households and included caregivers who were interviewed using structured questionnaire to gather information regarding to prevalence of diarrhea cases among their children, sociodemographic characteristics, drinking water factors and sanitation status. Observation checklist on hygiene factors and types of sanitation facilities. Water samples from main water sources were collected and taken to the laboratory for analysis (fecal coliform) by membrane filtration technique. Statistical data analysis was done using STATA version 15, univariate analysis, and bivariate analysis using Chi-square and multiple logistic regression.

Results: A total of 318 child/caregiver pairs were recruited in the study.51.9% of children aged 25-48 months and 53.8% male and 47.2% female. 94.5% of caregivers were biological mothers and 32.4% of them had 30-34 years, 96.5% were married and mostly had primary education. 58.8% of the households comprised of more than 6 members and 55.3% below 200,000Tsh income per month. The independent predictors of diarrhea cases among children under five were sources of drinking water, spring (AOR=0.23:95% CI, p-value 0.019) and (AOR=0.33, p-value=0.043) river-domestic point compared to treated water sources users. Absence of handwashing facilities (AOR=3.6:95% CI, p-value 0.04), not storing drinking water separately (AOR=5.4:95%CI, p-value 0.00) and absence of toilet cleaning tools (AOR=4.2:95%CI, p-value 0.002).

Conclusion and Recommendations: Drinking water sources, not separating drinking water from water for other domestic purposes, lacking handwashing facilities and poor toilet hygiene were significant factors for diarrhea among children under five in the households. Therefore, increasing awareness community and WASH promotion for behavior change is recommended on the water source selection, routine toilet cleaning and having a handwashing facility in the household so as to prevent childhood diarrhea

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABREVIATIONS

MUCHALI	Mfumo wa Uchambuzi wa Uhakika wa Chakula na Lishe
MDG	Millennium Development Goals
SDG	Sustainable Development Goals
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
WASH	Water Sanitation and Hygiene
WHO	World Health Organization

DEFINITION OF KEY TERMS

Terms	Definition
Diarrhea	A condition in which stool or faeces are discharged from the bowels frequently at least three times in 24hours and in liquid/ watery form.(Ayalew *et al.*, 2018)
Sanitation	Refers to provision of facilities and services for the safe disposal of human urine and faeces (Adane *et al.*, 2017).
Hygiene	Refers to practices of using soap with water, alcohol sanitizers to wash hands after using the toilet, before preparing and or eating food (Horng *et al.*, 2016).
Protected water source	Water sources which are properly constructed with masonry or covered by stonework, concrete or other materials that prevent the entry of physical, chemical and biological contaminants (Feleke, Medhin and Asrat, 2018).
Unprotected water source	Are those with no barrier or other structure to protect the water from contamination: lakes, rivers and streams or poorly constructed wells (Feleke, Medhin and Asrat, 2018).
Water quality	Refers to the chemical, physical and biological characteristics of water based on the standards of its usage (Daud *et al.*, 2017).
Improved sanitation facility	Flush toilets and pit latrines using the flush/pour-flush method that are connected to either a sewer or a septic system, ventilated improved pit latrines, and pit latrines with slab and composting toilet (Adane *et al.*, 2017).
Unimproved sanitation facility	Pit latrines without a slab, flush/pour-flush method connected to either a sewer or a septic system or shared sanitation facilities with more than one household (Adane *et al.*, 2017).

Waterborne diseases	Are any illness caused by drinking water contaminated by human or animal faeces, which contain pathogenic microorganisms (Butt and Khair, 2014).

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Diarrhea is both a waterborne as well as a water-washed disease. Diarrhea can be caused by ingesting water contaminated with human and animal feces which contain pathogenic agents or ingesting these pathogens directly through various fecal-oral pathways (Metrics, 2021). About 1.6 million people die of diarrheal diseases in a year globally. The highest death rates are in Sub Saharan Africa and South Asia ranges from 50 to 150 per 100,000 (Dadonaite, Ritchie and Roser, 2021). Diarrheal diseases are among the top five cause of childhood illness among children under five years of age with prevalence of 12% (TDHS-MIS) (2015-2016). According to the latest WHO data published in 2018, diarrheal diseases deaths in Tanzania reached 30,859 or 8.4% of total deaths. The age adjusted death rate is 85.37 per 100,000 of population ranks Tanzania number 22 in the world (Causes and Death, 2021).

Waterborne diseases are critical public health concerns in developing countries, close to a billion people most living in the developing world lack access to safe and adequate water (Kaoje *et al.,* 2019). Limited access to improved water from a protected water source like a borehole, well or municipal piped supply forces people to rely on unprotected sources such as surface water, contaminated wells or street vendors selling water of low quality (Bain *et al.*, 2018). Inadequate water supply also limits good hygiene practices, such as washing hands in critical times (Mshida *et al.*, 2017). Practice of handwashing with soap, is a mechanism to improve household health and therefore expect to be negatively associate to diarrhea incidence (Muhammed, 2016). However, people might have the knowledge and good hygiene behaviors but lack soap, safe water and washing facilities (Mshida *et al.*, 2017).

Improved sanitation facilities that hygienically separate human excreta and other wastes from human contact are important in securing people's health (Adane *et al.,* 2017). Without proper sanitation people find no choice than to use inadequate sanitation

facilities like communal latrines or open defecation practices (Mshida *et al.*, 2020). Improper sanitation exposes faeces immediately to the environment which is easily transferred back into people's food and water resources (Escamilla *et al.*, 2013).

Inadequate drinking water and sanitation are associated with considerable risks for diarrheal disease (Luby *et al.*, 2015). Poor practice of handling and treatment of drinking water, poor hand washing practices and inconsistent use of the toilet are associated with the occurrence of childhood diarrhea. A study done in India reported that safe child stool disposal is associated with decreased child diarrhea incidences by more than 23% (Majorin *et al.*, 2019).

Protection of water from contamination of microorganisms is a serious problem for water supply organizations around the world (Heitzinger *et al.*, 2015). Despite the fact that great success has been achieved in the field of water purification, cryptosporidium and giardia remain the two most important water pathogens (Id *et al.*, 2018). The majority of the confirmed cases from laboratory comes from the high-income countries. For instance, in the USA, 411,041 cases of outbreaks caused by Cryptosporidium and Giardia associated with drinking water were registered for 1990–2012 (Perkins and Trimmier, 2017).

1.2 PROBLEM STATEMENT

Worldwide, about 2.2 billion people still lack access to safe water. More than half of the global population does not have access to safe sanitation. Three billion people do not have access to handwashing facilities with soap and about 673 million people practice open defecation (UNICEF, 2019). In Tanzania an average of only 57% of households have access to safe drinking water, and 25% have safely managed sanitation services (Maduka, 2021)

In Korogwe district 80% obtain water from protected water sources (MUCHALI, 2017). Despite having this high coverage of people who obtain water from protected water sources and use sanitation facilities/toilets, diarrheal diseases still are a problem among households in Korogwe district. Prevalence of diarrhea among children 6-59 months in Korogwe district is 22.4% (MUCHALI, 2017). In cholera outbreak of 2019, 17 cases were reported from Tanga region and 9 cases were from Korogwe district (WHO, 2019).

The quality of water from river Pangani which is the source of water for some communities in Korogwe district is poor as it was confirmed to have significant higher number of *V. cholerae* (Temba *et al.*, 2018). However, microbial quality of water from other main sources such as wells, streams and other sources is not known. Moreover, little is known on household's sanitation status especially the type of toilets people use and their hygiene factors such as hand washing practices which can influence the occurrence of diarrhea cases in Korogwe district whereby children under five is the most affected group.

Studies have reported a correlation between WASH practices and diarrheal diseases (Oloruntoba, Folarin and Ayede, 2014), (Kaoje *et al.*, 2019). However, there are no studies that link water, sanitation and hygiene with diarrhea in Korogwe district despite having repeated outbreaks of diarrheal diseases. Therefore, this study intends to analyze the quality of water from the main sources, sanitation and hygiene and their association with diarrhea cases among children under-five ages in Korogwe urban district.

1.3 CONCEPTUAL FRAMEWORK

The conceptual framework (figure 1) shows the relationship between the study variables. Quality of water from the source and handling of drinking water, the use of unimproved toilet or open defecation expose faecal matter in the environment for flies to carry them in the households are potential risk factors for diarrhea. Also, lack of hand-washing facility with a soap predetermine poor handwashing practice especially in critical times like after using a toilet and before food preparation are associated with the incidence of diarrhea to under five children

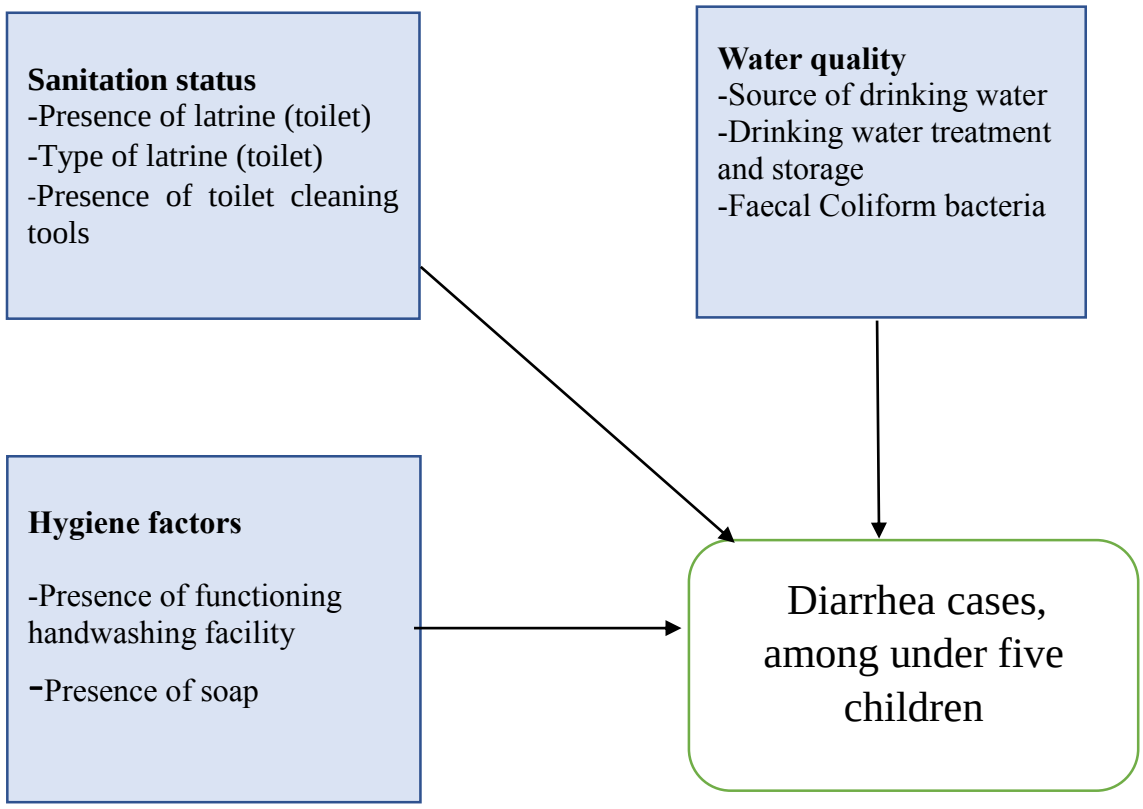

Figure 1: Conceptual framework (Source: Halfan, 2021)

1.4 Rationale

The findings of this study contribute in meeting SDG goal number 6 on ensuring clean water and sanitation by 2030. Enabling health and environmental sector to establish and strengthen the interventions and policies proper in reducing diarrhea prevalence in the population under study. Also, increase awareness to people in households on the proper WASH practices so as to reduce diarrheal diseases prevalence in Korogwe and other places lacking safe water and sanitation.

