FACTORS ASSOCIATED WITH WATER BORNE DISEASES AMONG PUPILS IN KIGANJO LOCATION NYERI DISTRICT, KENYA

NGARI PAULINE KATHUGU (HND)
I 57/0254/03

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PUBLIC HEALTH AND EPIDEMIOLOGY IN THE SCHOOL OF PURE AND APPLIED SCIENCES OF KENYATTA UNIVERSITY

AUGUST 2009

DECLARATION

I hereby declare that this thesis is my original work and has not been presented for a degree in any other university.

Signature..... Date..... 9/11/09

Ngari Pauline Kathugu

I 57 / 0254 / 2003

SUPERVISORS APPROVAL

We, the University supervisors confirm that the work reported in this thesis was carried out under our supervision. We have read it and hereby approve the thesis for submission to the University.

Signature..... Date..... 13-11-2009

Dr Michael Gicheru

Department of Zoological Sciences

Kenyatta University

Signature..... Date..... 05/10/10

Dr Lucy Kamau

Department of Zoological Sciences

Kenyatta University.

DEDICATION

This thesis is dedicated to my parents who were keen to see me pursue my education, and to my family for persevering with the situation of me being a wife , a mother, a civil servant and a scholar.

ACKNOWLEDGEMENTS

My sincere thanks go to my supervisors, Dr Michael Gicheru and Dr Lucy Kamau both of Kenyatta University for their support. It would not have been possible to complete this thesis without their commitment. I give my appreciation to Professor E. Kabiru of Kenyatta University, Professor Z. Ng'ang'a of Jomo Kenyatta University of Agriculture and Technology, and to Mr S. Mogere of Kenyatta University who were my initial supervisors hence creating a base to start on the research.

I wish to acknowledge the University for creating an enabling environment for workers like me to advance in education. I acknowledge the School of Pure and Applied Sciences for initiating the degree program of Masters of Public Health and Epidemiology in Zoological Sciences department which has now moved to Department of Public Health, School of Health Sciences. This gave me a chance to undertake my degree.

My sincere thanks go to the Nyeri District Health Management Team for their support, the entire staff of the District Public Health Office of Nyeri, especially to Boniface Macharia, and John Mugwe for their efforts to see me through the study by assisting me in getting the information required in the reported research in this thesis. Thanks to Mr P. Nyakiamo of Southern Nyanza Community Development Project for assisting in editing the thesis.

My gratitude also goes to the teachers and parents of Kahiga, Nyaribo, Kiganjo and Ndurutu primary schools for consenting to have their children participate in the study. I thank them all for the cooperation without which the study would have been impossible.

Lastly my thanks go to my husband Mr Ngari, my children Mwangi, Miguongo and Nyakiere for their moral support. To all my friends and colleagues, I honour your contributions to the study in whatever form.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

DEFINITION OF OPERATIONAL TERMS

Disease - An illness affecting living organisms often caused by an infection.

Health - A state of complete physical, mental and social well being of a person and not the mere absence of disease or infirmity as defined by WHO.

Hygiene - State of cleanliness of an individual, community and environment.

Lower Primary - Pupils of class four and below for the purpose of the study.

Prevalence - It is the number of cases in the population at a given time divided by the population at that time. It is normally expressed per year.

Sanitation - This refers to the safe collection, storage, disposal and maintenance of both liquid and solid wastes.

Upper primary - Pupils of class five and above for the purpose of the Study.

Water borne disease - A disease caused through ingestion of contaminated water either directly or indirectly.

ACRONYMS AND ABBREVIATIONS

CAP	Chapter in Law
CBS	Central Bureau of Statistics
DEO	District Education Officer
DFID	Departmental Fund for International Development.
DMOH	District Medical Officer of Health
ESACIPAC	Eastern and Southern Africa Centre of International Parasite Control
GOK	Government of Kenya
MOEST	Ministry of Education Science and Technology
MOH	Ministry of Health
SPSS	Statistical Package for Social Scientists
UNESCO	United Nations Education Scientific and Cultural Organization
UNEP	United Nations Environmental Program
UNICEF	United Nations Children Education Fund
WHO	World Health Organization

ABSTRACT

School children are exposed to various types of water borne diseases. There are different factors that contribute to the occurrence of these diseases in different schools. Water borne diseases are intricately linked to quality water, sanitation and hygiene. Sanitation is an environmental factor that is associated to occurrence of diseases such as intestinal worms, and other water borne diseases, while hygiene is equally import in occurrence of water borne diseases. Deforestation of the water catchment's towers at the Aberdare, Mau and Mt. Kenya forests have reduced the water quantities in the region. This may have compromised the water quantity and quality as well as sanitation and hygiene standards of Nyeri district which lead to occurrence of water borne diseases. There is scarce information on water borne diseases in Nyeri district and more recent information needs to be documented. The study was conducted in Kiganjo location of Nyeri district to determine the factors associated with the infection of water borne diseases among the pupils in the location as well as the levels of infection. The study area, being disadvantaged by its aridity and dependency on the depleting water sources from Mt Kenya and Aberdares, was purposively selected to represent Nyeri district. A random selection of schools from this location was done using the random numbers to select schools across the location. Pupils were selected using the systematic random sampling from the school's registers. A total of 375 pupils were sampled for the study. Data was collected by recording of the results on stool examination done to the respondents, and by using an observation checklist in the selected schools. Data on water quality was collected by carrying out a bacteriological water analysis on all the water sources in the location and recording the results for comparison with the infection rates of respondents. Secondary information was gathered from the location's health centre where school children get their medical services. Data was processed using SPSS soft ware and then analyzed using chi-square test to determine the associations between age, sex and infection, as well as infection rate and independence of the school. The results of the study showed that prevalence of water borne diseases was 54.4%. Of this prevalence, 38% was infection by *E. histolytica,* 7.2% by *G. lamblia*, and 21.65% by intestinal worms, the rest being *E. coli* which is a normal flora in the gastro intestinal track. The infection by water borne diseases was independent of school (chi-square = 13.680, p = 0.033). There was a significant relationship between the class category according to age and the infection by parasites that are water borne. The lower age group of 5 – 10 years being more infected (chi-square = 5.953, p = 0.015). The schools with poorer water quality, sanitation and hygiene had more infections by the water borne diseases. There was a significant correlation in hand washing and the infection (r = -0.986, p = 0.005), indicating the leading factor associated with infection of water borne diseases in the region. The availability of toilets in relation to infection was significant (r = -0.9765, p = 0.005) and was next to hand washing. It was recommended that health workers provide prompt treatment to the infected and also undertake regular deworming. Schools should adhere to the sanitation and hygiene standards set by MOEST together with the Public Health Act CAP 242 L.O.K. NYEWASCO should extend the supply of treated water to all the primary schools in Kiganjo location and other schools in Nyeri district.

CHAPTER ONE: INTRODUCTION

1.1 Background information

In the developing countries, there exists a high prevalence of water and sanitation related diseases with millions of the world's poorest dying from preventable diseases caused by inadequate water supply and sanitation services (WHO, 1999). Water borne diseases are the single most important cause of death and illness in the developing world (Winbad, 1996). More than three million people die annually due to water borne diseases (Winbad, 1996). Children are the main victims of the sickness that results due to inadequate water and sanitation services (DFID, 1998). The major causes of morbidity and mortality in Kenya are diseases and conditions that are preventable through proper environmental management, or basic hygiene. The existing environmental problems relate to the low level of safe drinking water, poor environmental sanitation and refuse disposal. As a result, water borne diseases such as typhoid and cholera among others have become major threats (Rukwaro, 2005). Inadequate and poorly maintained sewerage systems, untreated water supplies as well as lack of toilet facilities lead to water borne diseases (GOK, 1999). Globally, about 1.7 million deaths occur each year which are attributed to unsafe water, sanitation and hygiene, of which nine out of ten of such deaths are in children and virtually all such deaths are in developing countries (WHO, 2002).

Water borne diseases are transmitted by water such that water acts a passive vehicle for the infecting agents and depend also on poor sanitation (Rukunga, 2001). They arise from the contamination of water by human or animal faeces or urine infected by infectious material,

which are directly transmitted when the water is drunk or used in the preparation of food for example cholera and typhoid. There may be direct transmission through the faecal oral cycle (Morgan, 1990). Diarrhoea, skin diseases, and eye infection contribute greatly towards high outpatient morbidity in Kenya, where collectively approximately two million cases received care in health facilities in 1999 (MOEST & JICA, 2004). Though the exact proportion of school children affected may be unknown it is expected to be high. A study by Chabalala and Mamo (2001) indicates that water supply in Nakuru, Kenya falls short of demand, resulting in many residents using less than what is considered sanitary. Poor waste disposal mechanisms in both urban and rural areas are below satisfactory requirements and this contributes in the pollution of water sources.

1.2 Problem statement

World wide it has been reported that water borne diseases are responsible for over 1.2 million deaths an year. Kenya is one of the countries experiencing effects of global warming on water and sanitation management (www.oneworld.net/guides). Attack on water sources brings sanitation crisis (Barllet, 2009). Poor sanitation facilities and unsafe drinking, washing, and cooking water are contributing to water borne diseases (Hinrichsen, 1998). More people are killed by water borne diseases rather than any other diseases in the world (WHO, 1999). It is estimated that water, sanitation and hygiene are responsible for 4% of all deaths and 5.7% of the total disease burden occurring world wide, accounting for diarrhoeal diseases, schistosomiasis, trachoma, ascariasis, trichuriasis and hookworm disease (Pruss *et al.*, 2002). The rapid increase of primary school enrolment in Kenya has increased pressure on the limited water and sanitation facilities available in schools (Rukwaro, 2005). For

example, diarrhoea and intestinal parasites infections constitute 30% of diseases reported annually at Kiganjo health centre of Nyeri district where pupils in Kiganjo location seek medical attention (DMOH, 2003). This is higher than in the other health facilities in the district. Most schools do not have adequate water supply (MOEST, 2003). Sanitation facilities in Nyeri municipality are strained and as a result diseases related to sanitation and hygiene are prevalent (Rukwaro, 2005).

