PARASITIC CONTAMINATION OF WASTE STABILIZATION PONDS EFFLUENT, PREVALENCE AND RISK FACTORS ASSOCIATED WITH TRANSMISSION OF SOIL-TRANSMITTED HELMINTHIASIS AMONG SCHOOL-AGED CHILDREN IN THE SURROUNDING COMMUNITY IN DAR ES SALAAM

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By

Sheila Mbike

A Dissertation Submitted in (Partial) Fulfillment of the Requirements for the Degree of Master of Science (Tropical diseases control) of

Muhimbili University of Health and Allied Sciences
October, 2017

CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled, "**Parasitic contamination of waste stabilization ponds effluent, prevalence and risk factors associated with transmission of soil-transmitted helminthiasis among school-aged children in the surrounding community in Dar es Salaam**" in (partial) fulfillment of the requirements for the degree of the Master of Science in Tropical diseases control of Muhimbili University of Health and Allied Sciences.

_____

Dr. Billy Ngasala

Supervisor

_____

Date

DECLARATION AND COPYRIGHT

I, **Sheila Mbike** 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**.....

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I would like to thank my family especially my lovely father Mr. Omary Mbike. His support, encouragement, care and prayers gave me strength in time of unevenness and ease my path. Sincere thanks.

My deepest thanks

DEDICATION

This dissertation work is devoted to my very beautiful daughter Lisa for all the times she missed me so that I can accomplish my studies.

ABSTRACT

Background

Waste water can be treated by waste stabilization ponds (WSPs) to remove the parasites that might cause infectious diseases when released into environment. Partially or untreated waste water poses risk of transmitting potential infectious diseases like soil-transmitted helminths (STH) to the surrounding communities, the higher risk groups being irrigating farmers, vegetables consumers and children.

Aim/ broad objective

To determine the level of parasitic contamination in waste stabilization ponds effluent, prevalence and risk factors associated with STH among school-aged children surrounding two municipal waste stabilization ponds in Dar es Salaam.

Materials and methods

A descriptive cross-sectional study with a quantitative approach was used. A multistage sampling technique was used to select five primary schools located in area about 3 km in which a total of 342 pupils were enrolled in a study done in June 2017. Wastewater effluent was analysed by using modified Bailenger method, whereas stool specimen were examined by using Kato-Katz technique. Demographic data and hygienic practices information were collected by using a structured questionnaire and respective proportions calculated.

Results

Study respondents were 319 pupils and response rate was 93.3%. The mean concentration of nematode eggs in Vingunguti WSP was 1.1eggs/litre specifically hookworm eggs (1.13 eggs/litre) and *Ascaris* spp. egg (1.1 eggs /litre). No parasitic egg was seen in Buguruni effluent. Overall prevalence of STH was (1/319) 0.3% *Trichuris trichiura* infection (0.7% in Buguruni and 0.0% in Vingunguti).

Conclusion

The concentration of nematode eggs in effluent from Vingunguti was above WHO limits while effluent from Buguruni WSP abides by the guideline. There is very low prevalence of STH among school-aged children surrounding municipal WSPs in Dar es Salaam which might be due to high coverage of school deworming program.

Recommendation

There is a need for technical maintenance and monitoring of Vingunguti WSP to improve pond performance and complete treatment of waste water. Health education and behavior change programs should be provided to urban farmers and inhabitants surrounding WSPs to improve awareness and knowledge on modes of transmission and preventive measures of STH.

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ABREVIATIONS

AIDS	Acquired immunodeficiency syndrome
HIV	Human immunodeficiency viruses
IMS	Immunomagnetic separation
MDA	Mass drug administration
MUHAS	Muhimbili University of Health and Allied Sciences
NTDs	Neglected tropical diseases
PCR	Polymerase chain reaction
qPCR	Quantitative polymerase chain reaction
RNA	Ribose nucleic Acid
STH	Soil-transmitted helminths
UNEP	United Nations Environment Program
WASH	Water, sanitation and hygiene
WHO	World Health Organization
WSPs	Waste stabilization ponds

DEFINITIONS OF TERMS

Constructed wetland: are a series of shallow, densely-planted, man-made ponds that helps to filter water through physical and biological processes.

Soil-transmitted helminths: are the intestinal worms infecting humans that are transmitted through contaminated soil containing infective eggs or larvae of helminths.

Schistosomiasis: Parasitic disease caused by penetration of infective larvae of *Schistosoma haematobium* and *Schistosoma mansoni*.

Ascariasis: An intestinal parasitic infection disease caused by ingestion of an *Ascaris lumbricoides* eggs.

Maturation pond: receive wastewater from facultative ponds for tertiary treatment.

Facultative pond: receive wastewater from the anaerobic pond for secondary treatment

Anaerobic ponds: first unit of waste stabilization ponds receive the raw wastewater and where primary treatment occurs.

Waste stabilization ponds: man-made earthen basins, comprising at any one location one or more series of anaerobic, facultative and, depending on the effluent quality required, maturation ponds

Water related diseases: an illness caused by direct or indirect contact with contaminated water, diseases related to water shortage, diseases and diseases related to vectors which spend their lifecycle in water habitat.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Occurrence of infectious diseases can be prevented through environmental modification methods including sewage treatment systems such as waste stabilization ponds and constructed wetlands (1). Waste stabilization ponds (WSPs) are man-made earthen basin which comprise at any location one or more series of anaerobic, facultative and maturation ponds used as a natural wastewater treatment method (2) which if well designed are effective and reliable in removing pathogens and parasites (3,4).

The treated waste water or effluent is released into the environment(5) and can be reused for restricted or unrestricted irrigation activities upon meeting the recommended standards set by WHO. However reuse of treated waste water poses health risks of infectious disease transmission to humans and animals as it might carry potential parasites mostly roundworms, whipworms, hookworms, Schistosomes, Cryptosporidium, Hepatitis A and other viral pathogens (1). The risk increases if wastewater is not treated efficiently due to malfunctioning of treatment plants hence pathogens and parasites are not removed and escape into the environment and this might cause infectious diseases transmissions and outbreaks (6).

Living in close proximity to the waste stabilization ponds increases the risk of parasitic infections to both irrigating farmers, pond workers, children and non-farming who otherwise may have contact with products contaminated by poorly or partially treated waste water like soil (7). Also poorly designed ponds might flood during rainfall seasons and pour waste water contents to the environment and since eggs of soil-transmitted helminths (STH) are persistent in soil they can be transmitted to the neighborhoods in non-farmers community members.

According to WHO, more than 1.5 billion people or 24 percent of the world's population are infected with soil-transmitted helminth infections worldwide and the infections are higher in tropical and subtropical areas with greater occurrence in sub-Saharan Africa, the Americas, and East Asia(8). Current control efforts often focus primarily on mass drug administration (MDA) but this strategy does not address the environmental transmission cycle (9).

There are seven waste stabilization ponds in Dar es Salaam which are Vingunguti WSP, Buguruni WSP, Kurasini WSP, Mabibo WSP, Mikocheni WSP, Lugalo WSP and University of Dar es Salaam WSP which treats the municipal and industrial waste water in Dar es Salaam. There is rapid urbanization and increase in informal settlements in Dar es Salaam thus people tend to build houses near WSPs as seen in Buguruni and Vingunguti WSPs. These ponds are located in areas where they are prone to flood. During the rainy season the maturation/aerobic ponds floods to the surrounding human neighborhood, thus untreated fecal matter from the ponds contaminate the soil. Hence surrounding inhabitants might get the infection through penetration or ingestion of parasitic eggs or cysts. However the risk of infection is not only to surrounding community but also to other individuals since wastewater released flows into Msimbazi River and underground water.

The study to be described was aimed at determining the level of parasitic contamination of two municipal waste stabilization ponds in Dar es Salaam city which are located at Buguruni and Vingunguti and the prevalent soil-transmitted helminthic infections of the school-aged children from schools surrounding WSPs.

1.2 Statement of research problem

The parasitic infections are still a public health problem in Tanzania and are prevented through various measures including use of MDA with anti-helminthic drugs, and environmental modification and manipulation like treating waste water in waste stabilization ponds**.** Untreated or partially treated waste water increases the risk of acquiring infectious diseases to people using effluent water for agriculture or living closer to these ponds especially during rainy seasons. For example in Dar es Salaam region, Vingunguti and Buguruni WSPs are located in areas prone to flooding, and the effluent water which drain in Msimbazi River exposes the surrounding communities to contaminated environment that increases risks of continuing transmission of parasitic diseases especially to the surrounding community.

A recent study in Uganda has reported higher prevalence of intestinal parasites (75.6 %) predominantly hookworms and *Schistosoma mansoni* with a prevalence of 27.8 % and 23 % respectively in individuals exposed to contaminated waste water(10). However, there is limited information on the level of parasite contamination in WSPs and soil-transmitted helminths infections to the school-aged children surrounding the WSPs in Dar es Salaam city.

Therefore it was important to conduct a study which would describe the contamination of parasites in treated waste water, prevalence and risk factors associated with transmission of STH among school-aged children in surrounding neighborhood in Dar es Salaam. Finding in this study provides information to diseases control coordinators on other sources of disease transmission and thereby enabling modification of diseases control and prevention programs.