1.5 Research questions

1.5.1 Main research question

What is the association between water quality, sanitation and hygiene on diarrhea cases in Korogwe urban district?

1.5.2 Specific questions

1. What is the prevalence of diarrhea cases among children under five age in Korogwe urban district?
2. What is the association between household's sanitation status and diarrhea cases among children under five age in Korogwe urban district?
3. What is the association between household's hygiene factors and diarrhea cases among children under five age in Korogwe urban district?
4. What is the association between quality of water from the main sources and diarrhea cases among children under five age in Korogwe urban district?

1.6 Research Objectives

1.6.1 Broad Objective

To determine the association between water quality, sanitation and hygiene on diarrhea cases among children under five age in Korogwe urban district.

1.6.2 Specific Objectives

1. To determine the prevalence of diarrhea cases among children under five age in Korogwe urban district.

2. To determine household's sanitation status and its association to diarrhea cases among children under five age in Korogwe urban district.
3. To measure household's hygiene factors and their association to diarrhea cases among children under five age in Korogwe urban district.
4. To determine the association between quality of water from the main sources and diarrhea cases among children under five age in Korogwe urban district.

CHAPTER TWO

LITERATURE REVIEW

2.1 Prevalence of WASH related diarrheal diseases

According to World Health Organization (WHO) diarrheal diseases associated with WASH practices are estimated to be more than 25% (Neira and Prüss-Ustün, 2016). Diarrhea is one of the leading causes of child morbidity and mortality in low- and middle income countrie (Eshete *et al.*, 2020).The burden of diseases which are WASH related are more serious in low-income families (Kim, Cheong and Jeon, 2018).

2.2 WASH related diarrheal diseases

2.2.1 Cholera

Extreme diarrhea with rapid loss of body fluids. The causal agent for cholera is Vibrio cholerae, serovarieties O1 and O139 (Temba *et al.*, 2018). Cholera has been reported in 47 countries worldwide, and is most likely to affect the poor and most vulnerable populations, young children and older adults (Water, 2021). Provision of safe water and sanitation is important to prevent and control the transmission of cholera and other waterborne diseases. (WHO, 2021)

2.2.2 Typhoid fever

Bacterial disease spread by drinking or eating contaminated water or food, *Salmonella enterica subsp. enterica serovar Typhi* is the causative agent for typhoid fever (WHO, 2017). Poor personal hygiene at the household level and poor household water handling practices lead to high prevalence typhoid diseases (Osiemo, Ogendi and Erimba, 2019).

2.2.3 Diarrhea

The causative agents of diarrhea are *Escherichia coli*, particularly serotypes such as *O148, O157 and O1*. Diarrhea is the fifth leading cause of death among children under the age of 5 and about 88% are due to unsafe water (WHO, 2021).

2.3 WASH practices and their association to diarrhea

More than 884 million people globally have no safe water to drink and nearly 2.4 billion people lack access to basic sanitation facilities (WHO, 2021)**.** Open defecation is high in developing countries, at least 620 million people in India practice open defecation (Study, 2017). According to UNICEF more than half of Ethiopian household's in urban access improved drinking water and most of the population depend on unimproved water sources (Guo *et al.*, 2017). Factors that are significantly associated with childhood diarrhea are the number of under-five in the household, economic status, the main sources of drinking water, hand washing before water drawing from a storage container, water treatment, latrine use, domestic waste disposal site and use of soap for hand washing (Eshete *et al.*, 2020).

2.3.1 Sanitation and hygiene factors associated to diarrhea

Education level of the heads of the household has a strong association with the type of latrine the household owns (Mshida *et al.*, 2020). Low income settlements may diminish or reduce one's opportunities to quality, improved or adequate sanitation facilities (Mbuti Kimani *et al.*, 2019). Improvement in access to improved sanitation facility is one of the important contributors to accelerate the reduction of childhood diarrhea (Emina and Kandala, 2012). Contamination of water is potentially caused by livestock and human faeces that contaminate water sources, poor hygiene and sanitation practices (Mshida *et al.*, 2017).

The availability of water for anal and hand cleaning after using the toilet and presence of faeces on toilet floors are important factors that dispose under five children to diarrhea (Oloruntoba, Folarin and Ayede, 2014)**.** Also, children from households with regular cleaning of toilets/latrines are significantly better protected against diarrhea (Shrestha *et al.*, 2020). Inadequate sanitation factors such as presence of clogged drainage around the house and breeding places for flies near the house increase the risk of diarrhea among members in the households (Oloruntoba, Folarin and Ayede, 2014)**.**

2.3.2 Socio- demographic factors associated with WASH practices and childhood diarrhea

Households with stable economic status are better in hygienic practices and taking care of their children (Edwin and Azage, 2019). Occurrence of diarrhea is associated with child age of less than or equal to one, educational status of mother/guardians and breast feeding (Getachew *et al.*, 2018). Knowledge of WASH, age, education, and marital status are associated with engaging in proper WASH practices (Guo *et al.*, 2017).

Diarrhea diseases are major cause of mortality among young children in sub-Saharan Africa, West and Central Africa are top contributing to global childhood deaths caused by diarrhea diseases (Herrera *et al.*, 2017). In a study conducted in Uganda on exploring the geographic distributions of high-risk WASH practices (Hirai *et al.*, 2016), found that regions that are further away from Kampala have higher prevalence of WASH high risk practice than other regions. In Tanzania, variations in the prevalence of diarrhea in children between different place of residence are high in Kigoma, Rukwa, Mtwara and Mara Regions (Edwin and Azage, 2019).

2.3.3 Water quality factors associated with diarrhea among under five

The microbial quality of drinking water is inherently linked to poor sanitation practices. In areas where poor standards of hygiene and sanitation are practiced, fecal pathogens are the most common source of drinking water contamination (Wolf *et al.*, 2014). Reduction of total coliforms, E. coli and proper hygiene practices using the sources are important in protection of the water sources (Gwimbi, 2011). The best indicator of bacteriological quality of water is E. coli, easier to perform, available, affordable, fast, sensitive and specific (Osiemo, Ogendi and Erimba, 2019).

Life span of E. coli in water is short, thus it best determines the recently contaminations (Odonkor and Ampofo, 2013). The effect of point-of-use chlorine treatment significantly improves the quality of stored water in intervention households and also reduces the risk of diarrhea (Mengistie, Berhane and Worku, 2013).

Poor hygiene and sanitation practices are responsible for the fecal contamination of water obtained from shallow wells (Mengistie, Berhane and Worku, 2013). Contamination of drinking water supplies can occur in the source water as well as in the distribution system after water treatment has already occurred (Clasen *et al.*, 2007). Thus, drinking water quality interventions at the household level are to be effectively done to reduce diarrheal diseases (Adane *et al.*, 2017).

2.4 Techniques of water treatment and purification

2.4.1 Boiling

Water sources may provide water which is unsafe as it may contain parasites and germs things that may not see by bare eyes, their effects can be life threatening (Kinetico, 2020). Boiling water is the cheapest and safest method of water purification. It is widely used across the communities in Tanzania and it is found to improve microbial water quality with reduction in thermotolerant (TTC) coliform by 99.3% (Mohamed *et al.*, 2016).

2.4.2 Filtration

Use of chemical and physical processes to purify or remove unwanted compounds effectively from water making it safe for human consumption (Kinetico, 2020)

2.4.3 Chlorination

The use of chlorine as a chemical method to treat water for home consumption. A study conducted in Tanzania (Mohamed *et al.*, 2016) found that water guard improve microbial water quality by 99.4%.

CHAPTER THREE

METHODOLOGY

3.1 Study design

A cross-sectional design, a community survey and laboratory testing of water samples from the main water sources. Primary data on water, sanitation and hygiene in the households of selected wards in Korogwe were collected during survey and microbial water quality of water from the main sources was analyzed and how water quality from the sources, sanitation and hygiene associated with diarrhea cases among children under five age.

3.2 Study population

The study focused on children of under-five age and also included their caregivers in households of Korogwe urban district. The study was conducted in Korogwe urban district because the Town has been experiencing repeated waves of diarrheal diseases such as cholera with many cases compared to other districts in Tanga region despite the efforts made by the district authority through increasing the coverage of protected water sources such as boreholes, and treated pipe water from the Korogwe urban water supply and sanitation Authority (KUWASSA), together with campaigns of using toilets and handwashing that are available in the district.

3.3 Sample size and selection

Sample size was obtained using calculation formula, $n=z^2P(100-P)/\varepsilon^2$ (Naing, Winn and Rusli, 2006), n is minimum sample size, z=1.96, 95% C.I, P (22.4%), prevalence of diarrhea among children 6-59 months in Korogwe district(MUCHALI, 2017) and ε is margin of error(5%). 270, adjusting for non-response 15% (270/0.85) =318 pairs of child/caretakers in the households participated in the study. In the households with more than one under five children, one child was selected randomly**.**

Multistage sampling technique was used and simple random sampling in each stage to select 3 wards from 9 wards. Then simple random sampling (picking methods) was used

to select one street/village from each ward. Households with at least one child below five was selected randomly in the streets/villages to participate in the study.

3.3.1 Inclusion and exclusion criteria

Selected households with at least one under five child and a child's caretaker of above 18 years in Korogwe Town was included in the study and the household with under five children but without a respondent who is an adult during the survey was excluded.

3.4 Variables

The dependent variable is diarrhea cases, among under five children. The independent variables of this study included: drinking water treatment, handling and storage, microbial quality of water from the source, sanitation status, hygiene factors, social demographic characteristics; gender (caretaker), age (child and caretaker), education (caretaker), family size and income of the household

3.4.1 Measures of the variables

Dependent Variable

Diarrhea was measured by the participants reporting his/her child experiencing loose stools more than 3 times a day or frequently than usual within last one month.