There are more than 1.4 million children (87% of all children) living in developing countries where most of the environmental challenges exist (UNEP *et. al.*, 2002). In Kenya the primary school going age of 5-14 years comprise 30% of the national population (Vynckt and Nkinyangi, 1995). Since the introduction of free primary education toilet shortage and hygiene have hampered free education (Kirimi, 2004). Some areas in Nyeri municipality do not get treated water and depend on river water for washing and domestic requirements which result to water borne diseases (Ayeko, 1990). In Nyeri District the prevalence of diarrhoeal diseases and intestinal worms is 3.3% and 7% respectively, with Kiganjo location reporting 30% of them. The presence of amoebiasis and typhoid cases in Nyeri district has been associated to usage of untreated water (DMOH, 2003). Water samples from the areas where diarrhoea and typhoid have been suspected show the presence of bacterial contamination against the recommended levels (DMOH, 2004).

1.3 Justification of the study

Climate crisis affects sustainability of water and sanitation issues exposing people to conditions favourable for water borne diseases (Power, 2008). Kenya is experiencing the

effects of deforestation of the main water towers (Majtenyi, 2007). Nyeri is served by water from Mt Kenya forest and Aberdare ranges which are among the affected water towers. This study will establish factors associated with water borne diseases among the pupils within Kiganjo location of Nyeri district and determine the levels at which these diseases occur. The study also seeks to document more information on the current situation of water supply, sanitation and waterborne disease levels in the district. The results of the study will assist the Tana Water Services Board in providing the current levels of water contamination in the location, hence the interventions required to make the water safe in the location and other areas in Nyeri. The study will assist the Ministry of Public Health and Sanitation in setting interventions based on prevailing water borne diseases that will be found in Nyeri. The results will be of use to Ministry of Education Science and Technology, and Ministry of Health in policy making once the levels of the factors associated with water borne diseases in the area are established . The environmental health and hygiene policy has a goal to provide a national framework for integration of health and education matters through school based health interventions (Kirimi, 2004).

1.4 Research questions

(a) What are the common water borne diseases occurring among pupils in Kiganjo location?

(b) What are the factors associated with the spread of the common water borne diseases among pupils in Kiganjo location?

1.5 Null hypotheses

(a) There are no water borne diseases among pupils in Kiganjo location.

(b) The presence of water borne diseases among pupils is not related to sanitation practices.

1.6 Objectives of the study

1.6.1 General Objective

The main objective of the study is to determine the factors associated with prevalence of the common water borne diseases among pupils within Kiganjo location.

1.6.2 Specific objectives

(a) To investigate the factors associated with the spread of the common water borne diseases among the pupils in Kiganjo location

(b) To determine the prevalence of common water borne diseases among pupils in Kiganjo location.

CHAPTER TWO: LITERATURE REVIEW

2.1 Water supply

Water sources for human are rivers, lakes, wells, boreholes, springs, dams and rain (Morgan, 1990). Water is necessary for the existence of all living things with the human body, requiring 2-10 litres of water per day for normal physiological functions depending on climate and workload. Water consumption per capital per day is determined by several factors such as availability, quality, cost, income level, family size, cultural habits, standard of living, climate, and means of distribution (Rukunga, 2001). In countries where a large number of population does not have access to safe drinking water, a substantial number of water borne infections are encountered (Hunter, 1997). A range of 20-40 litres of fresh water per person per day is considered to be a necessary minimum to meet needs for drinking and sanitation. The lowest drinking water coverage rates are in the sub-saharan Africa (58%) and in the pacific (52%), with the largest numbers of affected people in Asia where sanitation is worse (WHO, 2000). In Africa, two out of five people lack adequate water supply (WHO, 2000).

Lack of safe water supply is a global emergency and one sixth of world population, which translates to over 1.1 billion people struggle daily without safe water while 2.6 billion people lack even basic toilet facilities (UNICEF, 2006). It was observed that in Nyeri, out of 68% of the schools with piped water in the compound, there are 14% of them experiencing water rationing (Rukwaro, 2005). Estimates in Kenya indicate that 50-75% of rural and urban population has access to safe drinking water, with 31% of the population having piped water (GOK, 2002). In Kenya, 56% of schools have access to safe water supply (UNICEF, 2003).

2.2 Hygiene and water supply

As early as 400 BC, it was recognized that polluted water was associated with disease (Whitlock, 1954). Studies on impact of water supply and sanitation improvement on health have generally found that for maximum health impact, the hygiene facilities have to be linked with promotion of personal and domestic hygiene. Results of a study done in Malawi on microbial quality of drinking water highlighted that there is need for improvements in the provision of wholesome water, improved personal hygiene and environmental sanitation (Jabu, 2004).

Surveys carried out on quality water tested at source and from the containers used to collect the water, indicated that the containers themselves may often be the source of some contamination (Morgan, 1990). No individual can possibly benefit from the hygiene practices associated with water unless water is available, close by and in reasonable quantities, while the water available must be accompanied by hygienic practices by individuals in order to have an effect on health (Morgan, 1990). Hands may be responsible for carrying pathogenic bacteria from contaminated places to the mouth and especially to children who seem to suffer most enteric diseases. A study done in Nyanza province observed that 93% of pupils learnt about water treatment at school (O'Reilly *et* al., 2006). Children should have accessible hand washing facilities as these are important hygienic practices after a person has used the toilet and before taking meals (Morgan, 1990). Safe drinking water and hygiene are essential in reducing the burden of diarrhoea, a major cause of childhood morbidity and mortality in Kenya (O'Reilly *et al.,* 2006).

2.3 Water quality and sanitation

The most widespread contamination of water is from disease bearing human wastes, usually detected by measuring faecal coliform levels. Human wastes pose great health risks to water sources. A study in Wajir town observed that shallow wells in the town were exposed to faecal contamination and 94% of the wells are grossly contaminated with faecal *Escherichia coli* (Saidi *et al.*, 2004). These authors recommended that there is need to improve on sanitation service delivery in Wajir town, so as to maintain good water quality. Water sources for schools should be protected from contamination by latrines, sewage works, refuse disposal sites and industries (GOK, 1996). In a study in Brazil it was observed that households with adequate excreta disposal facilities were significantly likely to be in the group classified as "mainly hygienic" and were experiencing less diarrhoea cases in children, as compared to those classified as "unhygienic" and were experiencing more diarrhoea cases in children (Strina *et al.*, 2002).

In Kenya, 28% of the population depend on lakes and rivers which are exposed to pollutants (CBS, 2002). Sewerage coverage is fairly low in urban areas and non existent in rural areas. The sanitary facilities used in rural areas consist mainly of un-improved pit latrines (Kiongo, 2005). Studies in the southern Nyanza community have revealed very low sanitation standards contributing to water contamination and causing diarrhoeal diseases among others (GOK, 2006). One of the Kenya government's policies is to supply water of good quality and in sufficient quantities for the various water needs while ensuring safe disposal of waste water and environmental protection (Kiongo, 2005). Studies show that providing access to safe water and adequate sanitation to all who lack it would reduce the health risks to

reasonable levels (WHO and UNEP, 1991). Most of gastro-intestinal illnesses are caused by drinking contaminated water while shortage and lack of good hygiene habits create the conditions for water washed diseases such as scabies, trachoma and diarrhoea diseases (Kiongo, 2005).

2.4 Common water borne diseases

The three major micro-organisms responsible for water borne diseases namely *Salmonella typhi*, *Giardia lamblia* and *Entamoeba histolytica* are an indication of poor water and sanitation facilities (Chabalala and Mamo, 2001). The water borne diseases are transmitted either directly by taking contaminated water or food or indirectly for example when the body comes into contact with contaminated water, like in the infection of schistosomiasis. The most common water borne diseases are typhoid, *Amoebiasis, Giardiasis*, cholera, gastro-enteritis and diarrhoea (Hunter, 1997). *Amoebiasis* is more common among institutionalized people with poor sanitation practices (Berkow and Beers, 1977). Likewise, *Giardiasis* which is common among children occurs where sanitation is poor. Typhoid bacteria are shed in faeces and urine of infected people. Inadequate hand-washing after defecation or urination spread *salmonella typhi* to food or water supplies (Berkow and Beers, 1997). *Escherichia coli (E. Coli)* is responsible for most diarrhoeal cases even in the developed countries *Giardia* and *cryptosporidia* are responsible for most gastroenteritis diseases while viral agents like hepatitis species are among the worst causative agents of water borne diseases in Africa (Chabalala and Mamo, 2001).

Diarrhoea diseases which are the major water borne diseases are prevalent in many countries mainly due to inadequate sewerage treatment. An estimation of 4 billion cases of diarrhoea disease is experienced every year causing 3-4 million deaths among children (Hinrichsen, 1998). A study by Swaddinwudhipong *et* al., (1998) showed that there is a strong association between shigellosis and drinking un-boiled water. An outbreak of diarrhoea in 1992 in Swaziland was found to be caused by *E. coli* as a result of consuming contaminated water (Effler *et al*, 1992).

2.5 Water and sanitation Services - situation analysis in Kenyan municipalities

The central bureau of statistics has indicated that some rural areas in Kenya (28%) depend on lakes and rivers as their source of water supply. This is unclean water as it is not subjected to any form of treatment. The other percentage depends on piped water, wells, boreholes and dams (CBS, 2002). However, 56% of schools in Kenya have access to safe water supply (UNICEF, 2003). Sewerage coverage is fairly low in urban areas and non existence in rural areas. The sanitary facilities used in rural areas consist mainly of un-improved pit latrines (Kiongo, 2005). According to MOEST (2003) the schools with improved water and sanitation services are served by the public systems operated by Ministry of Water Resources, National Water Conservation Cooperation, non governmental organizations and local authorities.