1.3 Conceptual framework

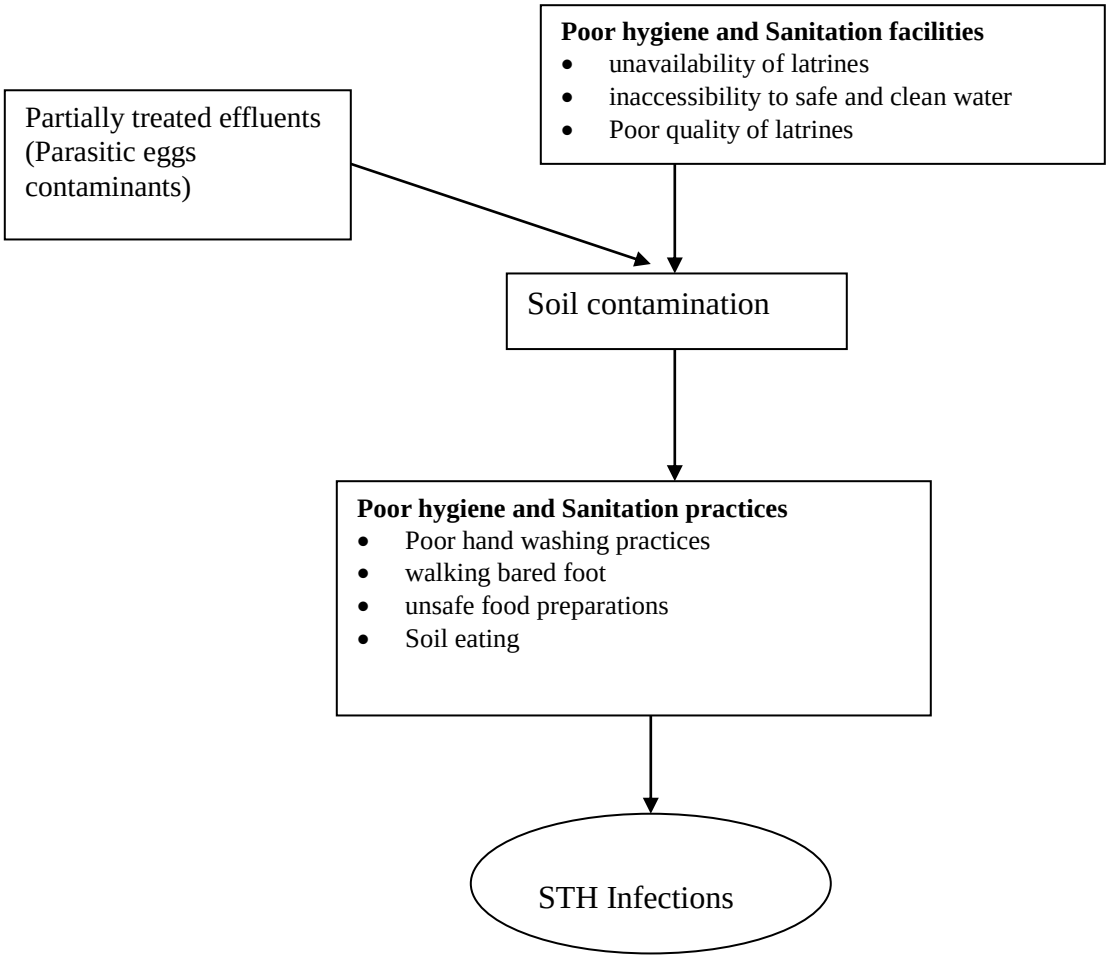


Figure 1: A conceptual framework

1.3.1 Description of the conceptual framework.

Partially treated or untreated waste water contaminated with parasitic eggs can contaminate soil and cause infections to people if they come into contact with the contaminated soil especially children among those at higher risk. Soil contamination occurs mainly during rainy season in which ponds overflow due to flooding and STH eggs are persistent in soil for up to 2 years. However the risk of STH can be high to individuals with poor hygienic practices.

1.4 Rationale

Findings in this study may be used as indicator of waste stabilization ponds performance and efficiency and thus offer a way forward for operational improvement which improve health of community.

The findings of STH magnitude among school-aged children may be used by diseases control coordinators as an indicator for monitoring school-based MDA program.

1.5 Research hypothesis

There is high prevalence of STH among school-aged children surrounding Buguruni and Vingunguti WSPs in Dar es Salaam.

1.6 Research questions

i. What is the level of helminthic eggs on waste water effluent released to the environment?
ii. What is the prevalence of soil-transmitted helminthic infections among school-aged children surrounding waste stabilization ponds?

1.7 Objectives

1.7.1 General objective

To determine the level of parasitic contamination in waste stabilization ponds effluent, prevalence and risk factors associated with transmission of STH among school-aged children surrounding two municipal waste stabilization ponds in Dar es Salaam.

1.7.2 Specific objectives

i. To determine level of soil-transmitted helminths eggs in effluent from Buguruni and Vingunguti waste stabilization ponds at point of treated water exit in Dar es Salaam.
ii. To determine prevalence of soil-transmitted helminthic infections among school-aged children surrounding Buguruni and Vingunguti WSPs.
iii. To identify the hygienic and sanitary practices associated with transmission of STH among school-aged children surrounding Buguruni and Vingunguti WSP.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Wastewater contamination by parasites

A waste stabilization pond (WSP) is a cost effective method of wastewater treatment which removes pathogens and polluting compounds (11). The resultant product, treated effluent can be released into rivers and ocean. According to WHO guideline on wastewater reuse , treated wastewater from waste stabilization ponds should have mean egg count of less than 1 egg per 1000 ml if it has to be used for agricultural activities in either restricted or unrestricted irrigation (11).

Different studies have been done on waste stabilization ponds and shown the evidence of pathogen contamination on treated waste water. In Spain (12) and Tunisia (13) parasites were recovered in effluent and sludge from waste stabilization ponds showing more health concerns of wastewater on disease transmission at favourable conditions. Also In Ghana the mean helminths eggs contaminant was found to be higher (2 ova/L) than the recommended guideline value in both dry and wet seasons (14).

In Tanzania there are limited data on parasitic contamination of treated waste water from waste stabilization ponds. A recent study was done on municipal waste stabilization ponds in Iringa, Morogoro, Moshi and Arusha municipality. In Iringa effluent was shown to have coliform counts higher than recommended 1000 cfu/100ml. Observation studies showed irrigational activities on vegetables even on harvesting day which puts consumer's health at risk of infections. Results from Arusha WSP showed reduction by 99.3% to 100% for nematodes, hookworms and whipworms. The eggs associated with schistosomiasis seemed to show a reduction of roughly 82%. In Morogoro parasites found were *Entamoeba histolytica*, rat tapeworm, *Isospora belli* and hookworm eggs which were the most plentiful and most persistent. However the study reported microscopic observation of smaller schistosome egg like particles though they lack internal structures of schistosome eggs hence were not proven to be schistosome spp eggs. One of the limitation of this study was that it did not assess the

health status of the exposed population(1).

2.1.1 Methods of determining parasitic eggs contaminants in treated effluent

The 2006 revised guidelines by WHO on waste water, fecal matter and sludge reuse in agricultural and aquaculture activities are based on the fraction of helminth ova/eggs that are removed during the wastewater treatment process in which 1-3 log removal is acceptable for helminth ova content in effluent used for irrigation in low and middle income countries (1) as shown on table 2.1, though for both restricted and unrestricted irrigation the number of helminths egg in effluent should be less than 1 egg per litre of treated waste water (7,15**).**

Before sample examination a collected wastewater sample collected should be representative and this can be assured if the sample is collected at a point where turbulence is at maximum and possibility of solids settling is minimized. The effluent should be sampled at the most representative site downstream from all entering wastewater streams prior to discharge into the receiving waters (16).

There are various methods that can be used to recover and quantify parasitic eggs in treated waste water but the most recommended method being the modified Bailenger (7,11,15). The Bailenger method involves sedimentation, centrifugation, concentration and quantification of helminths eggs and oocyst of *Giardia* and *Amoeba* in a waste water sample by a series of chemical analytical procedures (13)**.** Advantages of the method are its simplicity in time spent for microscopic examination (only 1-2 minutes per slides) hence technical error is reduced, inexpensive chemicals and equipments are required for sample collection and processing and it allows a replicate examination of sample to achieve greater accuracy. Since the ether is toxic, it can be replaced by ethyl acetate which is less toxic and a has lower boiling and flash points (11).