Independent/predictor variables

The respondents mentioned the contaminated water source as their source of drinking water and not reported making it safer through methods like boiling or using chlorine (water guard) or use filtration, let it stand and settle were regarded as drinking unsafe water without any or proper treatment method. Sanitation status was measured by asking questions on their site of defecation, and those who reported no facility, bush, or river or not seen through observation were considered as practicing open defecation and also observation checklist on the type of sanitary facility the household use (improved/unimproved?). Sanitation status score was constructed by percentages of answers from the questionnaire and the observations around the household using improved and unimproved type of latrine or sanitation facility. Hygiene factors was scored by direct observation on soap presence and the availability of handwashing

facility. Presence was coded YES and absence NO. Socio-demographic characteristics through interviews and water quality data was obtained through microbial analysis of water samples from the main sources of water in a particular community in the water microbiology laboratory in Tanga Region.

3.5 Data collection methods

The instruments that were used to collect data are questionnaire, observation checklist and laboratory water analysis. Primary data including socio-demographics, sources of drinking water, water storage practices, water treatment techniques and sanitation status were collected using standard questionnaires (UNICEF, 2009). Child's caregivers were also asked about the encounters and experience of diarrhea among their children of under five years in the households. The Observational checklist was used to assess drinking water storage containers, presence of functional handwashing facility, presence of soap and type of sanitary facility. Reasons of not treating drinking water and choosing particular treatment techniques reported by the caregivers were recorded by analyzing the content corresponding to given reasons in the questionnaire

The samples of water were collected from the reported sources of water by the community and stored in the sterile 250ml water sampling glass bottles and stored in a cool environment to avoid contaminants from breaking down and transported to water quality laboratory in Tanga region for microbial water quality analysis immediately after sampling process. In the laboratory filtration unit and suction devices were assembled and the sterile membrane filter was placed on the filter base (grid-slide uppermost) using some sterile blunt-ended forceps to ensure that no air bubble was trapped under the membrane. Each water sample was suctioned through membrane filter manually and the filter paper was removed from the filtration unit and placed in a culture plate on the culture medium pad in a Petri dish agar which contain Endo agar medium that contained lactose, peptone, agar, anhydrous sodium sulphite etc. to allow the bacterial grow and develop. The dishes were labeled with a code number of the water sample and volume of the water used, and finally, the dishes were incubated at 44°C for about 22h. Faecal coliform bacteria presence was evident by blue purple dots (bacterial colonies) which

was observed under a microscope. The number of lactose fermenting colonies were counted and presented in colony forming units (cfu) per water volume filtered in ml (cfu/100ml) through the calculation formula: (colonies counted/sample volume filtered in mLx100). Then results data were recorded in the data extraction sheet.

3.6 Investigation tools and validity and reliability issues

The Swahili version of the structured questions questionnaire for interview were developed and pre-tested in the field to check if it was clearly understood by the study participants. The research assistant used this pre-testing as an opportunity to gain more interview skills. Then the tools were checked to see whether they were complete filled every day and whether they generate the intended data or information. The process of water analysis from sampling to the laboratory analysis ensured the adherence of water quality determination protocol for data quality assurance. Errors were noted in the pre-test and corrected before the actual data collection.

3.7 Data analysis plan

Data entry of the information from questionnaires, observation checklist and Laboratory results were entered into Microsoft Excel version 2013 by the principal investigator and one research assistant. Then data were imported into STATA version 15 from the Excel for statistical analysis. Univariate analysis: Categorical data were summarized using percentages and presented by pie charts and histogram for microbial water quality data. Bivariate analysis: Chi-square test was used as a statistical significance test to determine the association between sanitation status, hygiene factors and quality of water from the sources and diarrhea cases among children under five ages in the households. Multiple logistic regression for independent variables which were statistically significant associated to diarrhea in bivariate analysis.

3.8 Ethical Issues

Ethical approval for this study was obtained from Muhimbili University of Health and Allied sciences directorate of research and publications committee, with approval number MUHAS-REC-07-2021-748. Permission to conduct the research was obtained from The Director, Korogwe Town Council. Informed consent was obtained from the

household leaders. Respondents were not forced to answer the interview questions and also personal information of the respondents were kept confidential. The purpose of the research was to address the WASH practices among the households in Korogwe urban so as to contribute in reducing diarrhea cases from study area and in Tanzania generally. Respondents were respected as their rights and welfare were protected in order to minimize physical risks and psychological harm, risks and benefits from the study was fairly and evenly in the population.

CHAPTER FOUR

RESULTS

4.1 Univariate analysis

4.1.1 Socio-demographic factors of a child and caregivers

Table 1 shows the socio-demographic characteristics of study participants. Majority of children were 25-48 (month), 53.8% male and 47.2% female. 94.9% of caregivers were biological mothers and 5.1% were other caregivers. Majority of the caretakers were 30-34 age (32.4%), 95.6% were married with 55% primary education. The household's members were mostly above six (58.8%) and income below 200,000Tsh (monthly) 55%.

Table 1: Socio-demographic factors of a child and caretaker

Variable	Frequency	Percentage (%)
Caregiver relationship		
Biological mother	302	94.9
Other caregivers	16	5.1
Age of caregiver		
18-24	54	16.98
25-29	91	28.62
30-34	103	32.4
35-39	41	12.9
40+	29	9.12
Marital status		
Married	304	95.6
Single	11	3.46
Separated	3	0.94
Level of education		
Primary school	175	55.02
Secondary	128	40.26
College	15	4.72
Age of a child(month)		
6-24	128	40.25
25-48	165	51.9
49-59	25	7.86
Sex of child		
Male	171	53.8
Female	147	47.2
Number of household members	187	41.2
<6		
6 above	131	58.8
Household income(monthly)		
<200,000	176	55.35
200,000 to 500,000	111	34.90
>500,000	31	9.75

4.1.2 Prevalence of diarrhea

The prevalence of diarrhea among children under five years who experienced at least one episode of diarrhea in last 4 weeks in Korogwe town is 19.3%. This is the average of diarrhea prevalence of the three wards/street were the study was conducted. The specific prevalence of diarrhea for each study site were (28%) at Mgombezi ward which was the highest prevalence, Masuguru had (17%) and Kilole had the lowest prevalence of (13%).

4.2 Bivariate analysis

Association between household's sanitation status, hygiene factors and drinking water sources quality, handling and storage on diarrhea cases among households was analyzed using SPSS and the variables with P-value <0.05 were considered significantly related to the outcome (diarrhea), 95% CI. Odds ratio was used as the measure of association between the independent factors and the dependent factor.

4.2.1 Household's sanitation status factors associated with diarrhea cases

Table 2 below shows the variables of households' sanitation status and their association with diarrhea cases. Type of sanitation facility/toilet used by the households was a significant factor to diarrhea cases among under five children (P=0.00). Presence of toilet cleaning tools in households' toilets was also a significant factor to diarrhea cases (P=.00) whereby defecation site of the households was not associated to children under five diarrhea cases (P=0.05).

Table 2: Association between household's sanitation status and diarrhea cases among under five children

Sanitation status	**Diarrhea history**		**Odds ratio ((95% C.I)**	**P value**
	Yes(N%)	**No (N%)**		
Defecation site				0.50
Toilet	58(18.3)	258(81.7)	Reference	
Open defecation	0	2(100)	0.45(0.02,26.97)	
Type of sanitation facility				0.00
Improved	13(7)	168(93)	Reference	
Unimproved	45(33)	92(67)	6.3(3.1,13.4)	
Presence of toilet cleaning tools				0.00
Present	20(9)	196(91)	Reference	
Not present	38(37)	64(63)	5.8(3.03,11.30)	

4.3 Households hygiene factors associated to diarrhea among under five children

Table 3 below shows the association between household's hygiene factors on diarrhea cases. Absence of a functional handwashing facility in the households was statistically significant to diarrhea among under five children (P=0.01). Also, the absence of soap at the handwashing facility was statistically associated with diarrhea among under five children (P=0.045).

Table 3: Association between household's hygiene factors and diarrhea cases among under five children

Hygiene factors	Diarrhea history		Odds Ratio (95% CI)	P value
	Yes(N%)	No(N%)		
Presence of functional handwashing facility				0.01
Present	10(10)	90(90)	Reference	
Not present	48(22)	170(78)	2.54(1.19,5.89)	
Presence of soap for handwashing at the facility				0.045
Present	1	17(100)	Reference	
Not present	58(19)	243(81)	4.06(0.61,172.4)	

4.4 Drinking water sources quality, handling and storage factors associated with diarrhea cases among children under five years of ages

Households drinking water sources, quality of water from the sources, water treatment practices, water treatment technique, storing drinking water separately, type of container for storing drinking water, container for storing drinking water closure and means of drawing water from the container were significantly associated with diarrhea cases among children under five with P-value less than 0.05 (Table 4).

Table 4: Association between drinking water sources quality, handling and storage and diarrhea cases among children under five ages

Water Quality related factors	History of diarrhea		Odd Ratio (95% CI)	P value
	Yes (N%)	No (N%)		
Drinking water sources				0.02
River-domestic point	13(18)	59(82)	1.49(0.61,3.55)	
Open surface(spring)	7(50)	7(50)	6.75(1.73,25.46)	
Shallow well	10(21)	38(79)	1.78(0.66,4.58)	
Borehole	12(20)	48(80)	1.69(0.67,4.13)	
Tape(treated) water	16(13)	108(87)	Reference	
Quality of Drinking water from sources				0.09
Safe	16(13.5)	103(86.5)	Reference	
Contaminated	42(21.1)	157(78.9)	1.7(0.89,3.46)	
Treat drinking water				0.00
Yes	15(8)	173(92)	Reference	
No	43(33)	87(67)	5.7(2.90,11.6)	
Water treatment technique				0.04
Boiling	7(5)	133(95)	Reference	
Use chlorine (water guard)	0	10(100)	1.9(0.04,17.39)	
Filtering	6(16)	31(84)	3.68(0.94,13.68)	
Let it stand and settle	2(40)	3(60)	12(0.89,125.4)	
Store drinking water separately				0.00
Always	19(10.6)	160(89.4)	Reference	
Sometimes	23(19)	97(81)	1.99(0.98,4.09)	
No	16(84.2)	3(15.8)	44(11,252)	
Container for storing drinking water				0.07
Bucket with a lid	58(19)	246(81)	3.3(0.48,141.9)	
Pitcher	0	14(100)	Reference	
Container for storing drinking water closure				0.00
Closed	58(17.7)	258(82.3)	Reference	
Not closed	0	2(100)	0.45(0.02,26.9)	
Means of drawing water from the container				0.07
Use cup	58(1)	246(81)	3.3(0.48,141.9)	
Pour water directly from the container	0	14(100)	Reference	