Most towns lack adequate means of waste collection This increases the risk of water borne diseases, for example only 20% of waste is collected in Kisumu city while only 10% of the town has sewerage coverage (htt;//ash-n-aafrica.blogspot.com/2007/02/kisumu-kenya html.).

The coastal towns in Kenya experience rampant water borne diseases due to lack of fresh water (Ochiewo, 2004) . A study in Ruiru town revealed that 30% of the children in the town's slums excreted in the open and 97% of the water sources were found to be contaminated. This contributed occurrence of water borne infections among the slum dwellers (Murage, 2006). In Kenya's municipalities water is contaminated by sewage infiltration while sanitation facilities are inadequate. This leads to high level of water borne infections (htt: //www.kwaho.org.loc-cd-kibera.html.). In Nyeri municipality, 25.1% of the population is connected to the sewer and 74.9 use pit latrines (CBS, 2002). The water services in Nyeri municipality are operated by Nyeri Water and Sewerage Services Cooperation (NYEWASCO), with the other sanitation methods in use being septic tanks, Ventilated Improved Pit latrines and ordinary pit latrines (NYEWASCO, 2003).

2.6 Prevention of water borne diseases

Communication strategy could be used in prevention of water borne diseases, leading to better health. Communication is important not only to achieve water and sanitation facilities, but also to ensure their maintenance and even their construction (Caincross, 1992). Non governmental organizations (NGOs) such as Eastern and Southern Africa Centre of International Parasite Control (ESACIPAC) and other partners are involved in promoting the health of pupils by treating the sick children. This has proved to be a cost effective strategy in improving the health of school aged children (Mwandawiro, 2003).

Legal obligation is another way of controlling the water borne diseases. It was proposed in Turkey that schools had a legal obligation to provide clean, well maintained toilet facilities

for children's use as a way of reducing water borne diseases (Radford and Maheswaran, 2007). Within the health sector the Public Health Act Cap 242, is the principle law on public health. It empowers the MOH to regulate activities concerning human wastes disposal and prescribes standards and procedures to be followed (GOK, 1996). National Environment Management Act (NEMA) regulates several aspects of he environment that may affect the health of the child (GOK, 1999). The Water Act Cap 272 entails the water safety and protection of catchment's areas (GOK, 2002).

The protection of public water supplies from faecal contamination reduces water borne infections. This can be done through sand filtration which removes nearly all cysts, chlorination of water as general practice in municipalities, and boiling of water whose quality has not been determined (Morgan, 1990). Investing in piped water greatly reduces water borne diseases like diarrhoea (Zwane and Kremer, 2007). Health agencies should supervise the sanitary practices of persons preparing food in public eating places and the general premises involved (GOK, 1996).

Controlling transmissions by sanitation will have three benefits. (1) It will reduce prevalence of infection, (2) reduce the intensity of the infection, and (3) greatly reduce the number of people with very intense infections (Caincross, 1992). Control of fly breeding by paying attention to proper disposal of garbage is recommended (Berkow and Beers, 1997). The WHO is spearheading the regional Healthy Environment Alliance, which envisages addressing the existing environmental sanitation issues holistically and appropriately (WHO, 2005). Transmission of faecal pathogens is enhanced by poor sanitation practices. Parasitic

infections for example those causing soil transmitted helminthes are of great concern to experts while bilharzias and hookworm infestations are some of the conditions that could be alleviated through a well planned school based environmental sanitation program (Magnussen *et al,* 1997).

Health promotion where mothers are educated on hygiene of their children as well as involvement of families in mass treatment process has been perceived as a positive measure that can be applied to deal with intestinal worms and other water borne diseases (Mustafa, 2006). Hygiene education aims at changing hygiene practices to good or safe ones in relation to personal, water, food and domestic hygiene. For example, hand washing with soap after defeacation and before taking food has proved to be effective in reducing incidences of diarrhoeal diseases (WHO, 2002). Training and community awareness campaigns, improved environmental sanitation practices through participatory health education processes and support for sanitation facilities are key activities aimed at reducing preventable water borne diseases (SNCDP, 2007).

Personal hygiene is a major factor closely linked to provision of water and adequate sanitation as well as behaviour change with the ultimate achievement of good health free from water borne diseases. Unhygienic and unsafe environments in schools place children at risk of contracting diseases and death (Black *et al.*, 2003). Ingestion of unsafe water, lack of access to or proper utilization of sanitation facilities contribute to about 88% of deaths from diarrhoeal diseases (Black *et al.*, 2003).

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study area

The study was conducted in Kiganjo Location, in Municipality Division of Nyeri District, Kenya (Figure 3.I). The location has a primary school population of 4153 pupils. It covers an area of 33.4km^2. It is located on northern side of Nyeri Municipality division (Figure 3.1). It is served by Kiganjo dispensary which caters for the majority of the location's population as well as the neighbouring Thegu and Mukaro locations. A new dispensary was opened in the location in year 2007 which covers Nyaribo sub location, Kiganjo location, Nyeri Municipality. It was not operational during the time of the study. The area is semi-arid, bordering the drier Kieni East division and a small portion of the eastern side bordering Mathira division. The area is served by the rivers Thego, Sagana, Nairobi, Amboni, and Honi. There is piped treated water in some areas which is supplied by Nyeri Water and Sewerage Cooperation (NYEWASCO). An earth pan is present near Nyaribo primary school. Water tanks for storing rain water are installed in some of the schools. The area was chosen because it showed higher infection of intestinal worms as compared to other parts of the Municipality. The aridity of this peri-urban section of Municipality division of Nyeri district makes the area experience lack of water. This may be a cause of water borne diseases.

3.2 Study population

The study population comprised of the pupils of Kiganjo location in class 1 to class 8 of Nyeri District. The ages varied from 5years to 20years.

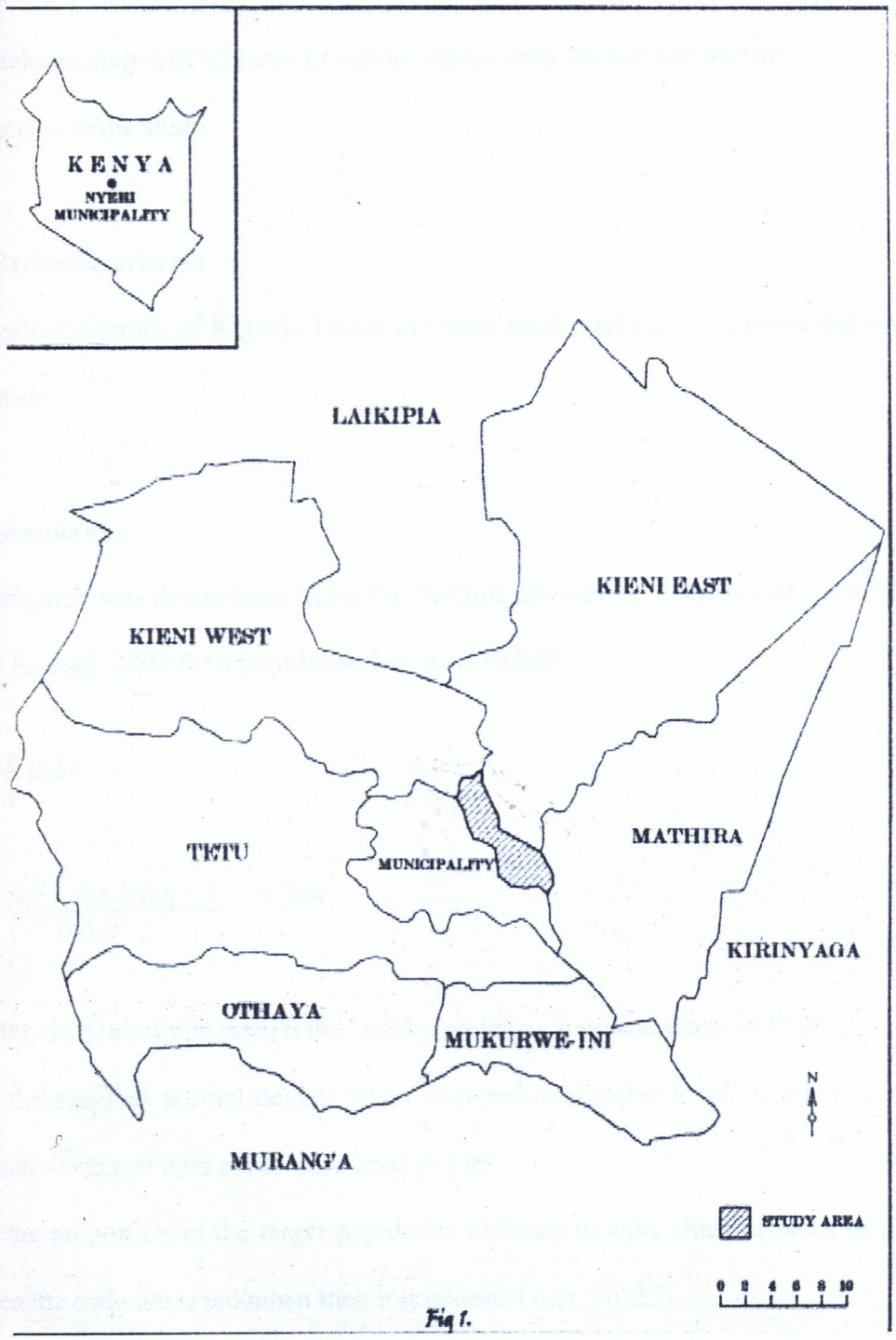

Figure 3.1. Map of Nyeri showing the study area. (Adopted from physical planning, Nyeri. 2006)

3.3 Inclusion criteria

The selected pupils of Kiganjo Location, whose head teacher and parents consented to the study.