Molecular techniques like polymerase chain reaction (PCR) can also be used to detect pathogens in wastewater. This method identifies a specific gene sequence in RNA strand or a pattern of a particular parasite (17). It is a very sensitive and highly specific method which can detect almost all known parasites that can be missed when using conventional methods (13). Examples of pathogens that are found on wastewater and that can be detected by this method are *Cyclospora* spp., *Isospora* spp., *Entamoeba* spp. and *Cryptosporidium* spp. (17). Molecular

techniques like PCR are very expensive and require highly trained person to perform the test.
Another method is immunomagnetic separation (IMS) which involves the use of commercial monoclonal antibody followed by epifluorescence microscopy (13). This includes sample centrifugation with specific commercial antiparasite beads followed by dissociation and neutralization of oocyst which is examined by epifluorescence microscopy. This method enables differentiation of parasites based on microscopic morphology but cannot distinguish morphological similar pathogens like *Entamoeba histolytica* and *Entamoeba dispar* (11).
Helminths eggs can also be recovered by using the quantitative rapid coupled method(18)**.** This method involves waste water sample filtration through a micropore membrane filter, sedimentation by $ZnSO_4/MgSO_4$ and microscopy. This method is simple to perform and inexpensive but the main limitations of it being not recommended for waste water samples with high turbidity and has a low efficiency in egg recovery with about 77% efficiency (18).

2.2 Prevalence and risk factors of Soil-transmitted helminthiasis in communities surrounding waste stabilization ponds

Water related diseases are mostly due to improper waste water treatment and poor handling of human excreta. The infections include bacterial diseases (such as cholera, shigellosis, skin infections), viral diseases (hepatitis, rotavirus infections) and parasitic infections including giardiasis, helminthic infections (Schistosomiasis, hookworms infections, Ascariasis and Trichuriasis) (1,5). The major parasitic infections associated with exposure to waste water are hookworms, Ascariasis, Schistosomiasis and Trichuriasis (1,11).
A prospective study in Vietnam on helminthic infections among people using wastewater and human excreta in peri-urban agriculture and aquaculture found that 39% of exposed community were infected with at least one of the three helminth species of which 21.6% had *Ascaris* spp.,9.8% had *Trichuris* spp. and 21.8% had hookworm when 807 stool samples from exposed individuals were examined by direct microscopy. The infections were more associated with inadequate sanitation and use of fresh human excreta for agricultural activities (19). Other studies have found that high risk of intestinal parasitic infections on farmers is associated with exposure to wastewater contaminated with helminthic eggs. A cohort study in

Ghana found exposed community was at higher risk of being re-infected by STH three months after deworming as compared to non-exposed community. Apart from that mean concentration of STH ova on effluent was higher (2.62 ova/L and 2.82 ova/L for dry and wet seasons, respectively) and hookworm (2.05 ova/L in the wet season) than the recommended guideline value for *Ascaris* spp (14).

Also in India Ensink (2008) reported the significant increase in risk of soil-transmitted helminths infection in farming communities irrigating with wastewater of which hookworm was the most prevalent with a prevalence of 29.8%, followed by *A. lumbricoides* and *T .trichiura.* Hence it was found that use of untreated and partially treated waste water was associated with increasing risks for both *A. lumbricoides* and hookworms infection and intensity (20). A similar study in Uganda also found higher prevalence of intestinal parasites (75.6 %) predominantly hookworms and *Schistosoma mansoni* with a prevalence of 27.8 % and 23 % respectively in urban farmers exposed to wastewater and sludge (10).

Risk of helminth infections is not only associated with exposure to wastewater ; a poor sanitation and human excreta use in agriculture also has prominent role in parasitic disease transmission (19). The association between wastewater and human health is linked with access to sanitation and with human waste disposal. Waste water management is a key component of health risk management in ensuring adequate sanitation which prevents contamination of drinking water with human excreta (21).

Another water related disease that can be caused due to exposure to untreated waste water is diarrhea. Diarrhea is the primary cause of morbidity and mortality in children both in urban and rural areas though it has shown to be more prominent in urban (18%) than in rural areas (13.6%) which is attributed to poor environmental sanitation especially in unplanned settlements (22). Dar es Salaam for instance, is faced with rapid urbanization and has an increase of informal settlements which accounts for 70-80% of total city population (23). This has caused the families to dominate in very poor areas with poor sanitation. The settlements have expanded to abandoned quarry areas, or built close to waste stabilization ponds in which

water logging is common. In such poor environments children are more prone to contracting infectious parasitic diseases (22).

2.2.1 Situation of soil-transmitted helminthiasis infections in Tanzania

Integrated control strategies for parasitic diseases in Tanzania have been applied in various regions including MDA, Water hygiene and sanitation (WASH) activities, behavior change programs and health education. The most current MDA administering Praziquantel and Albendazole for Schistosomiasis and STH control respectively was conducted in a period between 2014 -2015 covering about 80 districts and the main target group being the school-aged children (24). The elimination of the intestinal parasitic infection is not yet achieved and water related diseases are still major cause of hospitalization in Tanzania.

There has been decrease on the prevalence of soil-transmitted helminths infections and schistosomiasis among school-aged children in Dar es Salaam region and it has been shown that the overall prevalence of STH is 1% (25), although the situation is different in other regions in which prevalence of STH is still high as found in various studies done. A recent study in Bagamoyo found the prevalence of STH among pre-school children to be 3.8% commonest parasites being *Ascaris lumbricoides* and hookworms when involving 115 students (26). The risks factors for STH infections were found to be poor sanitation like drinking untreated water, lack of latrine at household level, poor handwashing practices during critical moments and foot wearing habit. The main limitation of the study was the small sample size of the study.

The parasitic infections affect significant number of school-aged children has been seen in various studies. The burden is very high in lake zone basin dominated by schistosomiasis (urinary and intestinal) followed by hookworms infection (27,28). Prevalence of *Schistosoma mansoni* was reported to be 15.1%, for hookworms was 12.6% and *Schistosoma haematobium* was 8.9%. Eating practices and environmental factors particularly type of soil, warmth and moist soil contributed to high prevalence of STH in the region (27). This also has been observed in Pemba study in which almost half of 550 diagnosed students were infected with at

least one of the three parasitic intestinal protozoa tested which were *Entamoeba histolytica / Entamoeba dispar* and *Giardia intestinalis* (29).

Among adults, the parasitic infections are also very common. A cross-sectional study done in Kilimanjaro among HIV/AIDS patients on intestinal parasites infection which enrolled 83 adult patients found *Ascaris lumbricoides* being the most prevalent with 52% prevalence, *Giardia lamblia* was found to be 32%, *Entamoeba histolytica* was found to be 16%. The study had a limitation in that it did not include the risk factors for acquisition of intestinal parasites such as hygiene, socio-economic and environmental factors (30).

2.2.2 Methods of detecting parasitic eggs in stool specimen

Stool samples can be examined directly for parasitic egg/ova detection by microscopy but this method has a low sensitivity(31). Therefore WHO has recommended the Kato-Katz method for stool examination and quantification in areas with moderate to high transmission rates of helminths of which more than 20-50% of individuals in a community are suspected to be infected. The sensitivity of this method is reduced in areas with low prevalence and transmission (32),with kato-katz technique the infection can be easily quantified.

Another method is the formol-ether concentration method. This method enables detection of parasitic eggs even if the prevalence has gone down though can't detect trophozoites and cyst of protozoans and it uses ether and formalin which are harmful chemicals (33). Parasitic eggs can also be detected by using molecular techniques most commonly by quantitative polymerase chain reaction (qPCR). This method is very sensitive and can determine larvae of *Strongyloides stercoralis* which can't be recovered by formal-ether or Kato-Katz technique though it is limited on its high cost of PCR reagents and operation (34).

Table 2.1: WHO Guideline on Wastewater Treatment

Eggs/ltr in influent	Eggs/ltr in effluent	Percentage egg reduction	Log removal
1000	100	90	1
1000	10	99	2
1000	1	99.9	3

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study area

This study was done in Ilala district in Dar es Salaam region in June 2017. It involved two waste stabilization ponds, the Vingunguti and Buguruni WSPs and five primary schools located in the area which are Mtakuja, Kombo, Buguruni kisiwani, Buguruni moto and Buguruni moto mpya primary schools. Ilala district has a population of 1,220,611 with 595,928 males and 624,683 females(35). The district cover an area of 364.97 km^2, lying at a latitude of 6° 55'S and longitude 39° 10'E. The Vingunguti WSP receives and treats municipal wastewater collected by septic/vacuum trucks while the Buguruni WSPs receives and treats domestic wastewater directly from households connected to a sewerage system. Both WSPs are surrounded by human habitats, in areas close to Buguruni WSP vegetable farming is taking place. Both treatment plants floods during heavy rains although Vingunguti WSP and its neighborhood experience seasonal flooding during rainy season. The Vingunguti WSP is shown on figure 3.1 while the location of Buguruni WSP is shown on figure 3.2 below.



Figure 3.1: Showing Vingunguti waste stabilization ponds. A photo was taken by Sheila Mbike.



Figure 3.2 : A map showing Buguruni WSPs and nearby primary schools (Map by Ramani huria).

3.2 Study population

The target population was primary school children of both sexes aged from 7-14 years who were attending the school surrounding Buguruni and Vingunguti WSPs.

3.3 Study design

This study was a descriptive cross-sectional study with a quantitative approach.

3.4 Sample size

3.4.1 Treated wastewater sample size

Ten litres of aerobic pond effluent were collected once per week for a period of three weeks on each studied treatment plant as described in WHO manual (11). Therefore on each pond a total of 30 litres were collected for analysis.

3.4.2 Sample size estimation for school-aged children

Sample size was calculated according to the following formula (36):

$$N = \frac{z^2 P (1 - P)}{\varepsilon^2}$$

N =Estimated Sample Size

Z =Standard normal deviate of 1.96 on using 95% Confidence interval.