4.5 Reasons for using the treatment technique

Respondents reported the reasons for choosing a treatment technique, 142(73.5%) respondents believed that the techniques they use was effective in treating drinking water while 50(26%) use treatment technique because it is cheap and 0.5% reported to use a technique because they do not know other

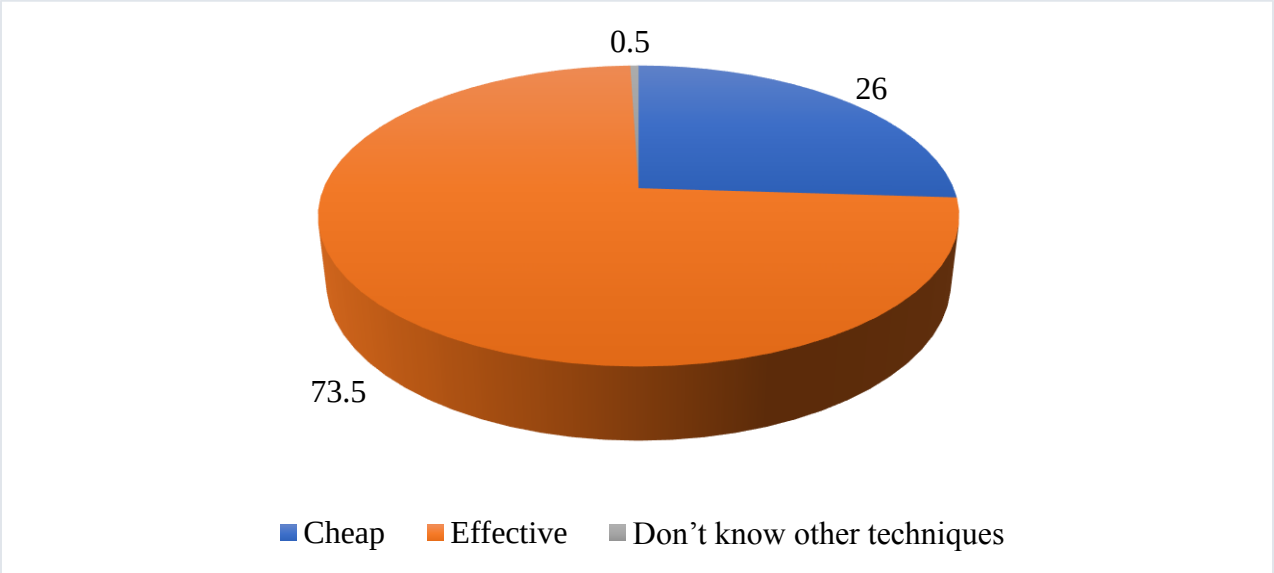

Figure 2: Reasons for choosing a water treatment technique

4.6 Reason for not treating drinking water

Respondents who reported not treating drinking water, 62(48%) believed that nothing happen to them when they drink untreated water, 53(41%) believed that water was safe from the source and 14(11%) reported not to treat drinking water due to bad smell of the treated water. (Figure 3)

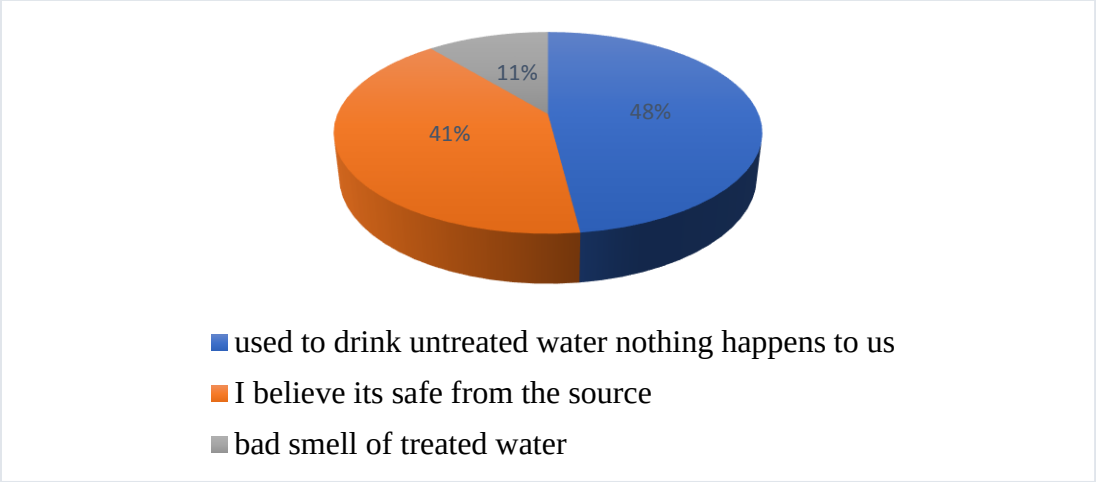

Figure 3: Reason for not treating drinking water

4.7 Source water quality

The laboratory analysis of water from five drinking water sources of in Korogwe Town are shown in Figure 4. River water from the domestic point at Kilole ward was the highest fecal contaminated source (417cfu/100ml) and the lowest contaminated was borehole at Masuguru(174cfu/100ml)

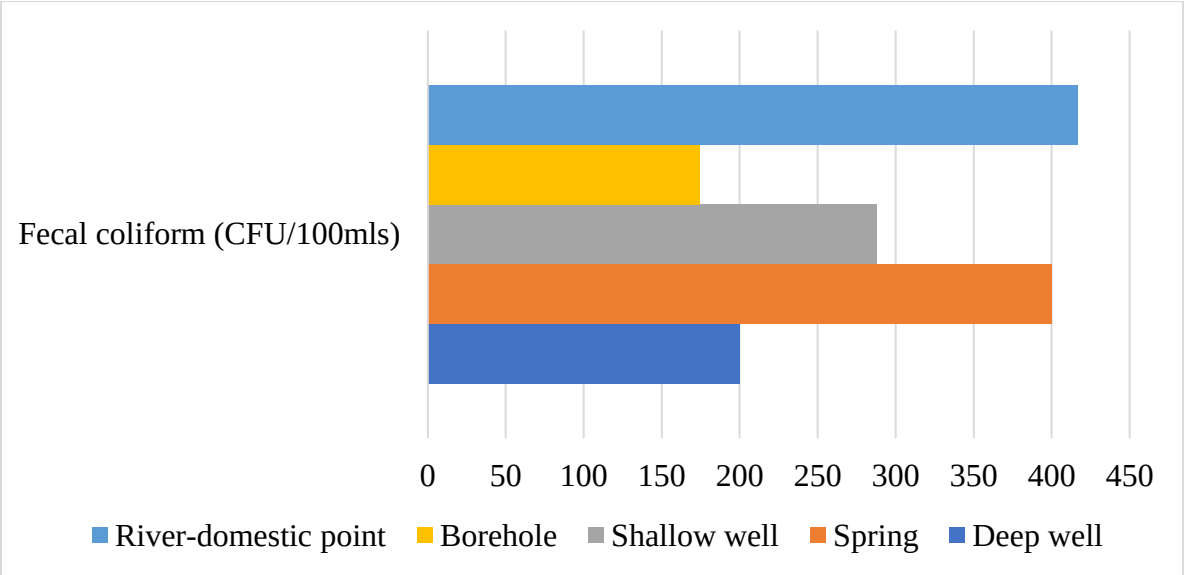

Figure 4: Laboratory results of quality of main drinking water sources

4.8 Multivariate analysis

Table 5 shows multiple logistic regression analysis results. Factors with p-value less than 0.2 in bivariate analysis were in-cooperated in the model. The analysis revealed some factors to be independent predictors or variables of diarrhea cases among under five children in the households although several variables were significantly associated with diarrhea in bivariate analysis, they lost their significance in multivariable analysis when adjusting for all probable confounders. Children whom their households reported river (domestic point) as their main source of drinking water were 76% more likely to experience diarrhea compared to those using treated (piped) water (AOR=0.23, P-value= .019). Also, children whom their caretakers reported to use spring as their main source of drinking water were 66% more likely to experience diarrhea compared to those who use treated water (AOR=0.33, P-value=0.043). Children in the households who reported not storing drinking water separately from the water for other purposes had five times higher odds of experiencing diarrhea (AOR=5.4,95% CI, p-value 0.00) compared to those who always store drinking water separately. The households which handwashing facilities were not present from the observation, their children had four times higher odds of experiencing diarrhea (AOR=3.6:95% CI, p-value 0.04) compared to those whom handwashing facilities were present. Children whom toilet cleaning tools were not present in their toilets had four times higher odds of experiencing diarrhea (AOR=4.2:95% CI, p-value 0.002) compared to those whom their toilets had toilet cleaning tools.

Table 5: Multiple logistic regression: Independent predictors of diarrhea cases among children under five in the households.

Variable	Adjusted OR (95%CI)	P-value
Drinking water source		
Shallow well	1.23(0.05,32.2)	0.89
Spring	0.33(0.11,0.81)	0.043*
River-domestic point	0.23(0.066,0.779)	0.019*
Borehole	0.28(0.069,1.146)	0.077
Treated-piped water	Reference	
Storing drinking water separately		
No	5.4(0.25,0.89)	0.00*
Sometimes	0.05(0.58,5.59)	0.58
Always	Reference	
Presence of handwashing facility		
Yes	Reference	
No	3.6(0.11,0.91)	0.04*
Presence of toilet cleaning tools		
Yes	Reference	
No	4.2(1.66,10.6)	0.002*

***Independent predictor of diarrhea cases. P<0.05, 95% CI**

CHAPTER FIVE

DISCUSSION

5.1 Prevalence of diarrhea among under five children in Korogwe Town District

This study shows a four weeks prevalence of diarrhea among under five children in Korogwe Town is 19.3%. The factors contributing to this prevalence are poor hygiene among children's caregivers especially poor handwashing practices, irregular cleaning of the toilets which lead to poor sanitation status of the households and majority of the sources of drinking water in Korogwe Town are fecal contaminated.

The prevalence of diarrhea in this study is high compared to 12% reported by Tanzania Demographic Survey (TDHS 2015-2016 and almost same to the study conducted in Debre Berhan Town(Shine *et al.*, 2020) 16.4% and that conducted in Longido Tanzania (Mshida *et al.*, 2017) 16%. The study survey conducted in Kilombero, Ulanga and Rufiji in Tanzania reported prevalence of 12% diarrhea in childhood within two weeks (Kanté *et al.*, 2015). This study revealed a relatively low prevalence of diarrhea compared to the survey by National Food Security and Nutritional Assessment (MUCHALI 2017) which covered the whole Korogwe District including Korogwe Rural and showed the prevalence of 22.4%.