3.4 Exclusion criteria

The selected pupils of Kiganjo Location whose head teachers and parents did not consent to the study.

3.5 Sample size

Sample size was determined using the formula as used by Fisher *et al.*, (1998) as adapted from Kothari, 2003 for a population less than 10,000.

$$n = \frac{Z^2pqD}{d^2}$$

$$= \frac{1.96^2 \times 0.5 \times 0.5 \times 1}{0.05^2} = 384$$

n = the desired sample size (if the target population is greater than (10,000)

Z = the standard normal deviate at the required confidence level. In this case the standard normal deviate at 0.05 confidence level is 1.96.

p = the proportion in the target population estimate to have characteristics being measured. When the estimate is unknown then it is assumed that p is 0.5.

q = 1- p = 1-0.5

d = the level of statistical significance set. (in the study 0.05)

D = Design effect usually 1 where there are no replications or comparisons. (There were no replications in the study).

The study involved a target population of less than 10,000, that is, 4153, then a final estimate of the sample size (n_f) was calculated using the following formula:

$$n_f = \frac{n}{1+\frac{n}{N}}$$

$$= \frac{384}{1+\frac{384}{4153}}$$

$$= 352$$

Where: N is the estimate of the population size of the pupils in Kiganjo location which is 4153.

n = the desired sample size (when the population is more than 10,000).

n_f = the desired sample size (when the population is less than 10,000).

The determined sample size was 352. However, due the assumption that some of the samples may not be delivered or may be spoilt then a sample size of 375 was used.

3.6 Ethical considerations

Approval of the research from Kenyatta University was obtained. Permission was sort from Ministry of Education, Science and Technology, District education officer Nyeri and District Medical Officer of Health Nyeri and the head teachers of the randomly selected schools. The respondents and their parents or guardians gave consent on being sensitized of the study. The

area chief consented on being informed of the intended study. Data and information obtained from the respondents was kept confidential.

3.7 The study design

A cross- sectional study was carried out. The study involved pupils in schools across the location. It was assumed that the four selected schools' pupils would be a representative of the location's sample population. The design was able to give the water borne disease situation at that time and the factors associated with their occurrence among the pupils. The design was also able to give the quality of the water accessible to the pupils within the location.

3.8 Sampling method

A random sampling of primary schools in Kiganjo location was done to pick 4 schools in the location out of a total of 11 primary schools. The schools were listed down and assigned numbers, then progressing down column five of the random numbers. Kahiga, Ndurutu, Nyaribo and Kiganjo were the four schools selected for the study. Four schools were preferred because it was noted that if all of them were used then there would be very few pupils from each school, and it would also be difficult to categorize the upper and lower classes and get a workable figure for statistical analysis. Respondents from the sampled schools were selected from the class register using the systematic random sampling. Distribution of respondents across each school was equal.

$k = 4153 / 375 = 11.07$

Every 11^{th} pupil was picked for the study. Each selected pupil gave a stool sample for laboratory examination. Since sex is a confounding factor for disease development, the

respondents' ratio of male to female of 1:1 was used. All the water sources for pupils in the location were sampled for bacteriological analysis. These included rivers, tap water, stored rain water and an earth pan. Chemical analysis was not considered in the study because there were no indicators like industries or horticulture to lead to the concern of chemical contamination.

3.9 Research instruments

Data was corrected using medical laboratory stool analysis instrument (Appendix I). A demographic data form (Appendix II) while a checklist (Appendix III) was used for quantitative and qualitative data on water supply, hygiene and sanitation. The water analysis results were recorded on a table showing the various parameters in bacteriological water quality and the count recorded was used to determine levels of contamination (Table 4.4).

3.10 Data collection method

The respondents' demographic data was collected and recorded. This was obtained from the class register for each selected child. This method gave the age of pupil, sex, category of class that is if in upper or lower class category. A stool sample for each selected pupil was examined under a microscope and the results were recorded for data analysis. The stool samples were examined in the locations health facility's laboratory immediately they were received from the pupils, each day for every selected school. The direct and concentration methods as described by Bauer *et al.,* (1974) of stool examination were applied to each stool sample to examine for bacteria, protozoa, larvae and ova which could be responsible for

water borne diseases. The procedures for the two methods are described in section 3.11 and 3.12.

3.10.1 Identifying protozoa in stool

Direct saline method of stool examination was used to test for the presence of protozoa in the stool. A small portion of stool (pea size) was emulsified in normal saline. It was then placed on a microscope slide and lugols iodine was added. A cover slip was then placed and the sample was examined under a microscope. The results were recorded for each stool sample. This procedure was repeated for every stool sample to identify protozoa. A day was allocated for each school so that it was possible to examine fresh stool.

3.10.2. Identifying Ova in stool

A small portion of stool (pea nut size) was emulsified in 7mls of formal saline. It was crashed with pestle and mortar. The mixture was then filtered through a two layer wet gauze into a 15 mls centrifuge tube. The tube was then coked. It was shaken hard and centrifuged for one minute. The supernatant was then poured out. Two drops of the supernatant were poured separately on a microscope slide. On one slide a drop of lugols iodine was added and covered with a microscope slide. It was then examined under power 10 and 40. The other slide was covered without adding lugols iodine and examined under power 10 and 40 of microscope for detection of larvae. This procedure was repeated for all the stool samples to identify presence of ova.

3.10.3 Bacteriological analysis of water

Bacteriological analysis was conducted on the water samples to determine the contaminants that could have been present in the water used by the pupils within Kiganjo location. In the bacteriological analysis, the total coliforms and faecal coliforms were used as the determinants of bacteriological contamination in the water, using the *E. coli* Count Petri film, sample ready medium system method for enumerating *E. coli* and coliforms in the water samples from all the water sources used by the pupils of Kiganjo location (www.rlc.dccd.edu/mathsci/reynolds/micro/labmanual/water.html). Bacteria were identified using a Petri film whereby 1 ml of the water sample was placed on the center of the Petri film plate. The top film was released and allowed to drop. A spreader was used to distribute the sample over the circular area of the Petri film avoiding rotating or twisting the spreader. The spreader was removed and the plates left standing for 1 minute for the agar to solidify. The plates were incubated with clear film side up at 30 degrees Centigrade for 48 hours. The bacteria colonies were then counted. The results were recorded for data analysis (Table 4.4).

3.10.4 Sanitation and hygiene situation analysis

A check list was used to show the sanitation situation, hygiene practices and situation of water supply in the selected schools. Records of morbidity were viewed on the daily morbidity registers at Kiganjo health centre and Nyaribo dispensary where pupils in Kiganjo location seek medical attention and data on water borne diseases recorded for analysis.

3.11 Data analysis

The data collected was keyed into a computer and processed using statistical package for social scientists (SPSS). Chi-square test of independence was used to determine the association between variables (sex, age). Regression was used to test the relationship between pupil/toilet ratio and infection, and also for the relationship between washing of hands and infection. Infection in different schools was compared using ANOVA. The results were considered to be significant at 0.05 significance level in all the tests.

CHAPTER FOUR: RESULTS

4.1 Water borne disease agents found in the stool samples

Different types of water borne disease causing agents among pupils in Kiganjo Location were found in the stool samples. These agents represent the waterborne diseases afflicting the gastro intestinal tract. The stool samples examined were found to have *Entamoeba histolytica* and *Giardia lamblia* which are primarily water borne. The other infections that were noted and those which are water related are the helminthes namely *ascaris lumbricoides* and hookworms. As noted from the above results the water borne diseases were in form of protozoa (*E. histolytica*, and *G. lamblia*). Also noted from the results were presence of helminthes namely *A. lumbricoides* and hook worms, but these may not be classified as directly water borne since they are not directly contracted from drinking water. All the same the helminthes were of importance in the study because of their indirect relation to water borne diseases. The protozoa, *E. histolytica* and *G. lamblia* are infective.

4.2 Infection by protozoa

The presence of protozoa was identified in the fresh stool of the respondents from the various schools in Kiganjo location. *Entamoeba histolytica* is a parasitic organism responsible for the disease amoebiasis (Berkow and Beers, 1997). When its infection was compared across the schools it was found that 143 out of 375 (38%) of the pupils had the infection of *E. histolytica*, with 12.3% being from Nyaribo primary school, 10.9% from Ndurutu, 9.1% from Kahiga, and 5.9% from Kiganjo. These results were found to be significantly different across the schools (Fig 4.1; $X^2 = 13.554$, df = 3, p = 0.004).