P =Prevalence of STH

ε=Margin of error

Prevalence of 27.8 % was used as determined in a study which was done in Uganda on communities surrounding WSPs (10)

$$N=\frac{1.96^2(0.278)(1-0.278)}{0.05^2}$$

N=308

Adjusted sample size for 10% non-response rate:

N=1/R*308

N=308/0.90

N=342

The estimated sample size for this study was 342 pupils.

3.5 Sampling design

The study used a multistage sampling technique to select required primary schools. In a first stage only primary schools located about 3 Km from the WSPs were selected involving a total of five schools which included two schools from Vingunguti and three schools from Buguruni area. Proportionate allocation of school children according to the total number of pupils recorded in school registers was used. A second stage a random sampling was used to select representative classes in each school from standard one to standard seven in which only classes with odd numbers were involved thus class three, class five and class seven. On each selected classes systematic sampling was used to select research subjects depend on the total number of students per class.

Hence 342 school children were enrolled in the study from five primary schools which had a total of 8124 school children. Each school contributed respondents by proportional to its proportional size (PPS).

3.5.1 Proportional to its population size calculation

Data presented for PPS calculation were:-

The sample size required for the study = 342

Grand total number of school Children in all 5 school selected =8124

Total pupils from a school (Kombo primary school) involved in the study =2151

The Contribution of pupils to the study sample size from selected Primary school =

$$\frac{\text{Total pupils from Primary School x Sample size required for the study}}{\text{Grand total number of school Children in all 5 schools selected}}$$

Hence :

The Contribution of pupils from Kombo P/school was $= \frac{2151 \times 342}{8124} = 91$ pupils

Thus, Kombo primary school contributed 91 school children to the sample size for the study. The same formula was used to calculate for other schools i.e. Mtakuja, Buguruni moto, Buguruni moto mpya and Buguruni kisiwani primary school to get a number of pupils, with the aim of making a total of 342 of school children for the study as shown on table 3.1 below.

Table 3.1: Number of pupils selected in each school by using PPS technique

School name	Total number of pupils/school	Number of pupils selected for study
Kombo	2151	91
Mtakuja	2093	88
Buguruni moto	1306	55
Buguruni kisiwani	1223	51
Buguruni moto mpya	1351	57
Total	8124	342

3.6 Eligibility criteria

3.6.1 Inclusion criteria

All primary school children from standard 1 to standard 7 aged between 7-14 years who were present at school at the day of study and who were approved to join in the study with a signed informed-consent were included in the study.

3.7 Study variables

3.7.1 Dependent variables

Soil transmitted helminthiasis

3.7.2 Independent variables

Latrine use .all the time whenever has an urge to attend toilet, not every time, never visit toilet.
Availability of latrine at home: have latrine-Yes/No
Drinking water source: Tap water, well water, buying from local water vendors, bottled water.
Type of latrine: Cemented, rough floor/non cemented, pit latrine, pour flush latrine.
Shoe wearing behaviour: Only at school, frequent, all the time when outside.
Hand washing practices: At critical moments (after toilet visit, before eating)
Eating behavior: Washing fruits before eating, eating soil, raw vegetables eating.

3.8 Data collection

3.8.1 Data collection for wastewater contamination

Ten litres of aerobic pond effluent was collected by the principal investigator once per week for a period of three weeks on each studied treatment plant at a point of exit as described in WHO manual (11). The Modified Bailenger method was performed by the principal investigator in a MUHAS parasitology laboratory to determine egg count in treated waste water effluent as described in a WHO manual (11). Each collected sample was allowed to settle for 2 hours after which 1 litre of sediment was collected. The collected sediment was centrifuged at 1000 RPM for 15 minutes and all collected sediments transferred into one test

tube. An equal volume of aceto- acetic buffer was added followed by two volumes of ethyl acetate and centrifuged. The volume of pellet was recorded and supernatant discarded. The pellet was resuspended in five volumes of zinc sulphate solution and mixed thoroughly, and then a volume of final product was recorded. An aliquot was transferred to a McMaster slide for examination. All eggs seen within the grid in both chambers were counted and recorded. The calculations were done to estimate number of eggs in 1 litre sample.

3.8.1.2 Egg count calculation in effluent.

To calculate the number of eggs per litre the following equation proposed by Ayres was used(11):

$N = AX/PV$

where:

N = number of eggs per litre of sample

A = number of eggs counted in the McMaster slide or the mean of counts from two or three slides

X = volume of the final product (ml)

P = volume of the McMaster slide (0.3 ml)

V = original sample volume (litres)

A single-chamber McMaster slide was used, Hence P = 0.15 ml.

3.9. Data collection for Soil-transmitted helminthiasis

The principal investigator and research assistants explained the stool collection procedures and gave stool containers to students. The students were directed to collect the stool specimen with given apparatuses during the school hours at the school toilets. Each stool specimen was fixed with 10% formalin to preserve helminths eggs before examined by using Kato-Katz as described in a WHO manual (32) at MUHAS parasitology laboratory. One slide per stool sample was prepared using fixed quantity of sieved 41.7mg of stool on a punched template. The sieved stool (41.7mg) was mounted on slides and covered with malachite green impregnated coverslip and left to clear for 30 minutes before examining under a microscope. The parasite egg concentration was expressed as egg per gram of stool. The number of eggs

counted in the Kato-Katz thick smear was multiplied by a factor of 24 to obtain a standard infection intensity measure, which is expressed in eggs per gram of stool (EPG).

3.9.1 Data collection to identify the hygienic and sanitary practices among school aged children around Buguruni and Vingunguti waste stabilization ponds

Principal investigator (PI) and research assistants (RAs) interviewed the pupils with a signed informed consent by using a structured questionnaire to get information on hygienic and sanitary practices after stool collection. The structured questionnaire collected the demographic and environmental factors which provided information on age, sex, latrine availability and accessibility, drinking water source, type of latrine at home and personal hygienic practices information. The questionnaires were filled at school under supervision of Principal investigator and research assistants thus sharing of information was at large minimized.

3.10. Data quality management

3.10.1 Recruitment and training of research assistants

The study was assisted by two research assistants with Medical laboratory skills on data collection and sample analysis. The assistants were trained on the research concept and procedures on data collection for one day.

3.10.2 Pretesting of data collection tools

A study pilot was conducted to primary school students Temeke Municipality. The questionnaire was pretested on a random sample of 10 primary school students. The pilot pretest provided a guide to modification of the tool.

3.10.3 Data Management

The filling of questionnaires during interviews and specimen analysis was primarily supervised by the principal investigator to ensure correctness and quality of data. The parasitic eggs were confirmed by using an atlas of medical parasitology (37)**.**

The data was coded prior to entering and feeding the information into statistical package SPSS

version 20 to run frequencies of the data. Data cleaning was done to ensure there is no information missing.

3.11. Data analysis

To determine level of STH eggs in waste water, data were analysed by using a formula given in a guideline and mean value was estimated. To determine the prevalence of STH and identifying the hygienic and sanitary practices associated with transmission of STH, all collected information were entered in SPSS version 20.0 and analysed for frequencies and proportions.

3.12. Ethical consideration

The study was conducted after being granted ethical clearance from the Muhimbili University of Health and Allied Sciences (MUHAS) Ethical Committee. Permission to conduct the study in Ilala District was obtained from Regional administration Secretary (RAS) Dar es Salaam, District Executive Director Ilala (DED), District education Officer (primary education) and DAWASCO after submitting an introductory letter from Muhimbili University of Health and Allied Sciences (MUHAS) attached with ethical clearance. Research subjects and teachers were informed on the aim of the study for purposes of understanding, and then students were given informed consent forms to be authorized and signed by their parents/guardians. Only students who came to school with signed informed-consent forms the next day of data collection were included in the study. The participants in each school were given number and urged to save them personally for further enquiry if by any case any of them is found with infection. For the infected child found a teacher was contacted and given a number of an infected pupil who was instructed to seek medical care, also all other schools with no infected pupils were given the results via teachers. Throughout the course of the study, confidentiality of the subjects was well maintained as numbers were used instead of names.

CHAPTER FOUR

4.0 RESULTS

4.1 Demographic characteristics of study participants

A total of 319 study respondents were recruited in the month of June 2017.Response rate for stool submission was 93.3%.The mean age of the study respondents was 11.07 years with a standard deviation of 1.640 years. Proportion of female and male was 52% (166/319) and 48% (153/319) respectively. Table 4.1 shows below shows demographics of study population.

Table 4.1.The general characteristics of a study population

		Name of Location		
		Buguruni n (%)	**Vingunguti n (%)**	**Total**
Gender of Pupil	Male	72 (47.1)	81 (52.9)	153
	Female	81 (48.8)	85 (51.2)	166
Total		**153 (48)**	**166 (52)**	**319**
Age Group	8 -10 years	56 (43.8)	72 (56.2)	128
	11 - 14 years	97 (50.8)	94 (49.2)	191
Class	3	68 (44.4)	70 (43.3)	138
	5	47 (30.7)	41 (24.7)	88
	7	38 (24.8)	55 (29.2)	93

4.2 Level of soil-transmitted helminths eggs in effluent from Buguruni and Vingunguti waste stabilization ponds

The hookworm egg and *Ascaris* spp. egg were found in Vingunguti WSP and no STH egg was found in Buguruni WSP. The level of overall mean parasite eggs contamination in Vingunguti WSP was 1.1eggs/litre. The results were as shown on Table 4.2 below.