5.2 Drinking water source quality, handling and storage factors associated with diarrhea cases among under five children

Main water sources for drinking had been found to be a dependent predictor of diarrhea cases among children under five in the households. Children from households with access to tap water had less odds of developing diarrhea compared to children from households using spring and river-domestic point water sources for drinking purposes. This is due to the reason that the sources other than tap water from the Authority are contaminated with fecal materials. The laboratory results for water sources analysis showed high contamination on the river-domestic point and spring, 417cfu/100ml and 400cfu/100ml fecal coliform respectively. Possible sources for this high contamination in this community sources could be sharing water sources with livestock, the animal faeces were seen all around the spring and the shallow wells, open defecation and the closer proximity

to households latrines (Escamilla *et al.*, 2013). Also, deeping objects inside the water source during drawing water could be a source of this contamination especially when these objects are not cleaned regularly. Such unsanitary practices may increase chances of surface water contamination especially during rainy season (Kraay *et al.*, 2020). Surface water and open water sources that sources for drinking water especially in the villages can be treated using chlorine (Brown *et al.*, 2014) to reduce the level of pathogens in the water sources. These unprotected water sources are not safe for drinking purposes and can be the source for waterborne diseases, it was noted from this study that more than 60% of the households in Korogwe Town use surface water and open wells as their main sources of drinking water. These findings are in line with the study conducted in Ethiopia (Eshete *et al.*, 2020) and in Monduli Tanzania (Mshida *et al.*, 2017). However, a study conducted in southwest Ethiopia (Gebru, Taha and Kassahun, 2014) did not find a significant association of diarrhea cases and drinking water sources. Although, unprotected water sources have higher chances of fetching germs from the intruding animals or from running water carrying waste matters.

The children whose caretakers reported not always separate drinking water storage had 5.4 times higher odds of experiencing diarrhea compared to those whose caretakers always separate drinking water in storage containers. This unhygienic storage of drinking water exposes children to experience diarrhea more likely than those storing drinking water separately from water for other domestic purposes because having no specific container for storing drinking water in the households exposes the children to contaminated water since the containers will be not regularly cleaned and also being contaminated through fetching by deeping fingers ones the used item has a short or no handle may contaminate water during washing and other domestic purposes.

Other studies also show association between hygienic storage of drinking water in the household with childhood diarrhea (Health, 2018).

5.3 Household's Sanitation Status associated with diarrhea cases among under five children

This study showed the presence of toilet cleaning tools is an independent predictor to diarrhea cases among children under-fives. Children from the households which were observed not to have toilet cleaning tools inside their toilets had four times higher odds of experiencing at least one episode of diarrhea in the past one month compared to those whom their toilets were observed to have toilet cleaning tools inside the toilet. Presence of faeces on the toilets floor has an association with childhood diarrhea. Presence of toilet cleaning tools determines regular cleaning of the toilets to prevent faeces and other dirty materials from coming into contact with the household's foods through flies influence the occurrence of diarrhea among under five children (Adane *et al.,* 2017). Sharing of sanitation facilities due to higher number of households members (six or more) sharing one sanitation facility and the widespread use of unimproved sanitation facilities tend to be inversely related to the cleanliness of the sanitation facilities (Simiyu *et al.*, 2017). The proportion of households practicing open defecation in this study was relatively low and not a risk factor in diarrhea cases. Although (Nataro *et al.,* 2016) a multicenter study in Kenya reported that practicing open defecation was a risk factor for moderate to severe diarrhea and having a latrine and proper use of it in the household were found to reduce the occurrence of diarrhea among children under five (Ayalew *et al.,* 2018).

5.4 Household's hygiene factors associated with diarrhea cases among under five children

Children living in households without hand washing facilities were 3.6 times higher odds to develop childhood diarrhea compared to households with hand washing facilities. This may be due to the fact that presence of a hand washing facility pre-determine the handwashing practices of the mothers/caretakers (Eshete *et al.,* 2020). Mothers/caretakers who do not wash their hands effectively using soap after using the toilet and before preparing or feeding their children expose the children to the fecal matters and microorganisms that cause diarrhea diseases(Nataro *et al.,* 2016). This finding is also in line with the study done in Bahir (Dagnew *et al.,* 2019).

5.5 Strength and limitation and mitigation

The study showed factors that have an association with diarrhea among under-fives in the households. The study also used multiple methods of data collection like on-site observation using a checklist, questionnaire and laboratory analysis of water sources quality. In addition, the data collection tools were pretested before the actual data collection to assure the collection of intended data. As limitation, recall bias might have led to underreporting and misreporting of information since diarrhea prevalence and morbidity reported by the children caretakers depended on the ability to correctly ascertain and understand the meaning of diarrhea. The researcher had to clarify the meaning of diarrhea to enable caregivers understand what is referred by diarrhea. Also, the study based on the period of past four weeks before survey that reduced recall bias. Beliefs among the household's members also affected the cooperation during the study, to minimize this the survey had to include the village leader who ensured their safety and freedom to participate in the study.

CHAPTER SIX

CONCLUSSION AND RECOMMENDATION

6.1 CONCLUSSION

The prevalence of diarrhea among under five children in Korogwe Town is relatively high. It is pulled by the prevalence of the village in Mgombezi ward which had 28% which is not supplied with treated (piped) water. The borehole in the village is not used, the used water sources are contaminated. Unimproved and improper use of toilets and poor handwashing behavior among caretakers are among the factors to the high prevalence in Korogwe Town.

Open defecation in Korogwe Town is relatively low, most of households use toilets. Although the type and designs mostly used are pit latrines which have challenges in terms of filling and smell. Irregular cleaning of the toilets may attract flies who then carry fecal materials inside the households and contaminate foods.

Presence of handwashing facility in the household especially near the toilet and kitchen significantly increase handwashing behavior among caretakers. Expanding the coverage and accessibility of treated (piped) water and protected water sources has greater effect to reduce the risk of diarrheal diseases.

6.2 RECOMMENDATION

In order to reduce the prevalence of diarrhea and improve child health, attention should be given to improving caregivers hand hygiene practices, toilets hygiene and drinking water purification. Regular cleanliness of toilets should be highly emphasized in the households and provide treated water (piped water) to the communities where the service is not provided. The protected boreholes and wells also have to be built and maintained so that people could not rely on open water bodies.

Environmental Health Officers (EHO) should emphasize hygiene behavior on hand washing, proper storage and handling of drinking water and prevention of water sources. This can be achieved through educational programs, meetings and house to house visit. Government should formulate and enforce policies that focus on emphasizing households use of pit latrine design standards and functional handwashing facility in households. Financial support to urban poor should be encouraged through investing in improving their living conditions to reduce their risks to diarrhea diseases. Also, government through the Ministry of water together with the responsible Authorities such as Korogwe Urban Water Supply and Sanitation Authority (KUWASSA), should expand the distribution of treated water to cover the whole Town in order to reduce the use of contaminated drinking water sources.

Further research should be conducted in the same area water sources to find out whether they contain specific cholera bacteria and if they are the source of the waves of cholera in Korogwe Town rather than the already known source river Pangani.

REFERENCES

Metadel Adane, Bezatu Mengistie, Helmut Kloos, Girmay Medhin, Worku Mulat (2017) 'Sanitation facilities , hygienic conditions , and prevalence of acute diarrhea among under- five children in slums of Addis Ababa , Ethiopia : Baseline survey of a longitudinal study', pp. 1–18.

Ayalew,Worku Tefera Mekonnen, Samson Wakuma Abaya and Zeleke Abebaw Mekonnen (2018) 'Assessment of diarrhea and its associated factors in under-five children among open defecation and open defecation-free rural settings of Dangla District, Northwest Ethiopia', *Journal of Environmental and Public Health*, 2018. doi: 10.1155/2018/4271915.

Bain Robert, Richard Johnston, Francesco Mitis (2018) 'Establishing sustainable development goal baselines for household drinking water, sanitation and hygiene services', *Water (Switzerland)*, 10(12). doi: 10.3390/w10121711.

Hussein Mohamed, Joe Brown;Rober Njee; Thomas Clasen; Hamisi Malebo; Steven Mbuligwe (2014) 'Point-of-use chlorination of turbid water : Results from a field study in', (August). doi: 10.2166/wh.2014.001.

Butt, Syed Muhammad Khair (2014) 'Cost of Illness of Water-borne Diseases : A Case Study of Quetta', *J. App. Em. Sc*, 5(2), pp. 133–143. doi: journal.buitms.edu.pk/j/index.php/bj/article/download/144/128.

Clasen Thomas (2007) 'Interventions to improve water quality for preventing diarrhoea: Systematic review and meta-analysis', *British Medical Journal*, 334(7597), pp. 782–785. doi: 10.1136/bmj.39118.489931.BE.

Dadonaite, B., Ritchie, H. and Roser, M. (2021) 'Diarrheal diseases', (November 2019), pp. 1–24.

Dagnew Amare (2019) 'Prevalence of diarrhea and associated factors among under-five children in Bahir Dar city , Northwest Ethiopia , 2016 : a cross-sectional study',

pp. 3–9.

Daud Khan, Shafaqat Ally (2017) ‘Drinking Water Quality Status and Contamination in Pakistan’, 2017. BioMed Research International. https://doi.org/10.1155/2017/7908183

Edwin Paul (2019) ‘Geographical Variations and Factors Associated with Childhood Diarrhea in Tanzania: A National Population Based Survey 2015-16’, *Ethiopian journal of health sciences*, 29(4), pp. 513–524. doi: 10.4314/ejhs.v29i4.13.

Emina Jacques and Kandala Ngianga (2012) ‘Accounting for recent trends in the prevalence of diarrhoea in the Democratic Republic of Congo (DRC): Results from consecutive cross-sectional surveys’, *BMJ Open*, 2(6), pp. 1–7. doi: 10.1136/bmjopen-2012-001930.

Escamilla Veronica (2013) ‘Influence of Latrine Proximity and Type on Tube well Water Quality and Diarrheal Disease in Bangladesh’, 103(March).

Eshete Negasa (2020) ‘Association between microbial water quality , sanitation and hygiene practices and childhood diarrhea in Kersa and Omo Nada districts of Jimma Zone , Ethiopia’, 396, pp. 1–17. doi: 10.1371/journal.pone.0229303.

Feleke Hailemariam (2018) ‘Household-stored drinking water quality among households of under-five children with and without acute diarrhea in towns of Wegera District , in North Gondar , Northwest’.

Gebru, Teklemichael,.Taha Mohamed (2014) ‘Risk factors of diarrhoeal disease in under-five children among health extension model and non-model families in Sheko district rural community, Southwest Ethiopia: Comparative cross-sectional study’, *BMC Public Health*, 14(1), pp. 1–6. doi: 10.1186/1471-2458-14-395.