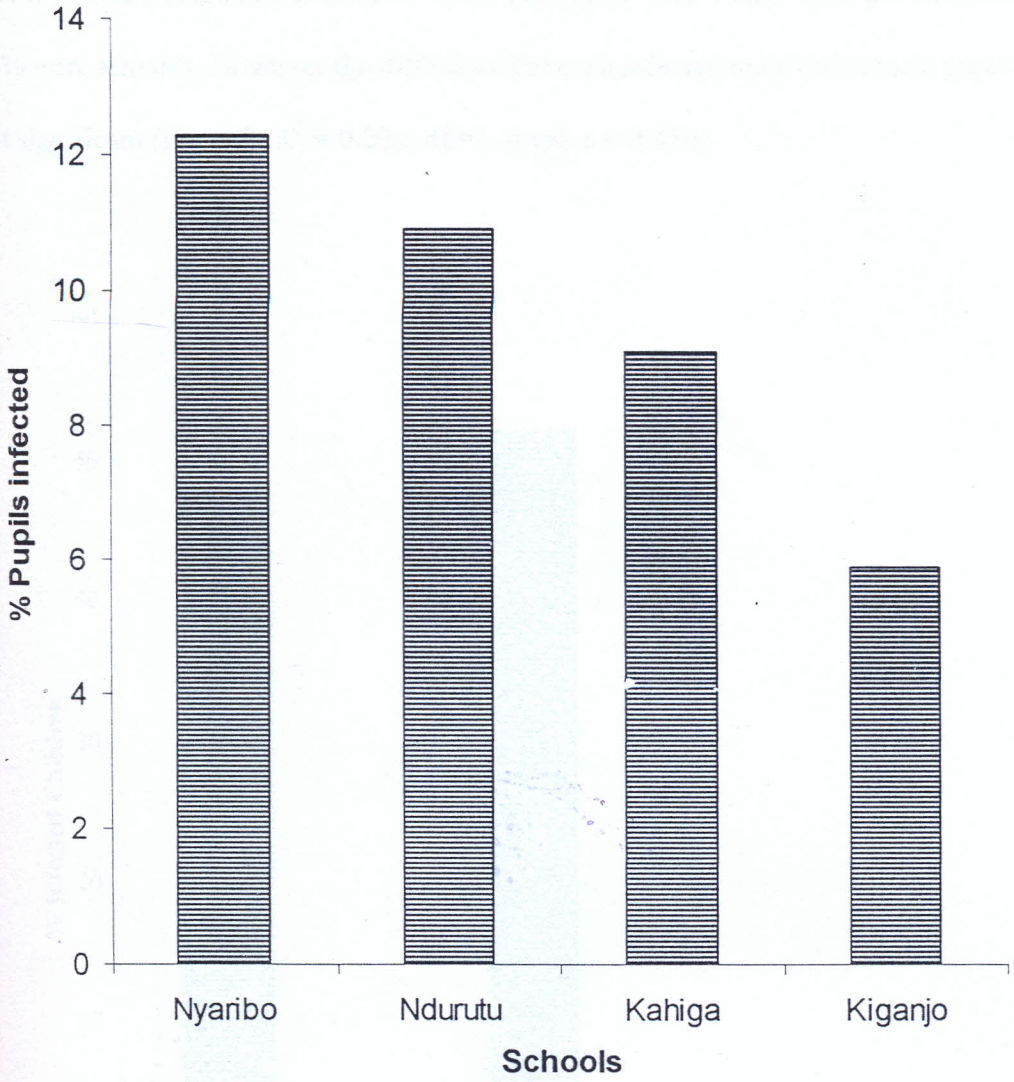

Figure 4. 1: Infection by *E histolytica* across the schools. |There was a significant difference in infection by *E. histolytica* across the schools

Infection of *E. histolytica* was also compared between the sexes in all the schools. In the location the distribution of males and that of females is one to one, that is a ratio of 1: 1. Almost two out of five of the respondents were infected by *E. histolytica.* It was found

that 48% of the respondents infected by *E. histolytica* were males while the rest, that is 52% were females. However the difference between infected male and female pupils was not significant (Fig. 4.2; $X^2 = 0.036$, df =1, p value = 0.850).

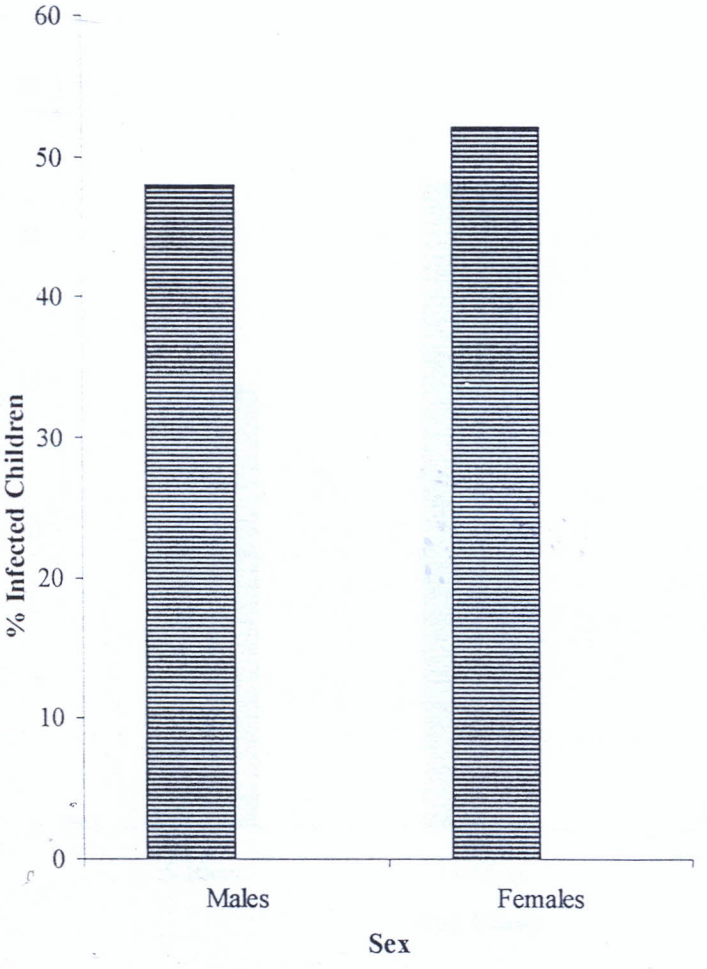

Figure 4.2: Infection by *E. histolytica* between the sexes

The infection by *E. histolytica* was compared between the lower (ages 5- 10yrs) and upper class (ages10-15 yrs) comparison between the ages revealed that the age 10-15

years was more infected, with 80 out of 375 (21.8%) followed by age 5-10 years with 56 out of 375 (14.9%) infections by *E. histolytica*. A reduction in infection was seen in the age above 15 years where 7 children were infected (1.3%). (Fig. 4.3; $X^2 = 5.607$, df = 1, p value = 0.018).

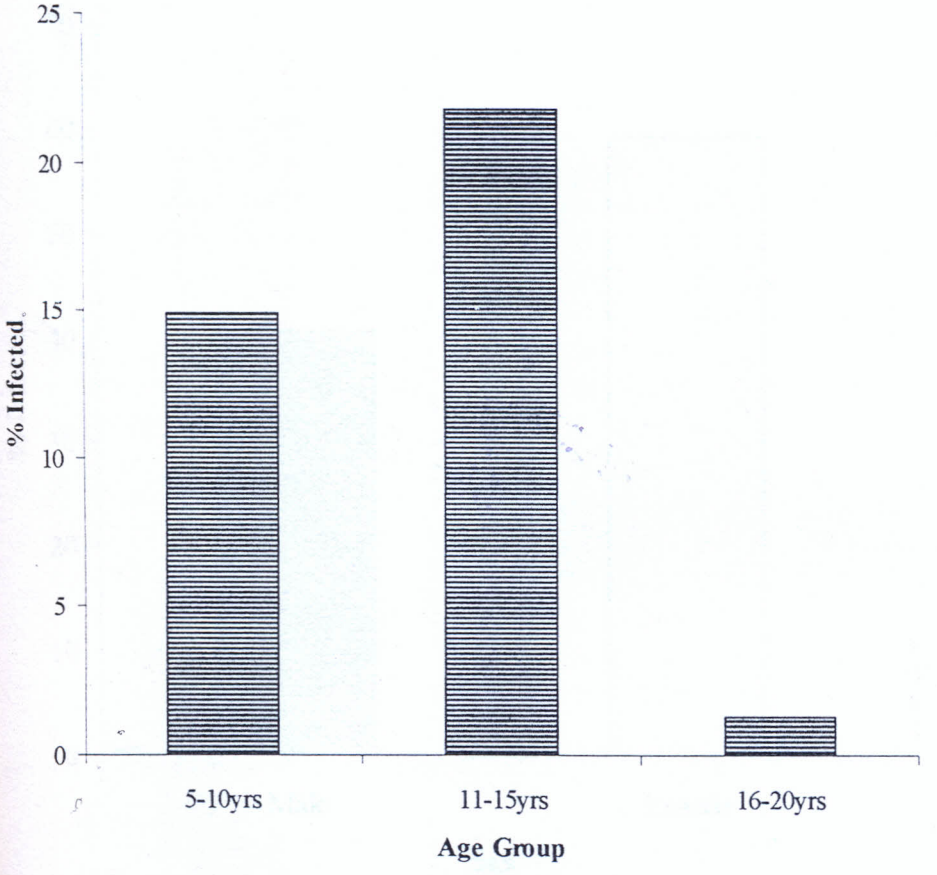

Figure 4.3: Distribution of *E. histolytica* by age group. There was a significant difference in infection by age group

Other than *E. histolytica* the other protozoa found in the stool samples was the *G. lamblia*. Giardiasis is a disease commonly found in children especially those living in

places where sanitation is poor. Out of the 375 children examined a total of 7.2% was found to be infected by *G. lamblia*. When infection by *G. lamblia* was considered between the sexes, female pupils were found to have higher (59.26%) infections than the male pupils (40.74) but the difference was not significant (Fig 4.4; $X^2 = 0.448$, df = 1, p = 0.503).