Table 4.2: Level of soil-transmitted helminths eggs in effluent from Buguruni and Vingunguti waste stabilization ponds

WSP	Number of samples/three weeks	Number of eggs	Mean egg count/litre
Buguruni	3	0	0
Vingunguti	3	2	1.11** 1.1*

Note: **hookworm egg and ****Ascaris* **egg.

4.3 The prevalence of soil-transmitted helminthiasis among school-aged children surrounding Buguruni and Vingunguti waste stabilization ponds

The overall prevalence of STH among school-aged children was found to be 0.313% light trichuriasis infection with 48 eggs per grams in male child aged between 11-14 years. Table 4.3 shows the distribution of Prevalence of soil-transmitted helminthiasis among school-aged children surrounding Buguruni and Vingunguti waste stabilization ponds.

Table 4.3 Prevalence of soil-transmitted helminthiasis among school-aged children surrounding Buguruni and Vingunguti waste stabilization ponds

Location	No STH n (%)	With STH n(%)	Total
Buguruni	152 (99.3)	1(0.7)	153
Vingunguti	166 (52.2)	0	166
Total=N	318	0.3	319

4.4 The hygienic and sanitary practices associated with transmission of soil-transmitted helminthiasis among school-aged children surrounding Buguruni and Vingunguti waste stabilization ponds

A total of 319 pupils were interviewed with a structured questionnaire to provide the information on the distribution and pattern of hygienic and sanitary practices among school-aged children in Buguruni and Vingunguti. Out of 319 pupils, 146 and 161 from Buguruni and Vingunguti respectively reported tap as a source of drinking water at home.5 pupils and 1 from Buguruni and Vingunguti respectively uses shallow well as a source of drinking water at home. Proportion of pupils who drinks untreated water was high in Buguruni (65/96) as compared to Vingunguti (31/96).2 pupils (1 from Buguruni and Vingunguti each) had no latrine at home. Hand washing was high in Vingunguti (166/315) unlike in Buguruni in which 149/315 reported to wash hand before Proportion of eating raw unwashed foods was reported most Vingunguti (155/290) while of Buguruni was 135/290 (Table 4.4).

Anthelminthic coverage was high in Vingunguti which 162/309(52.4%) pupils were dewormed whereas in Buguruni 147/309(47.6%) were dewormed.10/319 (6 from Buguruni) pupils reported not be dewormed. In Buguruni 73/125 and 52/125 were dewormed. The School deworming program covered 125/246 and 121/246 pupils in Buguruni and Vingunguti respectively (Table 4.4). Because of the very low level of STH prevalence, association between hygienic and sanitation practices and STH could not be analysed.

Table 4.4: The general distribution of hygienic practices among school-aged children by location

		NAME OF LOCATION		Total
	N=319	BUGURUNI n(%)	VINGUNGUTI n (%)	n(%)
Source of Drinking Water at Home	Tap Water	145 (47.4)	161 (52.6)	306 (95.9)
	Shallow Well	5 (83.3)	1 (16.7)	6 (1.9)
	Bore Hole	3 (42.9)	4 (57.1)	7 (2.2)
Treating drinking water at home	Boiling	60 (34.3)	115 (65.7)	175 (54.8)
	water treatment chemical	28 (58.3)	20 (41.7)	48 (15)
	None	65 (67.7)	31 (32.3)	96 (30.1)
Home latrine ownership	No	1 (50)	1 (50)	2 (0.6)
	Yes	152 (47.9)	165 (52.1)	317(99.3)
Home latrine cemented	No	2 (28.6)	5(71.4)	7 (2.2)
	Yes	151 (48.4)	161 (51.6)	312 (97.8)
Use of the latrine	Continously	128 (44)	163 (56)	291 (91.2)
	Sometimes	24 (88.9)	3 (11.1)	27 (8.5)
	Don't Use	1 (100)	0	1(0.3)
Hand washing before eating	No	4 (100)	0	4 (1.3)
	Yes	149 (47.3)	166 (52.7)	318 (99.7)
Eating unwashed raw food or fruits	No	18 (62 1)	11 (37.9)	29 (9.1)
	Yes	135 (46.6)	155 (53.4)	290 (90.9)
Shoes wearing	No	37 (82.2)	8 (17.8)	45 (14.1)
	Yes	116 (42.3)	158 (57.7)	274 (85.9)

Soil eating	No	150 (47.5)	166 (52.5)	316 (99.1)
	Yes	3 (100)	0	3 (0.9)
took ant-helminthic drug	No	6 (60)	4 (40)	10 (3.1)
	Yes	147 (47.6)	162 (52.4)	309 (96.9)
When took an ant-helminthic drug	Not dewormed	6 (60)	4 (40)	10 (3.1)
	This Year	73 (58.4)	52 (41.6)	125 (39.2)
	Last Year	69 (41.1)	99 (58.9)	168 (52.7)
	I Don't remember	5 (3.3)	11 (68.8)	16 (5.0)
Where got the anthelminthic drug	Not dewormed	6 (60)	4(40)	10 (0.3)
	At School	125 (50.8)	121 (49.2)	246 (77.1)
	From Health Facility	22 (34.9)	41 (65.1)	63 (19.7)

4.4.1 The distribution of hygienic practices associated with transmission of soil-transmitted helminths among school-aged children by schools

4.4.1.1 The distribution of hand washing practices among school children by schools

Hand washing practice before eating was high (100%) in Mtakuja, Kombo and Buguruni kisiwani primary schools and was 96% at Buguruni Moto and Buguruni Moto mpya primary schools as shown on figure 4.1.

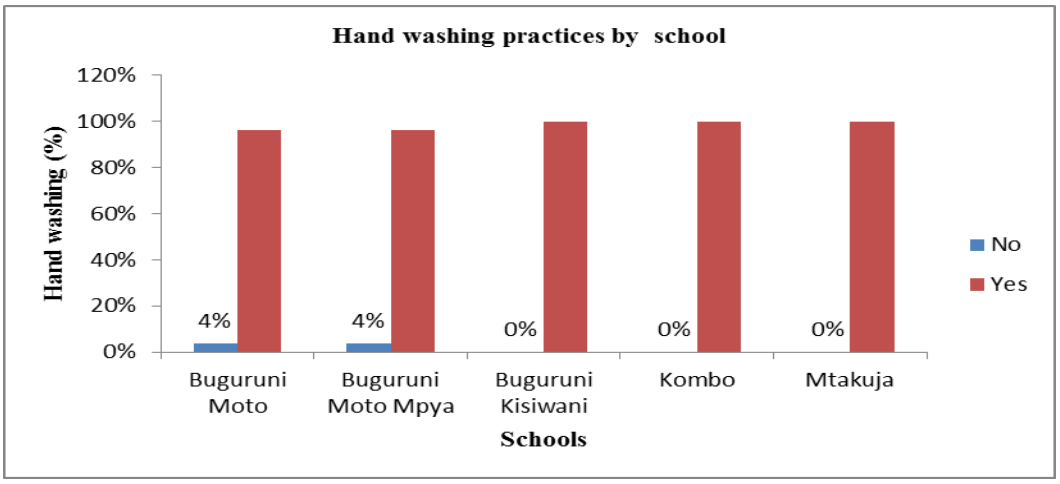


Figure 4.1: The distribution of hand washing practices among school children by schools

4.4.1.2 The distribution of eating raw unwashed foods among school-aged children behavior by schools

The eating of raw unwashed foods was very common among school children from all schools and only 11.7%, 15.4%, 10.4%, 7.5% and 2.2% from Mtakuja, Buguruni Moto mpya, Buguruni Kisiwani, Buguruni moto and Kombo primary school respectively as shown on Figure 4.2 below

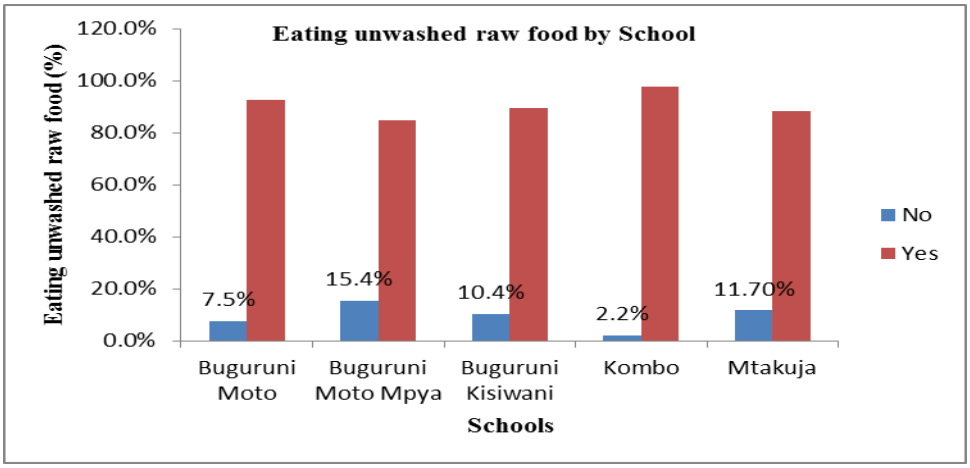


Figure 4.2: The distribution of eating raw unwashed foods among school-aged children behavior by schools

4.4.1.3 The distribution of soil eating behavior among school-aged children by school.

Figure 4.3 shows that the distribution of soil eating behavior was not common among school-aged children although 3.8% and 2.1% pupils from Buguruni Moto and Buguruni Kisiwani respectively were reported to eat soil.