Getachew Atalay (2018) ‘Diarrhea Prevalence and Sociodemographic Factors among Under-Five Children in Rural Areas of North Gondar Zone , Northwest Ethiopia’,

2018.

Guo Army (2017) ‘Water, sanitation, and hygiene in rural health-care facilities: a cross-sectional study in Ethiopia, Kenya, Mozambique, Rwanda, Uganda, and Zambia’, *American Journal of Tropical Medicine and Hygiene*, 97(4), pp. 1033–1042. doi: 10.4269/ajtmh.17-0208.

Gwimbi, Patrick (2011) ‘The microbial quality of drinking water in Manonyane community : Maseru District (Lesotho)’, 11(3).

Health (2018) ‘Diarrheal status and associated factors in under five years old children in relation to implemented and unimplemented community-led total sanitation and hygiene in Yaya Gulele in 2017’, pp. 109–121.

Heitzinger, Kristen (2015) ‘Improved but not necessarily safe: An assessment of fecal contamination of household drinking water in rural Peru’, *American Journal of Tropical Medicine and Hygiene*, 93(3), pp. 501–508. doi: 10.4269/ajtmh.14-0802.

Herrera, Diego (2017) ‘Upstream watershed condition predicts rural children’s health across 35 developing countries’, *Nature Communications*, 8(1). doi: 10.1038/s41467-017-00775-2.

Hirai, Mitsuaki (2016) ‘Exploring geographic distributions of high-risk water, sanitation, and hygiene practices and their association with child diarrhea in Uganda’, *Global Health Action*, 9(1). doi: 10.3402/gha.v9.32833.

Horng, Lin (2016) ‘Healthcare worker and family caregiver hand hygiene in Bangladeshi healthcare facilities: results from the Bangladesh National Hygiene Baseline Survey’, *Journal of Hospital Infection*, 94(3), pp. 286–294. doi: 10.1016/j.jhin.2016.08.016.

Id, Alua Omarova (2018) ‘Protozoan Parasites in Drinking Water : A System Approach

for Improved Water , Sanitation and Hygiene in Developing Countries', pp. 1–18. doi: 10.3390/ijerph15030495.

Kanté, Almamy (2015) 'Childhood Illness Prevalence and Health Seeking Behavior Patterns in Rural Tanzania', pp. 1–12. doi: 10.1186/s12889-015-2264-6.

Kaoje, Amiru (2019) 'Drinking water quality , sanitation and hygiene practices in a rural community of Sokoto State , Nigeria', (January). doi: 10.5455/ijmsph.2019.0824324102018.

Kim, Jong-Hun (2018) 'Burden of disease attributable to inadequate drinking water, sanitation, and hygiene in Korea', *Journal of Korean Medical Science*, 33(46), pp. 1–12. doi: 10.3346/jkms.2018.33.e288.

Kinetico (2020) 'Methods to Purify Your Water'. Available at: https://www.schultzsoftwater.com/blog/4-methods-to-purify-your-water.

Kraay, Alicia (2020) '*Understanding the Impact of Rainfall on Diarrhea* : Testing the Concentration- Dilution Hypothesis Using a Systematic Review and Meta-Analysis', 128(December), pp. 1–16.

Luby, Stephen (2015) 'Microbiological contamination of drinking water associated with subsequent child diarrhea', *American Journal of Tropical Medicine and Hygiene*, 93(5), pp. 904–911. doi: 10.4269/ajtmh.15-0274.

Maduka, Mashala (2021) 'Water , sanitation and hygiene for all'. Water, Sanitation and Hygiene for All | News | Tanzania | U.S. Agency for International Development. pp. 2020–2021. https://www.usaid.gov/tanzania/news/water-sanitation-and-hygiene-all

Majorin, Fiona (2019) 'Determinants of disposal of child faeces in latrines in urban slums of Odisha, India: A cross-sectional study', *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 113(5), pp. 263–272. doi:

10.1093/trstmh/try142.

Mbuti Kimani (2019) 'Diarrhea Risk Factors Associated with Water, Sanitation and Hygiene Among the Under Five in Kasarani, Nairobi County', *Central African Journal of Public Health*, 5(6), p. 272. doi: 10.11648/j.cajph.20190506.18.

Mengistie, Bezaatu (2013) 'Household Water Chlorination Reduces Incidence of Diarrhea among Under-Five Children in Rural Ethiopia: A Cluster Randomized Controlled Trial', *PLoS ONE*, 8(10), pp. 1–7. doi: 10.1371/journal.pone.0077887.

Metrics, Health (2021) 'the Global Burden of Disease. Estimates of the global, regional, and national morbidity, mortality, and aetiologies of diarrhoea in 195 countries: a systematic analysis.

Mohamed, Hussein,. Thomas Clasen,. Robert Mussa Njee,. Hamisi Malebo,. Stephen Mbuligwe and Joe Brown (2016) 'Microbiological effectiveness of household water treatment technologies under field use conditions in rural Tanzania', *Tropical Medicine and International Health*, 21(1), pp. 33–40. doi: 10.1111/tmi.12628.

Mshida, Hoyce (2020) 'Sanitation and hygiene practices in small towns in Tanzania: The case of babati district, manyara region', *American Journal of Tropical Medicine and Hygiene*, 103(4), pp. 1726–1734. doi: 10.4269/ajtmh.19-0551.

Mshida, Hoyce (2017) 'Influence of Water, Sanitation, and Hygiene Practices on Common Infections among Under-Five Children in Longido and Monduli Districts of Arusha, Tanzania', *Journal of Environmental and Public Health*, 2017. doi: 10.1155/2017/9235168.

MUCHALI (2017) 'The united republic of Tanzania Comprehensive Food Security and Nutrition Assessment Report The Mfumo wa Uchambuzi wa Uhakika wa Chakula na Lishe (MUCHALI) Partners ii', (February).

Naing, Lin,. Winn, Than (2006) ‘Practical Issues in Calculating the Sample Size for Prevalence Studies’, *Archives of Orofacial Sciences*, 1, pp. 9–14. Available at: http://www.kck.usm.my/ppsg/stats_resources.htm.

Nataro, James (2016) ‘Sanitation and Hygiene-Specific Risk Factors for Moderate-to-Severe Diarrhea in Young Children in the Global Enteric Multicenter Study , 2007 – 2011 : Case-Control Study’, pp. 2007–2011. doi: 10.1371/journal.pmed.1002010.

Neira, Maria and Prüss-Ustün (2016) ‘Preventing disease through healthy environments: A global assessment of the environmental burden of disease’, *Toxicology Letters*, 259, p. S1. doi: 10.1016/j.toxlet.2016.07.028.

Odonkor, Stephen (2013) ‘Escherichia coli as an indicator of bacteriological quality of water : an overview Development of indicators : the’, 4(Table 1), pp. 5–11. doi: 10.4081/mr.2013.e2.

Oloruntoba, Elizabeth,. Folarin, Bukola (2014) ‘Hygiene and sanitation risk factors of diarrhoeal disease among under-five children in Ibadan , Nigeria’.

Osiemo, Mercy Mandela., Ogendi, George and Erimba, Chaeles (2019) ‘Microbial Quality of Drinking Water and Prevalence of Water-Related Diseases in Marigat Urban Centre , Kenya’. doi: 10.1177/1178630219836988.

Perkins, Allen. and Trimmier, Marirose (2017) ‘Recreational Waterborne Illnesses: Recognition, Treatment, and Prevention’, *American family physician*.

Shine, Sisay (2020) ‘Prevalence and associated factors of diarrhea among under-five children in Debre Berhan town, Ethiopia 2018: A cross sectional study’, *BMC Infectious Diseases*, 20(1). doi: 10.1186/s12879-020-4905-3.

Shrestha, Akina (2020) ‘Association of nutrition, water, sanitation and hygiene practices with children’s nutritional status, intestinal parasitic infections and diarrhoea in

rural Nepal: A cross-sectional study', *BMC Public Health*, 20(1), pp. 1–21. doi: 10.1186/s12889-020-09302-3.

Simiyu, Sheillah., Mark Swilling, Sandy Cairncross and Richard Rheingans (2017) 'Determinants of quality of shared sanitation facilities in informal settlements : case study of Kisumu , Kenya', *BMC Public Health*, pp. 1–13. doi: 10.1186/s12889-016-4009-6.

Study, Institute of Community Medicine (2017) 'WASH Practices-A Determinant of Gastrointestinal Community Health : A Journal of Gastrointestinal & OMICS International WASH Practices-A Determinant of Gastrointestinal Community Health : A Community Study from Rural Odisha , India', (May). doi: 10.4172/2161-069X.1000490.

Temba, David., Lucy Namkinga,. Sabrina Moyo,. Thomas, Lyimo and Charles, Lugomela (2018) 'Occurrence of pathogenic vibrio cholerae serogroups o1 and o139 in some estuaries of Tanzania', 44(1), pp. 145–158.

United Nations Children's Fund (2019) 'Water, sanitation and hygiene', pp. 37–41. doi: 10.18356/d77acec7-en.

Water, Global (2021) 'Disease Threats and Global WASH Killers : Cholera , Typhoid , and Other Waterborne Infections The Global Impact of Waterborne Infections and WASH-related Diseases', pp. 1–4.

World Health Organization (2019) 'EVD Preparedness , Cholera and Dengue Fever Update –'. Available at: http://old.tzdpg.or.tz/fileadmin/documents/dpg_internal/dpg_working_groups_clusters/cluster_2/health/DPG_H_Meeting_Documents_2019/3_.2_Final___EVD_PREP_OUTBREAK_RESPONSE_UPDATE_DPG_.pdf.

Wolf, Jennyfer (2014) 'Systematic review: Assessing the impact of drinking water and sanitation on diarrhoeal disease in low- and middle-income settings: Systematic

review and meta-regression', *Tropical Medicine and International Health*, 19(8), pp. 928–942. doi: 10.1111/tmi.12331.

APPENDICES AND ATTACHMENTS

Appendix I: Informed Consent English Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

DIRECTORATE OF RESEARCH AND PUBLICATIONS

CONSENT FORM

Form no: ……

Greetings,

I am Halfan R. Mkongo, student of Muhimbili University of Health and Allied Science pursuing Master of Public Health. I am conducting a research on ASSOCIATION OF WATER QUALITY, SANITATION AND HYGIENE ON DIARRHEA CASES IN KOROGWE DISTRICT, TANGA, TANZANIA a requirement for the Master's degree fulfilment.