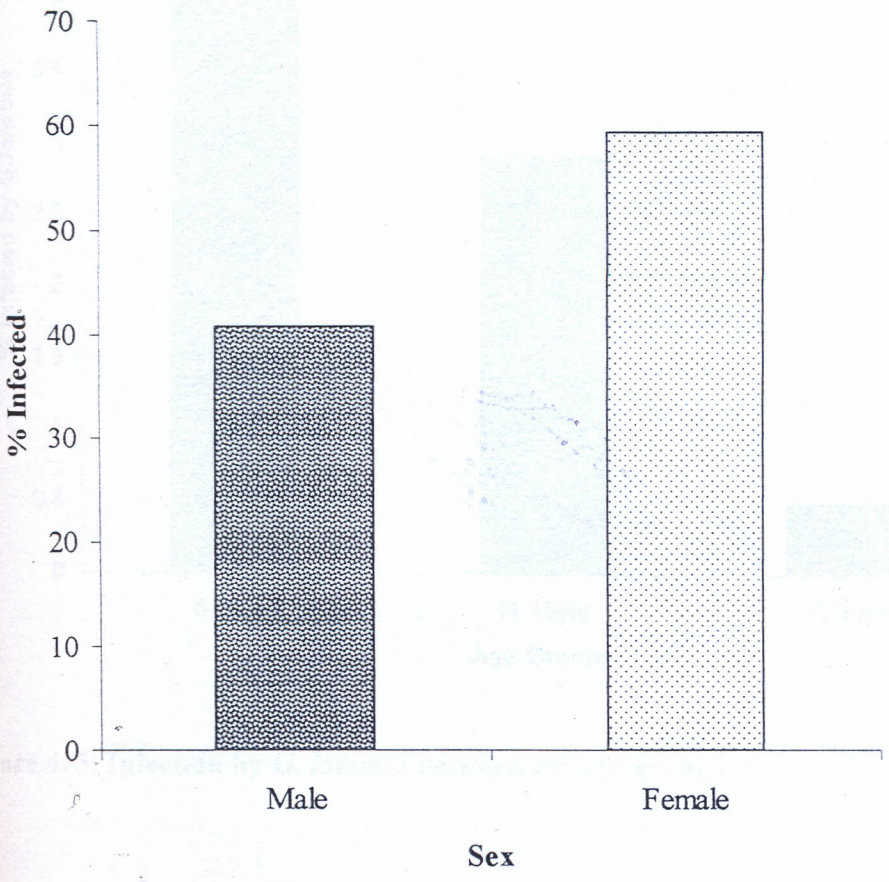

Figure 4.4: Infection by *G. lamblia* between sexes

When infection by *G. lamblia* was considered across the age groups it was found that the lower classes with the lower age group of 5 – 10 years had a higher (4.3%) infection than the upper age group 10-15 years (2.9%) and 16-20 years (0.5%). The difference in the

infection was not significant (Fig 4.5; $X^2 = 1.775$, df = 1, p = 0.183).

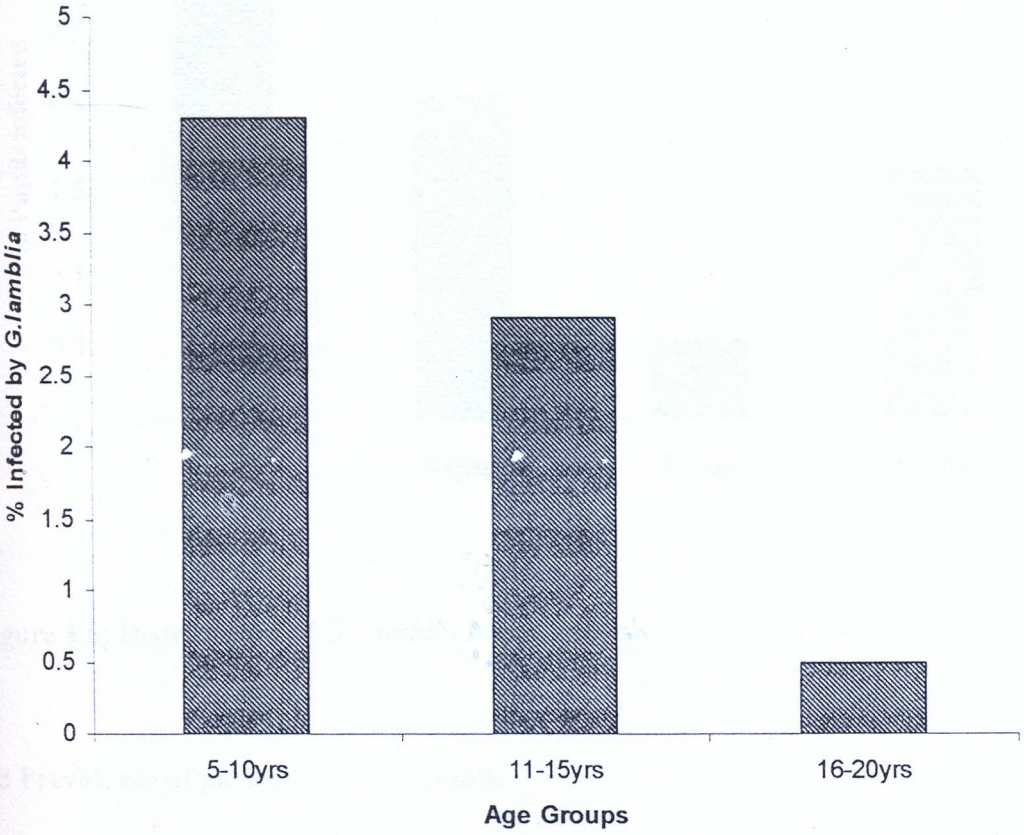

Figure 4. 5: Infection by *G. lamblia* between the age groups

When infection by *G. lamblia* was considered 27 pupils out of 375 (7.2%) had *G. lamblia* infection. The distribution of the infection across the schools was 2.9% for Nyaribo, 2.1% for Kiganjo, 1.6% for Ndurutu and 0.5 for Kahiga primary school. There was no significant difference in the infection by *G. lamblia* across the schools (Fig 4.6; $X^2 = 6.704$, df = 3, p = 0.082)

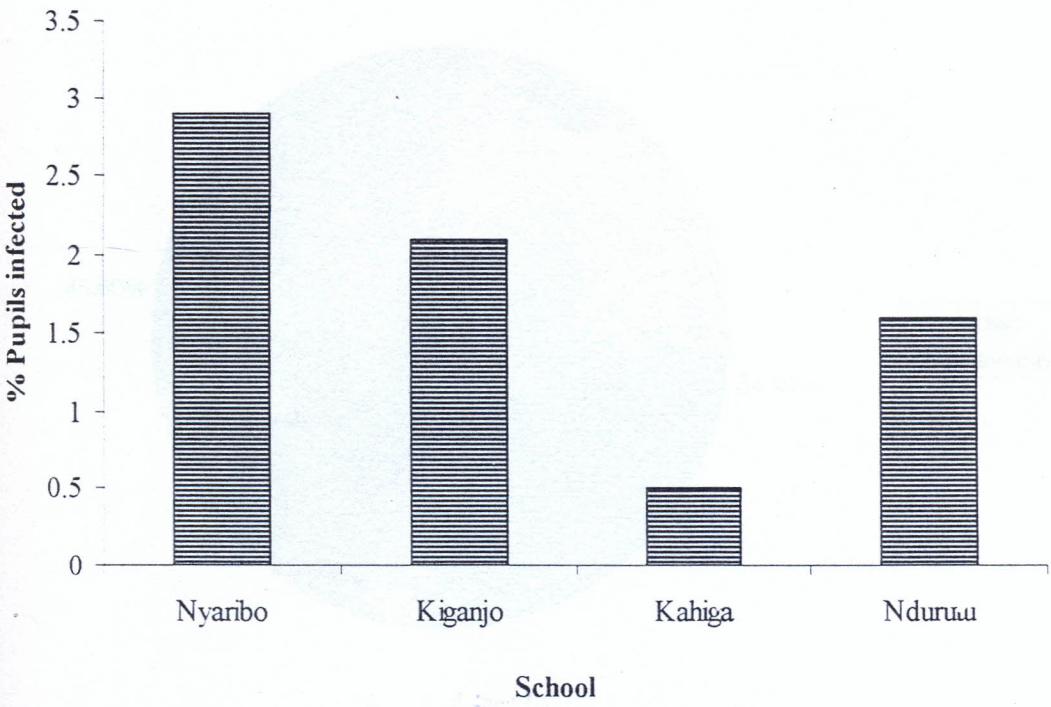

Figure 4.6: Distribution of *G. lamblia* across schools

4.3 Prevalence of parasites among pupils

When infection by the parasites found in the stool samples was considered it was found that there is prevalence of water borne disease among primary school children in Kiganjo location with slightly more than a half, that is 204 (54.4%) of the students being infected with at least a parasite or more while171 (45.6%) were not infected (Fig.4.7).

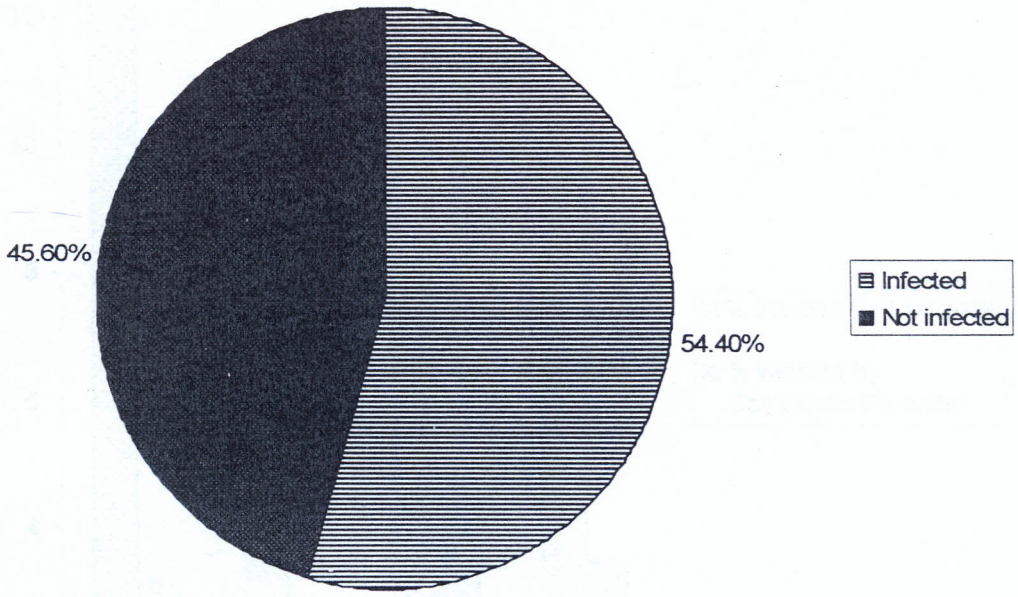

Figure 4.7: Infection by parasites among the pupils

When the infection by either one or multiple parasites was considered across the schools Nyaribo had the highest infection (13.3% by one parasite and 3.2% had composite infection), Ndurutu was second (10.7% by one parasite and 3.46% had composite infection), Kahiga was third (8.5% by one parasite and 4.8% had composite infection) while Kiganjo was the least infected (7.7% of children infected by one parasite and 2.66% had composite infection). The infection across all the schools was significantly different (Fig. 4.8; $X^2 = 13.680$, df = 3, p =0.033).