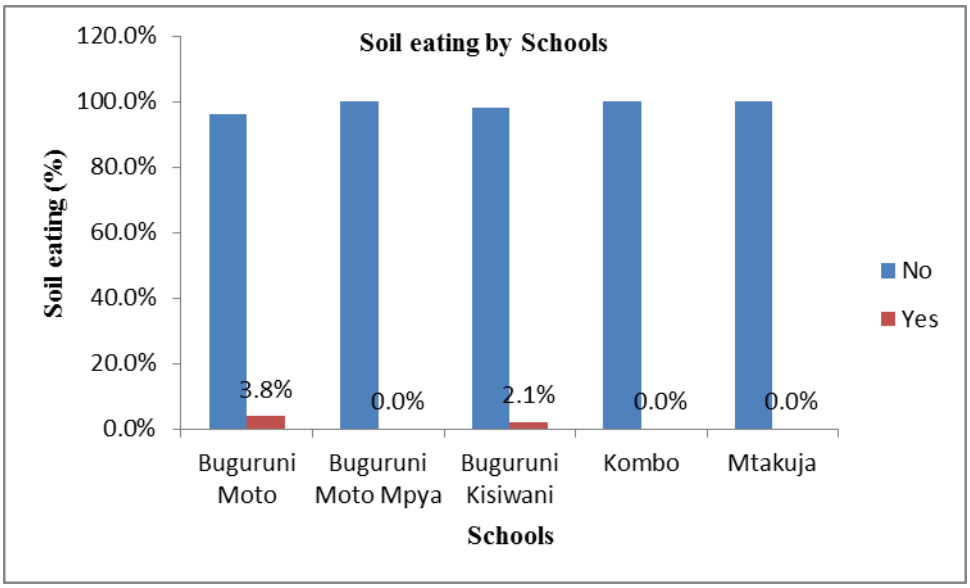


Figure 4.3: The distribution of soil eating behavior among school-aged by school children

4.4.1.4 The distribution of shoe wearing practice among school-aged children by location

The shoe wearing behaviour was reported high among school children in almost all schools except in Buguruni kisiwani where 44% pupils at Buguruni Kisiwani reported not to always wear shoes at home as described on Figure 4.4.

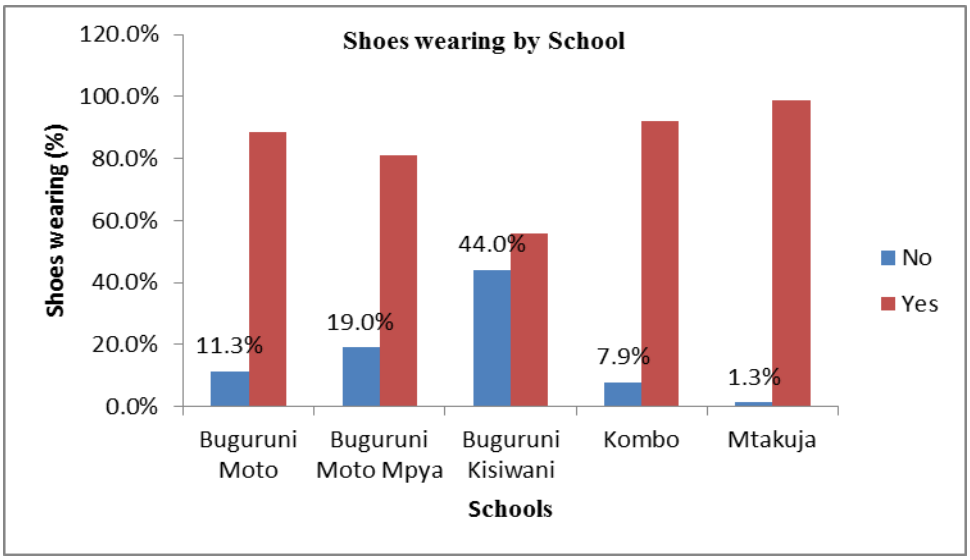


Figure 4.4 The distribution of shoe wearing practice among school-aged children by location.

4.4.1.5 The deworming coverage among school-aged children by schools location.

The deworming was reportedly high (100%) in both Buguruni kisiwani and Mtakuja primary schools while the lowest coverage was 96.2% in Buguruni Moto primary school as described on Figure 4.5.

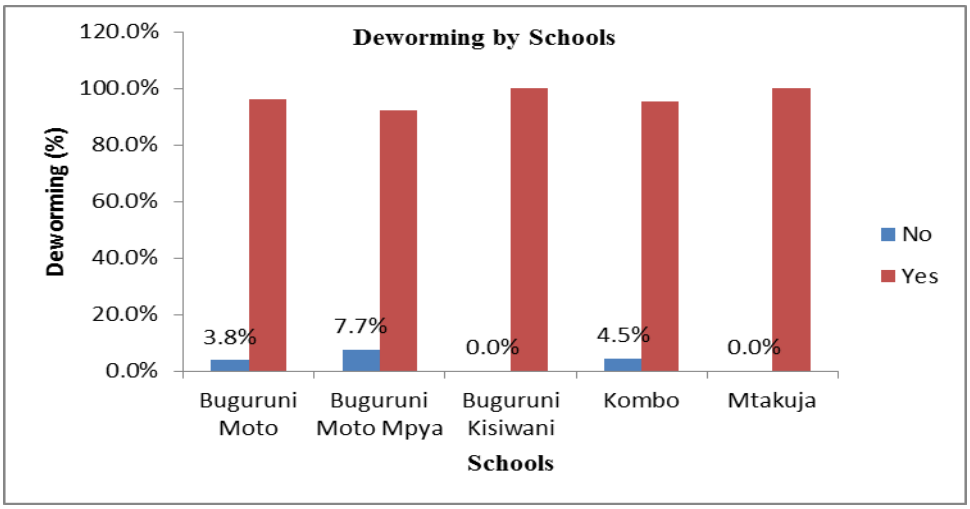


Figure 4.5: The deworming coverage among school-aged children by schools location.

CHAPTER FIVE

5.0 DISCUSSION

This study aimed at determining the level of contamination by helminthic eggs in treated water effluent located at Buguruni and Vingunguti in Ilala district. It also aimed at exploring prevalence of STH and hygienic and sanitary practices that are associated with transmission of STH among school-aged children surrounding the WSPs. Generally the study found low level of STH eggs in effluent in Vingunguti WSP while the effluent from Buguruni WSP was free of STH eggs. The prevalence of STH was very low among school-aged children surrounding the Buguruni and Vingunguti WSPs.

5.1 The level of contamination in wastewater effluent by Soil-transmitted helminthic eggs

The effluent from Buguruni WSP did not contain any parasitic egg and thus level of contamination was 0 eggs/Litre hence comply with a WHO guideline of <1 egg/litre. The results are similar as found in Arusha and Iringa WSP (1). The Buguruni WSP receives only domestic waste water directly from households connected to sewerage system hence could be have high performance and efficient in removing STH eggs. The effluent from Buguruni WSP was shown to have helminths egg concentration level meeting the WHO guideline, this was similar to findings from WSP in Shinoga (38) in which the effluent helminth value was below WHO maximum limit. Hence effluent from Buguruni can be used for restricted irrigation provided farmers use protective gears that inhibit direct contact with the wastewater effluent.

However an overall mean 1.1 eggs/litre of nematodes eggs was found in Vingunguti WSP. This does not comply with the WHO guideline on treated waste water quality requiring <1 nematode egg per litre and reduced to <0.1 egg/litre if children under age of 15 years are exposed to waste water either through playing or irrigating (2). This results shows health risks posed by effluent from this pond especially to the community living in surroundings. According to reports from neighborhood the aerobic flooded during the rainfall season in month of May so there is also need to assess level of soil contamination. Also children were

found playing and trespassing inside the pond areas as shown on Figure 5.1 and some individuals were observed farming vegetables on nearby stream. Studies have shown many WSP in developing countries do not function properly hence the quality of effluent is compromised(2).



Figure 5.1. A photo showing children trespassing near the anaerobic pond in Vingunguti WSP. Photo taken by Sheila mbike

The most prevalent nematode eggs in Vingunguti WSP were Hookworm (1.11 eggs/l) and *Ascaris* eggs (1.1 egg/litre) and were both above the recommended limit. Hookworm eggs were persistent in waste water and were recovered in Morogoro (1). Therefore despite nutrient richness of wastewater , there is potential health risk for irrigation and consumers of ingesting

helminth eggs or penetration for farmers. The *Ascaris* eggs are persistent in soil for up to 2 years hence their presence in aerobic pond which have a seasonal flood indicates soil contamination and transmission of STH during favourable conditions is possible among local inhabitants in Vingunguti.