Study title

ASSOCIATION OF WATER QUALITY, SANITATION AND HYGIENE ON DIARRHEA CASES IN KOROGWE DISTRICT, TANGA, TANZANIA

Purpose of the study

To determine water quality, sanitation status and hygiene practices in households and how they influence the prevalence of diarrhea cases in Korogwe Urban district.

Confidentiality

Respondents will not be forced to answer the interview questions and also personal information of the respondents will be confidential. Respondents will be respected as their rights and welfare will be protected in order to minimize physical risks and psychological harm, risks and benefits from this study will be fairly and evenly in the population.

Potential risk

There are no harm or risks associated with participating in this study.

Benefits

Participating in this study will give us an opportunity to know the quality of water from the main sources, sanitation status of the society and the hygiene level that may be the fundamental influence of the diarrhea cases in the Korogwe Urban district. The findings of this study will be useful in planning for more interventions in improving WASH practices in the community under study and other areas with similar context so that to prevent the occurrence of diarrheal diseases.

Rights of the participant

This study matter has been reviewed and allowed to be conducted by Institutional Review Board of Muhimbili University, with the aim of protecting the rights of participants. The participant has a right to withdraw from the study at any time. If a participant has a question or any concern on his/her rights as a participant in this study, should not hesitate to call and ask the principle investigator: Halfan Mkongo, Muhimbili University P.O Box, 65001, Dar es Salaam. (Contact 0746563526) or DR. Hussein Mohamed, who is the supervisor of this study (Contact: 0714217172).

Whom to Contact

In case of any question or query concerning this study, please contact the principal investigator, HALFAN MKONGO (MPH) from MUHAS, P. O. BOX 65001, Dar es Salaam, mobile number 0746563526. Also, you can contact Dr. HUSSEIN MOHAMMED (Supervisor), MUHAS P.O BOX 65001, Dar es salaam (Tel: 0714 217172) for more help and clarification.

CONSENT

I …….. have read the contents of this form and understood it, my questions have been adequately answered. I agree to participate in this study. Signature of participant……

Date…….

Signature of investigator…… Date……

Appendix II: Questionnaire

MUHIMBILI UNIVERSITY OF ALLIED HEALTH SCIENCES

QUESTIONNAIRE ON ASSESSMENT OF THE ASSOCIATION BETWEEN WATER QUALITY, SANITATION AND HYGIENE ON DIARRHEA CASES IN KOROGWE DISTRICT, TANGA, TANZANIA.

ID NO……. DATE OF INTERVIEW……

INTERVIEWER NAME…….

WARD…… VILLAGE……

INTERVIEW QUESTIONS

SECTION A: DEMOGRAPHIC CHARACTERISTICS

1. Status of the respondent
    a) Mother b) Grandmother c) Housemaid d) Father e) Other
2. Sex of the child a) Male b) Female
3. Age of the respondent (estimate allowed) …….
4. Age of the child…….
5. Marital status
    a) Single b) Married c) Separated d) Other
6. Level of education
    a) Primary b) Secondary c) College d) Non
7. How many people live in your household? ……..
8. Household income per Month
    a) Less than 200,000
    b) 200,000/= to 500,000/=
    c) More than 500,000/=

SECTION B: DRINKING WATER SOURCES, HANDLING AND STORAGE

1. What is the main source of drinking water in the household?
    a) Tape water
    b) Open surface (river, streams)

c) Well (Open, borehole)

d) Other

2. Do you do anything to make water safer to drink? YES ……. NO …….
3. If yes in (2) above what do you do to make water safer to drink?
    a) Boiling
    b) Use chlorine (water guard)
    c) Filtering
    d) Let it stand and settle
4. Why do you use this method for making drinking water safer?
    a) Cheap b) I don't know other methods c) The method is effective d) other reasons
5. If no in (2) above, why don't you treat water for drinking?
    a) Bad smell of treated water
    b) I believe it's safe from the source
    c) We are used to drink untreated water nothing happens to us
    d) Other reasons
6. Do you store water for drinking separately from water for other domestic purposes?
    a) Always b) Sometimes c) No
7. Which container do you use to store drinking water? (observe and write the answer)
    a) Bucket with a lid b) bucket without a lid c) Pitcher d) Other
8. How do you draw water from your container?
    a) Use small pan
    b) Use cup
    c) Pour water directly from the container
    d) Other

SECTION C: HOUESHOLDS SANITATION STATUS

1. Where do you go for defecation?
    a) Toilet
    b) Bush
    c) River

SECTION D: INCIDENCE OF DIARRHEA TO HOUSEHOLD MEMBERS

1. Has your child experienced diarrhea in the past one month? YES…. NO ….

Appendix III: Observation Checklist

MUHIMBILI UNIVERSITY OF ALLIED HEALTH SCIENCES

OBSERVATION CHECKLIST ON ASSESSMENT OF THE ASSOCIATION BETWEEN WATER QUALITY, SANITATION AND HYGIENE ON DIARRHEA CASES IN KOROGWE DISTRICT, TANGA, TANZANIA.

S/N	Observation	Results	Code
1.	Observe hand washing facility if present/not present	**YES**	**1**
		NO	**2**
2.	Observe presence of soap in the hand washing place	**YES**	**1**
		NO	**2**
3.	Observe type of sanitation facility (improved/unimproved?)	**YES**	**1**
		NO	**2**
4.	Observe presence of toilet cleaning tools	**YES**	**1**
		NO	**2**
5.	Observe the container for storing drinking water if closed/not closed	**YES**	**1**
		NO	**2**

Appendix IV: Microbial water quality determination protocol

Sampling

Materials

1. Rubber gloves
2. Sterile sample containers
3. Ice pack

Procedures

- Samples were taken in locations that are represetative of the water source and at the point of use
- All bottles were lebeled according to the name of the site of sample collection and the type of the water source
- The water samples were kept in a cool place

Sampling techniques

Tap water

1. Checked if there was any leaks from the tap.
2. Wore gloves.
3. Then water was opened fully to let it run for 2 minutes to allow clearing of the service line.
4. Reduce the flow and filled the bottle without splashing.
5. Then, the cap of the bottle was tightly closed and put in a cooler packs.

Reservoir and well water

1. Wore gloves.
2. Hold the closed bottle near its base and deep it below the surface.
3. Then, removed the top/cap and place the bottle neck points slightly upward and the mouth was directed towards the current. When there was no currents, it was created by pushing the bottle forwardaway from the hand.
4. Replace the cap before pulling the sample out.

5. Then, cap the bottle tighly.

Things considered when sampling the water sample

- The sample containers were not opened until just before taking the water sample
- Did not rinse the sample bottle prior to sampling
- The cap of the sterilized bottle was not placed down at any point neither came into contact with underside of the lid
- New rubber gloves were used on each sample
- The sample bottle was left with air space to facilitate mixing by shaking before examination
- The samples were delivered to the laboratory within 6 hours for analysis

Bacteriological water analysis

1. The microbes from the water samples were determined through membrane filtration, following the procedures
2. Suction devices were assembled and the sterile membrane filter was placed on the filter base (grid-slide uppermost) using some sterile blunt-ended forceps.
3. The 100ml of each water sample was mixed thoroughly and filtered through the membrane.
4. The filter paper was removed from the filtration unit and placed on the culture medium pad in a Petri dish containing malt agar medium. The dish was labeled with a code number of the water sample and volume of the water used.
5. Then, dishes were incubated at 37°C for 24h, the membranes were examined, and the number of yellow lactose fermenting colonies were counted and recorded.
6. Calculation was done using the formula: (colonies counted/sample volume filtered in mL) x100 and presented in cfu/100ml whereby cfu (colony forming unit)

Interpretation of bacteriological analysis results

The presence of bacteria organisms i.e coliform bacteria in the water sample, suggests that the supply may also contain the contaminant as well, therefore the water source is not suitable for human consumption such as drinking without proper water

treatment. Since specific disease-causing organisms are difficult to detect, the microbial quality is determined indirectly through counts of these indicator organisms.

Appendix IV: Fomu ya ridhaa.

CHUO KIKUU CHA AFYA NA SAYANSI SHIRIKISHI - MUHIMBILI.

KURUGENZI YA UTAFITI NA MACHAPISHO

Nambari ya utambulisho

Jina la Utafiti: Uhusiano wa ubora wa Maji, hali ya usafi wa mazingira katika kaya na kesi za kuhara katika wilaya ya Korogwe Mjini.

Jina la mtafiti: Halfan Mkongo

Jina la taasisi na anwani yake:

CHUO KIKUU CHA AFYA NA SAYANSI SHIRIKISHI - MUHIMBILI.

S.L.P 65001, DAR ES SALAAM, TANZANIA

Utangulizi

Fomu hii ina habari kuhusu jina la utafiti lililotajwa hapo awali. Ili uweze kujua habari muhimu zinazohusu huu utafiti na kushiriki inakubidi uisome hii fomu kwa makini na kuielewa kabla ya kuisaini. Utaisaini mbele ya mdamini na kupewa nakala yako. Hii fomu inaweza kuwa na maneno magumu au hujayafahamu vyema tuulize ili upate maelezo ya kujitosheleza kabla ya kuisaini.

Madhumuni ya Utafiti

Utafiti huu una lengo la kutoa taarifa za Ubora wa maji ya vyanzo vya maji,hali ya usafi wa mazinngira katika kaya na jinsi vinavyohusiana na kesi za kuharisha katika wialya ya Korogwe Mjini.

Ushiriki.

Ukikubali kushiriki utajibu maswali utakayoulizwa na mtafiti moja baada ya linguine kwa muda utakaokutosha kujibu.

Usiri

Unahakikishiwa kwamba taarifa zote zitakazokusanywa kutoka kwako zitakua ni siri wala hakuna atakaye husishwa kwenye taarifa za utafiti, ni watu wanaofanya kazi katika utafiti huu tu ndio wanaweza kuziona taarifa hizi. Hatutaweka jina lako wala namba ya nyumba yako au taarifa yoyote ya utambulisho kwenye kumbukumbu za taarifa utakazotupa.

Madhara

Hatutarajii madhara yoyote kujitokeza pindi utakapo shiriki utafiti huu

Faida

Taarifa utakayotupatia itasaidia kuelewa na kujua ukubwa wa tatizo la kuharisha kwa Watoto hapa wilayani Korogwe na kujua hali hatarishi zinazohusiana na utokeaji wa kesi za kuhara ili kuweza kuzipunguza na hatimaye kuzuia kabisa utokeaji wa kesi hizi.

Haki zako za kushiriki

Utafiti huu ulishapitiwa na kukubaliwa na bodi ya ndani ya mapitisho ya chuo kikuu cha Muhimbili. Lengo ni kulinda haki za mshiriki. Mshiriki anahaki ya kujitoa katika ushiriki wake muda wowote. Iwapo mshiriki ana maswaIi kuhusu haki zake za ushiriki katika utafiti huu anaweza kuwasiliana na mratibu mkuu wa utafiti, Halfan Mkongo, Chuo Kikuu cha Muhimbili, S.L. P 65001, Dar es Salaam (Simu. Numbari 0746563526), au DR. Hussein Mohamed ambaye ni msimamizi wa utafiti huu (Simu nambari 0714217172).