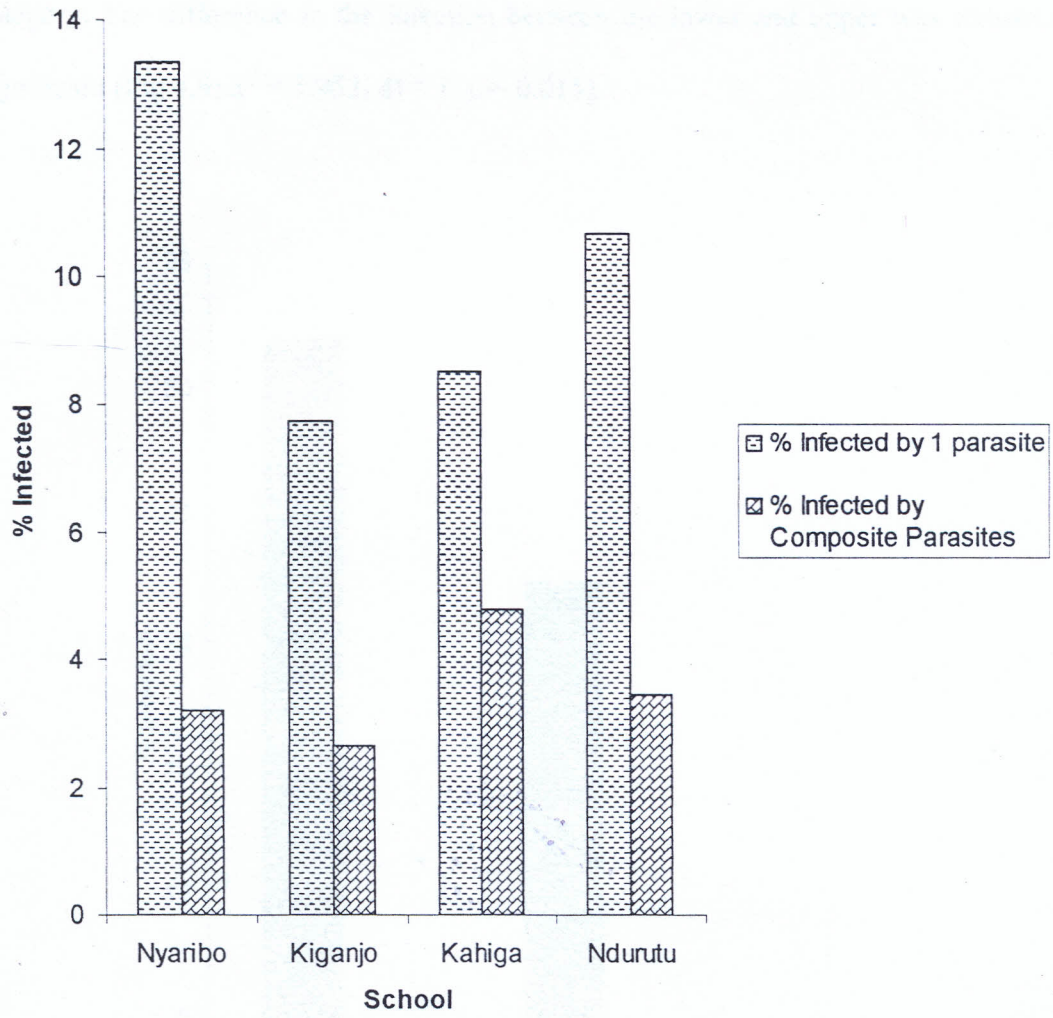

Figure 4.8: Distribution of parasitic infection across schools. There was a significant difference in infection by parasites across the schools

When the all infections out of the 54.4% positive stool samples were considered between the lower and upper class categories, the lower category of age 5-10 years was higher (32%) than that of the upper category of the age above 11-15 years (22.4%). Age 16-20 had the least (1.3%). Out the 204 infections 120 were of age 5-10 years, 84 were age 11-15 years and 5 were above 15 years. When grouping according to class category age 5-10 years was considered as "lower" while 11year and above were considered as "upper"

category. The difference in the infection between the lower and upper was statistically significant (Fig 4.9; $X^2 = 5.953$, df = 1, p = 0.015).

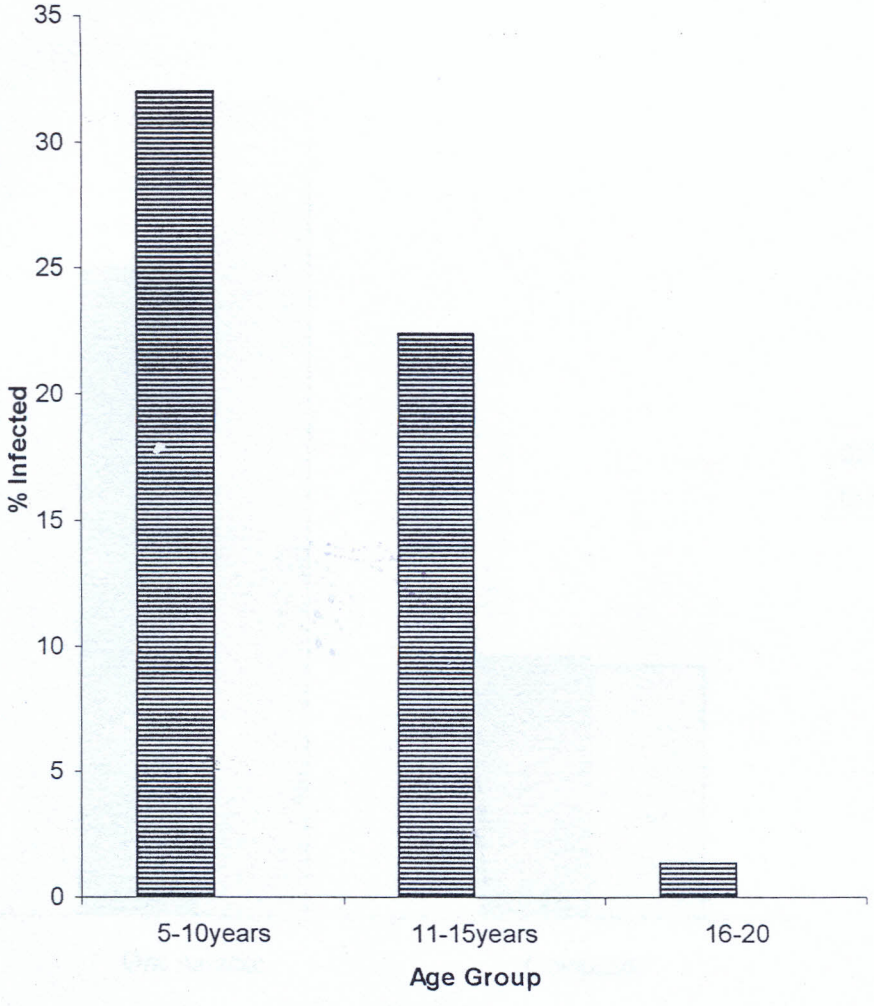

Figure 4.9: Distribution of parasitic infection among age groups. |There was a significant difference in infection across age groups

When infection by one or more parasites between sexes was considered it was found that 22.40% of females had an infection by one parasite while 6.93% had multiple infections,

17.86% of the males had one parasite while 7.20% had multiple infections. There was no significant difference in the distribution of infections by one or more parasites between the sexes (Fig 4.10; $X^2 = 0.325$, df = 1, p = 0.569).