The high level of WSP contamination by helminths in Vingunguti might be attributed to by maintenance neglect and lack of screening at the anaerobic pond. The screening prevents accumulation of sludge and improves pond performance (2).The pond is heavily surrounded with vegetation and continuously receives septic/vacuum trucks throughout the day and this also could affects performance of the pond.

5.2 Prevalence of soil-transmitted helminthiasis among school-aged children surrounding Buguruni and Vingunguti waste stabilization ponds

Significance of STH among school-aged children has been reduced due to ongoing school based program in Dar es Salaam. This study has revealed low prevalence of STH and the found parasite was *Trichuris trichiura* (0.3%). An overall of 96.9% pupils reported to have been dewormed during period of Dec 2016-January 2017 and it is likely that has played role in reduction of the STH. Mass drug administration has positive significance in reducing the prevalence and intensity of STH in school-aged children 6 months after treatment (39).

In Vingunguti 41/63 pupils took anthelminthic from the health facilities, this indicates prescription of anthelminthic could be due to presence of STH Infections in the area. Several studies had evidenced reduction on urban STH prevalence after mass drug administration intervention and Dar es Salaam was found to have an overall prevalence of >1% (25). Also decline of STH burden in urban can be due to improvement of hygienic behavior like latrine availability and use and access to clean water.

This study showed an overall low prevalence of 0.3% although the prevalence of STH in Buguruni Moto primary school in Buguruni (1.9%) exceeds the regional magnitude showing there is still a transmission of STH in the area. One of the factors for this can be explained by

low coverage of deworming and poor hygienic practices including hand washing in a particular school.

Age is an important factor for the prevalence of geohelminth infection and in this study the prevalence (0.7%) was observed on older age pupil of 11 year. Similar trend was found in study done at Magu in which higher prevalence was observed on older children(28). This may possibly due to the fact that as the child grows older the exposure to different risk factors for geohelminth infections increase. Moreover, this age group probably eats raw unwashed fruits and do not wash their hands properly before eating and after playing in the school.

In contrast to these findings, studies done on communities surrounding WSP have shown high burden of STH to the local communities. In Vietnam, prevalence of STH was found to be 39% and predominant parasite was *Trichuris spp* with burden in adult being higher than in children (19). The infection was associated with use of human feces as fertilizers and inadequate hygiene and sanitation practices. Also in Uganda highest prevalence of STH was found among urban farmers predominantly hookworm infection(27.8%) and was supposedly due to higher concentration of hookworm(2 eggs/litre) in effluent from nearby wetland (10). Since adults and children have different exposures and children are periodically dewormed suggesting need to investigate the health status of farmers doing irrigation in Vingunguti.

5.3 Hygienic and sanitary practices associated with transmission of soil-transmitted helminthiasis among school-aged children surrounding Buguruni and Vingunguti waste stabilization ponds

Access to clean water was high in which 96.2% reported to use tap water as source of drinking water. Hence water is highly accessible as an important aspect in sanitation and hygiene. The toilet is also available in pupils' households and only 0.6% reported not to have toilets at their households. This is a crucial aspect in control of STH as absence of toilets leads to open defecation and hence propagate cycle of parasitic diseases transmission. Hand washing behavior was reportedly high among pupils covered about 98.7%. This findings supports low prevalence of STH in the studied areas since improving hygiene and sanitation reduces

transmission of STH among at risk population (40). Contrary to this findings, low hygienic practices were found among pre-school children in Bagamoyo (26) on which hand washing and shoe wearing frequencies were 59.1% and 50.4% respectively and were associated with high prevalence of STH. The findings were due to low age of respondents (3-6 six years) with little knowledge on STH transmission.

The overall deworming coverage was high in Buguruni (96.1%) and Vingunguti (97.6%) although the coverage varied by schools in which Buguruni moto (96.2%), Buguruni moto mpya (92.3%) and Kombo (95.5%) while Mtakuja and Buguruni kisiwani both had a 100% coverage. The school teachers in schools with low coverage reported that some parents were reluctant for their children to take deworming drugs believing might have adverse health effects hence affected school deworming activities. WHO recommends periodic deworming as an efficient and effective control method for STH (41) since it helps in reducing morbidity and burden of STH while low coverage of deworming is associated with high burden of STH and increases risk of transmission in the community (42). Therefore a call to increase awareness of parents on STH transmission and control is very important to enable higher coverage of school deworming program.

5.4 Limitation of the study

The main limitation of the study was inaccessibility of a more sensitive advanced sample analysis tool like PCR which could be able to detect parasites at a very low prevalence that cannot be detected microscopy. This could have missed some of the infection in waste water and in stools of pupils.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study has found concentration of nematode eggs in effluent from Vingunguti above WHO limits and effluent from Buguruni WSP abides by the guideline. Hence Vingunguti WSP effluent cannot be used for both restricted and unrestricted irrigation since can transmit parasitic infections unless the pond is maintained technically to improve performance and routine monitoring to ensure quality of effluent released. There is very low prevalence of STH among school-aged children surrounding municipal WSPs in Dar es Salaam which might be due to school deworming program in which the overall coverage was 96.87% (309/319). Despite of the low prevalence of STH among school-aged children in the areas surrounding WSP the risk of STH transmission is present if the MDA will be phased out as waste water effluent from Vingunguti had STH eggs contamination higher than recommended level.

6.2 Recommendations

There is a need for technical maintenance and monitoring of Vingunguti WSP to improve pond performance and hence complete treatment of waste water as it was designed to do. Health education and behavior change programs should be provided to urban farmers and inhabitants surrounding WSPs to improve awareness and knowledge on modes of transmission and preventive measures of STH. Also there is a need to take routine monitoring of health status of communities surrounding WSP for an effective STH control program.

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APPENDICES

Appendix I: Consent form- English Version

To be signed by a guardian/parent of a student.

Title: Parasitic contamination of waste stabilization ponds effluent, prevalence and risk factors associated with transmission of soil-transmitted helminthiasis among school-aged children in the surrounding community in Dar es Salaam.

Consent to Participate In the Study

Greeting! My name is Sheila Mbike, a postgraduate student from Muhimbili University of Health and Allied Sciences. I am currently conducting a study titled" **Parasitic contamination of waste stabilization ponds effluent, prevalence and risk factors associated with transmission of soil-transmitted helminthiasis among school-aged children in the surrounding community in Dar es Salaam."**

Purpose of the Study

The study is intended to assess the level of parasitic eggs in treated effluent from Vingunguti and Buguruni waste stabilization ponds, prevalence and risk factors associated with transmission of soil-transmitted helminthiasis among primary school children on the surrounding schools. The results obtained will determine extent, magnitude and a way forward to deal with the observed situation among the surrounding community.

Benefits of the Study

Results from this study will be an important source of information to disease coordinators and Pond operators. The Ministry of Health and Social Welfare children gender and elderly, NTD program, municipal wastewater management authority is expected to use the information to improve control programs of soil transmitted helminthiasis.

What participation Involves

We ask for the participation of your child in the study because she/he is among the school aged

students that are regarded as a group at risk of exposure to soil-transmitted helminthiasis. If you agree he/she will be interviewed on hygienic and sanitary practices, and asked to collect his/her stool for examination.

Confidentiality

All obtained information will be treated as confidential and will be used only for the intended purposes of this research. The research team will compile a report that will contain information about all students examined and interviewed while maintaining confidentiality. No names will be used throughout the research but rather numbers.

Potential Risks

We do not expect any harm to research participants in the study.

Right to withdraw

The child has right to participate or not to participate in the study without giving any reason for so made decision. When you have decided to that he/she participates you are also free to terminate your child's participation at any time in the course of the study.

Contacts

If you have any questions about this study you are free to contact, the principal investigator, Sheila mbike (0782 845182) or mbikesheila@yahoo.com.

If you have any questions/concerns about the rights of a participant you may contact Director of MUHAS Research and Publications Committee. Dr Joyce Masalu P.O.BOX 65001 Dar es Salaam. Telephone number: 2150302-6 and Dr. Billy Ngasala (0754316359).

If you agree to this research, please sign this consent form.

I …… have read and understood the contents of the consent form and my questions have been answered adequately. I therefore consent for the participation of my child on the study.

Signature of the guardian/ parent ……..... Date ……

Signature of the interviewer ……....……. Date ……

Appendix II: Consent Form-Swahili version

Form ya Ridhaa

Isainiwe na mzazi/ mlezi wa mwanafunzi

Utafiti: Uchafuzi wa majitaka kwa minyoo katika mabwawa ya majitaka, minyoo ya tumbo na viashiria hatarishi vya kueneza minyoo ya tumbo kwa watoto wa rika la shule katika jamii inayozunguka mabwawa hayo jijini Dar es Salaam.