Mshiriki kuridhia kushiriki utafiti

Hii fomu imeelezea faida, madhara na taratibu zote kuhusu huu utafiti nimesomewa na kuelezewa vya kutosha. Hivyo nimeekubali kushiriki kwa ridhaa yangu mwenyewe.

Tarehe..... Sahihi ya mshiriki.....

Iwapo mshirirki hajui kusoma hii fomu na kuielewa mwenyewe, hivyo basi mdamini ataisaini kwa niaba yake. Na atahitajika kuwepo wakati mshiriki anasomewa faida, madhara na taratibu za utafiti. Maswali yote yatajibiwa na hivyo kumtaka mshirirki kukubali kwa ridhaa yake kushirirki kwenye utafiti mbele ya mdamini.

Tarehe..... Sahihi ya mdamini .....

Ninathibitisha uhalisi na umuhimu, faida muhimu, madhara yanayoweza kutokea kutokana nakushirikiki kwenye huu utafiti yameelezewa vya kutosha kwa washirirki wote.

Tarehe …… Sahihi ya mratibu utafiti msaidizi ……

Appendix V: Dodoso la utafiti

CHUO KIKUU CHA AFYA NA TIBA MUHIMBILI

KITIVO CHA SAYANSI YA AFYA YA JAMII

DODOSO LA UTAFITI WA SABABU ZAUGONJWA WA KUHARISHA KWA WATOTO CHINI YA MIAKA MITANO KWA KUANGALIA HALI YA UBORA WA MAJI YA VYANZO VIKUU VYA MAJI, HALI YA USAFI WA MAZINGIRA NA WAKAZI KATIKA KATA WILAYANI KOROGWE MJINI

NAMBA……. TAREHE YA MAHOJIANO…….

KIJIJI……. KATA…….

JINA LA MHOJAJI…….

SEHEMU YA KWANZA: TAARIFA BINAFSI

NA	MASWALI	MAJIBU
1	Mhojiwa (Chagua inayohusika)	a) Baba b) Mama c) Bibi d) Babu e) Mwingine
2.	Jinsi ya mtoto	a) Me b) Ke
3.	Umri (Unaweza kukadiria)	Miaka…….
4.	Umri wa mtoto	…….
5.	Hali ya ndoa	a) Ameoa/ameolewa b) Ameoa/Ameolewa c)Wameachana d) Nyingine

6.	Kiwango cha elimu	a) Shule ya msingi b) Secondary c) Chuo+	
7.	Unaishi na familia ya watu wangapi?		
8.	Wastani wa kipato nyumbani kwenu ni kiasi gani?	a) Chini ya 200,000/= b) Kwanzia 200,000/= mpaka 500,000/= c) Zaidi ya 500,000/=	
SEHEMU YA PILI: VYANZO VYA MAJI YA KUNYWA, UTHIBITI NA UHIFADHI			
1.	Chanzo chenu kikuu cha maji ya kunywa ni:	a) Maji ya bomba b) Kisima(wazi/kimefunikwa) c) Mto d) Chemchem e) Vingine	
2.	Huwa unatakatisha maji?	a) Ndio b) Hapana	
3.	Kama ndio(2),unatumia njia gani kutakatisha maji?	a) Kuchemsha b) Waterguard c) Chujio maalum/kitambaa d) Naacha yatulia e) Nyingine	
4.	Kwanini unatumia njia hiyo?	a) Ni nafuu b) Naiamini c) Sijui nyingine d) Sababu nyingine	
5.	Kama hapana (2) Kwanini hautakatishi maji yako yakunywa?	a) Harufu mbaya ya maji yaliyotakaswa	

		b) Naamini ni salama kutoka kwenye chanzo c) Nimekua nikinywa maji yasiyotakaswa bila matatizo yoyote d) Sababu nyingine	
6.	Unahifadhi maji ya kunywa tofauti na maji ya matumizi mengine?	a) Mara zote b) Mara chache c) No	
7.	Kifaa gani unatumia kutunzia maji ya kunywa?	a) Ndoo yenye mfuniko b) Ndoo isiyo na mfuniko c) Jagi d) Vingine	
8.	Huwa mnachukuaje maji yakunywa kutoka kwenye chombo yalikohifadhiwa?	a) Tunatumia kikombe b) Bakuli c) Tunamimina d) Nyingine	
SEHEMU YA TATU: HALI YA USAFI WA MAZINGIRA KATIKA KAYA			
1.	Mnaenda wapi kwaajili ya haja?	a) Choo b) Vichaka c) Mto d) Nyingine	
SEHEMU YA NNE: TAARIFA YA UTOKEAJI WA KUHARISHA KWA WATOTO CHINI YA MIAKA 5 KATIKA KAYA			
1.	Je, mwanao alipata kuharisha ndani ya mwezi mmoja uliopita?	a) Ndio b) Hapana	

CHUO KIKUU CHA AFYA NA TIBA MUHIMBILI

KITIVO CHA SAYANSI YA AFYA YA JAMII

ORODHA YA UCHUNGUZI WA SABABU ZA UGONJWA WA KUHARISHA KWA WATOTO CHINI YA MIAKA MITANO KWA KUANGALIA HALI YA UBORA WA MAJI YA VYANZO VIKUU VYA MAJI, HALI YA USAFI WA MAZINGIRA NA MAKAZI KATIKA KAYA WILAYANI KOROGWE MJINI

NYUMBA NAMBA……TAREHE YA MAHOJIANO…….

KIJIJI……. KATA…….

Na	Uchunguzi	Majibu	Alama
1.	Angalia kituo/mahali kwaajili ya kunawia mikono (Ipo/Haipo)	NDIO	1
		HAPANA	2
2.	Angalia sabuni kwaajili ya kunawia mikono katika kituo (Ipo/ haipo)	NDIO	1
		HAPANA	2
3.	Angalia aina ya choo (kilichoboreshwa/ kisichoboreshwa)	NDIO	1
		HAPANA	2
4.	Angalia vifaa vya kusafisha choo (vipo/havipo)	NDIO	1
		HAPANA	2
5.	Angalia chombo cha kuhifadhia maji ya kunywa (kimefunikwa/hakijafunikwa)	NDIO	1
		HAPANA	2

Appendix VI: Ethical clearance

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR - RESEARCH AND PUBLICATIONS

Ref. No.DA.282/298/01.C/ Date: 08/07/2021

MUHAS-REC-07-2021-748

Halfan R.Mkongo
MPH -School of Public Health and Social Sciences
MUHAS

RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED: ASSOCIATION BETWEEN WATER QUALITY, SANITATION AND HYGIENE ON DIARRHEA CASES IN KOROGWE DISTRICT, TANGA, TANZANIA.

Reference is made to the above heading.

I am pleased to inform you that the Chairman has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 08/07/2021
EXPIRATION DATE OF APPROVAL: 07/07/2022

STUDY DESCRIPTION:
Purpose:
The purpose of this cross sectional study is to determine quality of water from the main water sources, sanitation status and hygiene practices in households and how they associate to prevalence of diarrhea cases in Korogwe Urban district. Contribute in meeting SDG goals number 6 on ensuring clean water and sanitation by 2030 globally.

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided: https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%20838.pdf and in the MUHAS archives.

The PI is required to:

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain data transfer agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain material transfer agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country,
8. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
9. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
10. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/.

Dr. Bruno Sunguya
Chairman, MUHAS Research and Ethics Committee

Muhimbili University of Health and Allied Sciences
DIRECTOR
Research & Publications
Box 65001

Cc: Director of Postgraduate Studies

Appendix VII: Permission letter

HALMASHAURI YA MJI KOROGWE.
(BaruaZoteZiandikwekwaMkurugenziwaMji)
S. L. P. 615, Simu: 027-2650050 Nukushi: 027-2650075
BaruaPepe:info@korogwetc.go.tz/korogwetowncouncil@gmail.com
Tovuti: www.korogwetc.go.tz
KOROGWE, TANGA, TANZANIA.

HMK/T.2/04A/97 , 22/07/2021

MTENDAJI WA KATA ,
KATA YA KILOLE/MGOMBEZI/MASUGURU
S.L.P 615.
KOROGWE.

YAH: KIBALI CHA KUFANYA UTAFITI HALMASHAURI YA MJI KOROGWE.

Tafadhali, husika na somo hapo juu,

Ofisi ya Mkurugenzi imepokea Barua yako ya tarehe 12/07/2021 **yenye Kumb. Na. HD/MUH/T.720/02020** kutoka kwa mkuu wa chuo, Chuo kikuu cha Afya Muhimbili ya kuomba kibali cha kufanya utafiti juu ya" **Association Betwen water Quality Sanitation and Hygiene on Diarrhea Cases in Korogwe Town Council"**

Kwa barua hii, unaelekezwa kutoa ushirikiano utakaohitajika katika kukusanya takwimu na kukamilisha utafiti wake.

Nawatakia ushirikiano mwema.

Gino J. Mbwilo,
Kny: Mkurugenzi wa Mji,
KOROGWE.

Nakala:
Mkurugenzi wa Mji- Aione Jaladani.
Halfa R. Mkongo –Mtafiti.

Appendix VIII: Water quality laboratory results

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF WATER

E-mail: tangalab@maji.go.tz

Tanga Zonal Water Quality Laboratory

P.O.Box 5027

Tanga.

LAB. No. **TANGA/ZWQL 343/21**.....

29/07/2021

SAMPLING DATE: 26/07/2021 **DISTRICT:** KOROGWE

REQUESTED BY HALFAN MKONGO

ANALYTICAL RESULTS

WARD	Sample Source	SAMPLING POINT	FECAL COLIFORM	Unit	Remarks
MGOMBEZI	SHALLOW WELL	MGAMBO/ AT SOURCE	200	CFU/100 ml	Contaminated
MGOMBEZI	SPRING	MGAMBO/ AT SOURCE MGAMBO/ AT SOURCE	400	CFU/100 ml	Contaminated
MGOMBEZI	SPRING	MGAMBO/ AT SOURCE	288	CFU/100 ml	Contaminated
MASUGULU	SHALLOW WELL	KWASEMANGUBE/AT SOURCE	174	CFU/100 ml	Contaminated
KILOLE	PANGANI RIVER	KAMBI YA MAZIWA DP	417	CFU/100 ml	Contaminated

29/07/2021

Date

Analyst

Laboratory Manager

WATER QUALITY LABORATORY TANGA