Ridhaa ya kushiriki kwenye utafiti

Habari! Jina langu ni Sheila Mbike, mwanafunzi wa shahada ya uzamili kutoka chuo cha sayansi ya tiba na afya Muhimbili. Ninafanya utafiti wa kuangalia uchafuzi wa majitaka kwa minyoo katika mabwawa ya majitaka, minyoo ya tumbo na viashiria hatarishi vya kueneza minyoo ya tumbo kwa watoto wa rika la shule katika jamii inayozunguka mabwawa hayo.

Lengo la utafiti

Utafiti huu una lengo la kuangalia kiasi cha mayai ya minyoo katika majitaka yanayotoka katika mabwawa ya kutibu majitaka katika eneo minyoo ya tumbo kwa watoto na viashiria hatarishi vya kueneza minyoo ya tumbo kwa watoto wa rika la shule katika jamii inayozunguka mabwawa hayo maeneo ya Buguruni na Vingunguti jijini Dar es Salaam.

Ushiriki

Tunaomba ushiriki wa mtoto wako katika utafiti huu maana yeye ni miongoni mwawanafunzi wa rika la shule walio katika hatari ya kupata magonjwa ya minyoo ya tumbo kutokana na umri wake. Ukikubali ashiriki ataulizwa maswali kuhusu viashiria hatarishi pia ataombwa kuleta choo chake kikubwa kwa ajili ya uchunguzi zaidi.

Faida za kushiriki katika utafiti

Utafiti huu utatoa taarifa muhimu kwa mamlaka zinazohusika na kudhibiti magonjwa na mamlaka zinazohusika na utunzaji wa mabwawa ya majitaka. Wizara ya Afya na Ustawi wa Jamii, jinsia wazee na watoto, Mamlaka ya majisafi na maji taka pamoja na kitengo cha taifa cha kudhibiti magonjwa yasiyopewa kipaumbele wanatazamiwa kutumia matokeo haya

kuandaa mikakati thabiti kwa ajili ya kudhibiti magonjwa ya minyoo tumbo.

Usiri

Taarifa zote atakazotoa zitakuwa siri na hazitatumika kwa matumizi mengine mbali na utafiti huu. Timu ya utafiti itachambua taarifa hizi na kutoa ripoti ambayo haitatoa siri yoyote binafsi kwa kuwa majina au taarifa inayomlenga mtu binafsi haitakusanywa katika utafiti huu.

Athari

Katika utafiti huu hatutegemei madhara yoyote kwa mshiriki kwa kipindi chote cha utafiti au hata baada ya utafiti huu.

Haki ya kujitoa na mambo mbadala

Mshirii anao uhuru wa kushiriki katika utafiti huu au kutokushiriki pasipo kutoa sababu yoyote juu ya hatua utakayokuwa umechukua. Ukishakubali ashiriki katika utafiti huu na ukaona kwamba hawezi kuendelea unao uhuru wa kusitisha ushiriki wako muda wowote wa utafiti.

Mawasiliano

Kama utakuwa na swali lolote kuhusu utafiti huu unaweza kuwasiliana na kiongozi wa utafiti huu ambaye ni Sheila Mbike. Simu- 0782845182 au barua pepe- mbikesheila@yahoo.com. Kama utakuwa na swali juu ya haki ya mshiriki kuhusu utafiti huu unaweza kuwasiliana na, Mkurugenzi wa kamati ya utafiti namachapisho yachuo cha afya Muhimbili kwa anuani Dr Joyce Masalu S.L.P 65001 Dar es salaam. Simu ya mezani: 2150302-6, pamoja na Dr. Billy Ngasala (0754316359).

Kama umekubali kushiriki, tafadhali saini hapa:

Mimi ……..,nimesoma na kuelewa kilichoelezwa kwenye fomu hii na maswali yangu yamejibiwa kiufasaha. Hivyo ninakubali mtoto wangu ashiriki katika utafiti huu.

Sahihi ya mzazi/mlezi …….. Tarehe ……..

Sahihi ya mtafiti…… Tarehe……

Appendix III: Questionnaires English version

Questionnaire number…..

Name of school**:……..**

PART A: Demographic Characteristics

1. Where do you live?……
2. Sex…… (Put a tick)
    i. Male ( )
    ii. Female ( )
3. What is your age ……. (in years)?
4. Which class are you? Standard…….

PART B: The hygienic and sanitary practices associated with transmission of soil-transmitted helminthiasis among school-aged children sorrounding Buguruni and Vingunguti WSP

5. Where do you get your drinking water?
    i. From the tap ( )
    ii. From protected cleaned spring ( )
    iii. From protected well ( )
    iv. From a river ( )
    v. From other source .specify……
6. How do you treat drinking water at home?
    i. By boiling ( )
    ii. By using water treatment chemical ( )
    iii. None ( )
7. Do you have latrine at your home?
    i. Yes ( )
    ii. No ( )

8. Is a latrine at your home cemented on the floor?
    i. Yes ( )
    ii. No ( )
9. How often do you use the latrine?
    i. Continuously ( )
    ii. Sometimes ( )
    iii. Never use ( )
10. Do you always wash your hands before you eat?
    i. Yes ( )
    ii. No ( )
11. Do you ever eat unwashed raw food or fruits?
    i. Yes ( )
    ii. No ( )
12. Do you always wear shoes?
    i. Yes ( )
    ii. No ( )
13. Do you eat soil?
    i. Yes ( )
    ii. No ( )
14. Have you ever taken ant-helminthic drug?
    i. Yes ( ) if yes go to Question 15
    ii. No ( )
15. When did you last take an ant-helminthic drug?
    i. This year ( )
    ii. Last year ( )
    iii. I don't know ( )
16. Where did you get the anthelminthic drug?
    i. At school ( )
    ii. From health facility ( )

Appendix IV: Questionnaire-Swahili version

Dodoso la Kiswahili

Dodoso nambari ..…..

Jina la shule……..

SEHEMU A: Taarifa binafsi

1. Unaishi wapi? ……
2. Jinsia (Weka tiki)
    i. kiume ( )
    ii. kike ( )
3. Umri (Miaka)….....
4. Unasoma darasa la ngapi? Darasa la ……

SEHEMU B: Viashiria hatarishi vya kueneza minyoo ya tumbo kwa watoto wa rika la shule katika jamii inayozunguka mabwawa hayo maeneo ya Buguruni na Vingunguti jijini Dar es salaam.

5. Unapata wapi maji ya kunywa nyumbani?
    i. Toka bombani ( )
    ii. Toka kwenye chemchem ( )
    iii. Kisima kinachotunzwa ( )
    iv. Kutoka kwenye mto ( )
    v. Chanzo kingine elezea.....
6. Je ni njia gani huwa mnatumia kutibu maji ya kunywa nyumbani?
    i. Tunachemsha ( )
    ii. Tunaweka dawa ( )
    iii. Tunakunywa hivyo hivyo bila kuchemsha( )

7. Kuna choo nyumbani kwenu?
    i. Ndiyo ( )
    ii. Hapana ( )
8. Choo cha nyumbani kimesakafiwa?
    i. Ndiyo ( )
    ii. Hapana ( )
9. Unatumia choo mara ngapi?
    i. Wakati wote ( )
    ii. Mara chache( )
    iii. Situmii kabisa ( )
10. Unaosha mikono yako kabla ya kula?
    i. Ndiyo ( )
    ii. Hapana ( )
11. Huwa kula vya kula ama matunda bila kuosha?
    i. Ndiyo ( )
    ii. Hapana ( )
12. Unavaa viatu mara Kwa mara?
    i. Ndiyo ( )
    ii. Hapana ( )
13. Unakula udongo?
    i. Ndiyo ( )
    ii. Hapana ( )

14. Ulishawahi kupata dawa ya minyoo?

    i. Ndiyo ( ) Kama ni Ndiyo endelea swali la 15

    ii. Hapana ( )

15. Ulipata lini dawa ya minyoo?

    i. Mwaka huu ( )

    ii. Mwaka uliopita ( )

    iii. Sikumbuki ( )

16. Ulipewa dawa za minyoo wapi ?

    i. Shuleni ( )

    ii. Kituo cha kutolea huduma ya afya ( )

Asante kwa kushiriki

Appendix V: Laboratory stool examination results sheet

ID No	Date	School	*Trichuris trichiura*							*Ascaris lumbricoides*							Hook Worms						
			Eggs/gram	Light Infection		Moderate Infection		Heavy Infection		Eggs/gram	Light Infection		Moderate Infection		Heavy Infection		Eggs/gram	Light Infection		Moderate Infection		Heavy Infection	
				Yes	No	Yes	No	Yes	No		Yes	No	Yes	No	Yes	No		Yes	No	Yes	No	Yes	No

KEY:

infection	Light infection	Moderate infection	Heavy infection
Ascaris lumbricoides	1-4999 eggs per gram	5000-49999 eggs per gram	≥50,000
Trichuris trichiura	1-999 eggs per grams	1000-9999 eggs per gram	≥10,000
Hookworms	1-1999 eggs per gram	2000-3999 eggs per gram	≥4,000

Appendix VI: Laboratory wastewater examination results sheet

	Name of WSP:						
Date	Volume of Pellet	Volume of Final Product		Types of Parasitic Eggs			
			No. of eggs	Trichuris Egg	Ascaris Egg	Hook worms egg	Others