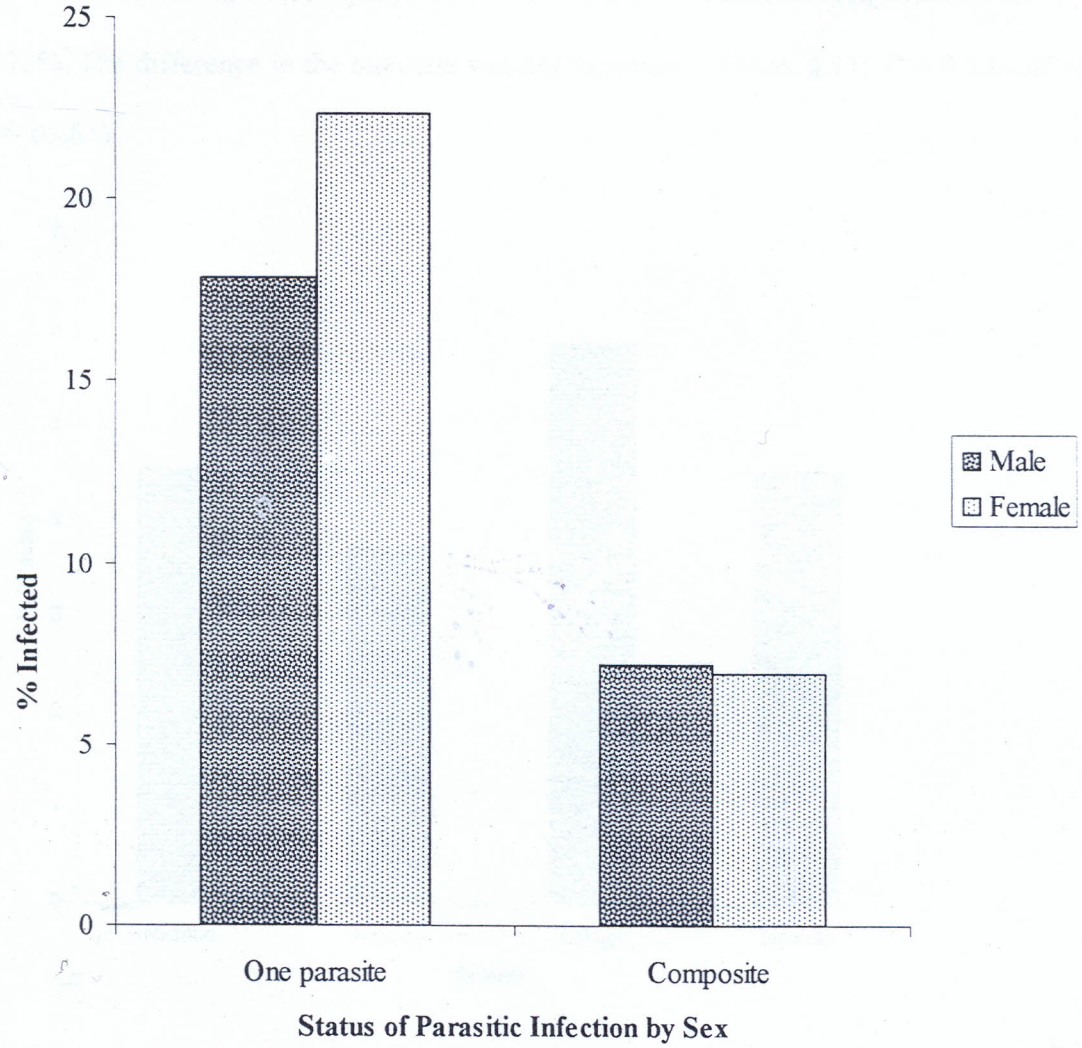

Figure 4.10: Distribution of parasitic infection between the sexes

4.4 Other infections found in stool samples

When infection by other parasites not directly water borne was considered it was found

that there were presence of helminthes. Among the helminthes found were the *Ascaris lumbricoides* and hookworms. When the distribution of the *A. lumbricoides* was considered across the schools it was found that Kahiga had the highest (5.86%) followed by Ndurutu (4.53%) while Nyaribo had 4.53% of the infections and Kiganjo had the least 3.73%. The difference in the infection was not significant (Figure 4.11; $X^2 = 0.542$, df =3, p = 0.461).

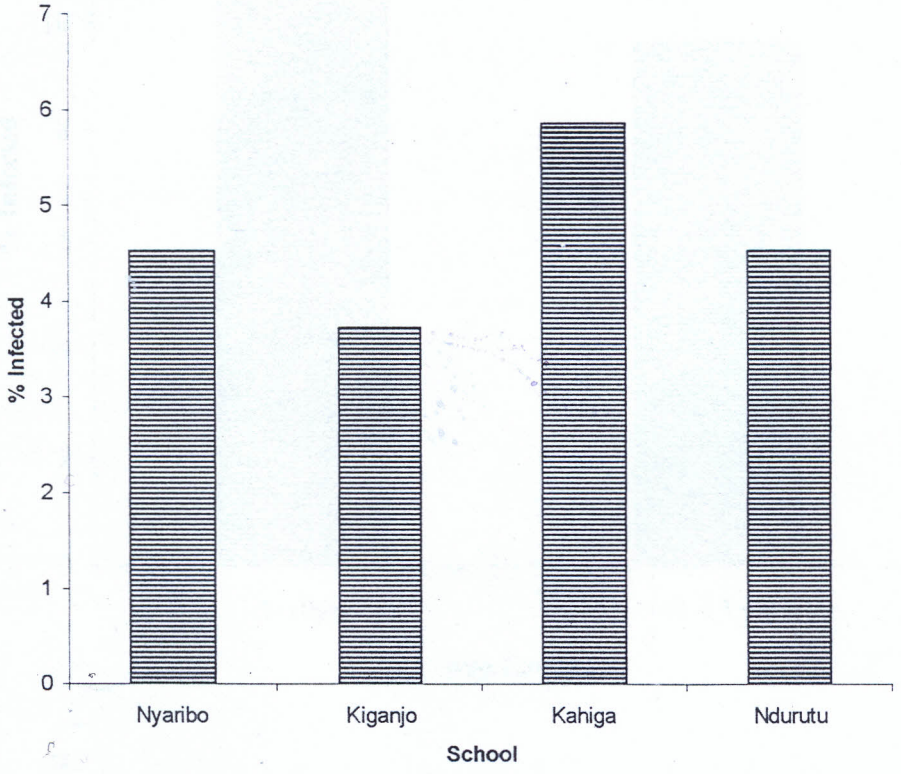

Figure 4.11: Infection of *A. lumbricoides* across schools

When the infection by *A. lumbricoides* was considered between the class categories representing the two age groups, it was found that the lower class was more infected than

the upper class but the difference was not significant (Figure 4.12; $X^2 = 0.57$, df = 1, $p > 0.05$).

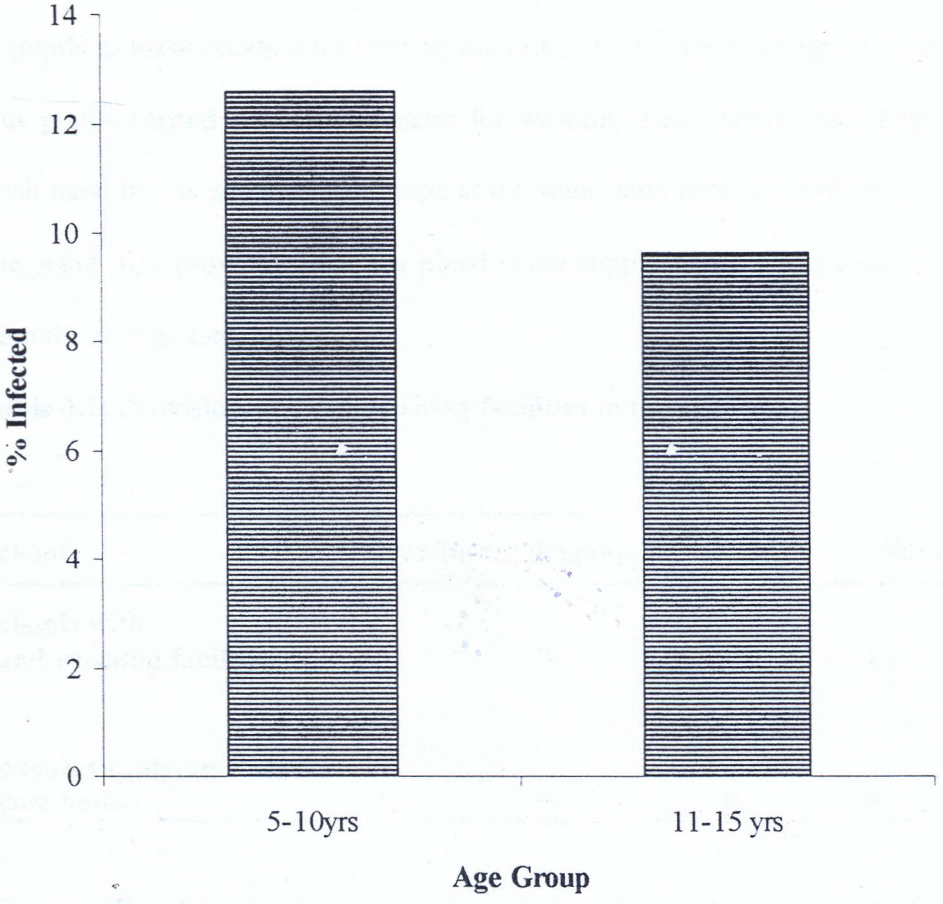

Figure 4.12: Distribution of *A. lumbricoides* between age groups

Infection of hookworm was only one case in Kahiga primary school. No conclusive result was made from a single infection.

4.5 Hygiene practices

It was found that hand washing facilities were provided by provision of a stand pipe instead of wash hand basins except for Kiganjo primary school which had both provisions (Table 4.1). Nyaribo had 1 stand pipe which was not near the toilets for access to pupils to wash hands after visiting the toilet. There was shortage of water in Nyaribo thus pupils carried water from home for washing their classrooms. Kiganjo had two wash hand basins and one stand pipe at the water tank near the staff room. Ndurutu had one stand pipe provided from the piped water supply while Kahiga had one stand pipe from the storage tank outlet.

Table 4.1: Provision of hand washing facilities in the schools

School	Nyaribo	Kiganjo	Kahiga	Ndurutu
Schools with hand washing facilities	1	3	1	1
Schools supplying water from home	1	0	0	0

When hand washing habits was considered after visiting the toilet it was found that 20% of pupils in Nyaribo washed hands, 70% in Kiganjo and Kahiga, and about 50% in Ndurutu washed hands after visiting toilet using the existing facilities. In three schools plastic bottles and jelly cans were used to store water for use during peak hours (break time), hence increasing the chances of available water for hand washing. Only Kiganjo primary school had the hand washing facilities fixed next to the toilet walls and 70% accessed these facilities. In Kahiga and Ndurutu the stand pipes are located near the

staffroom. There was a significant negative correlation in hand washing and infection by parasites (Figure 4.13; $r = -0.9765$, $df = 1$, $p < 0.05$). The schools where hand washing was observed had fewer infections.

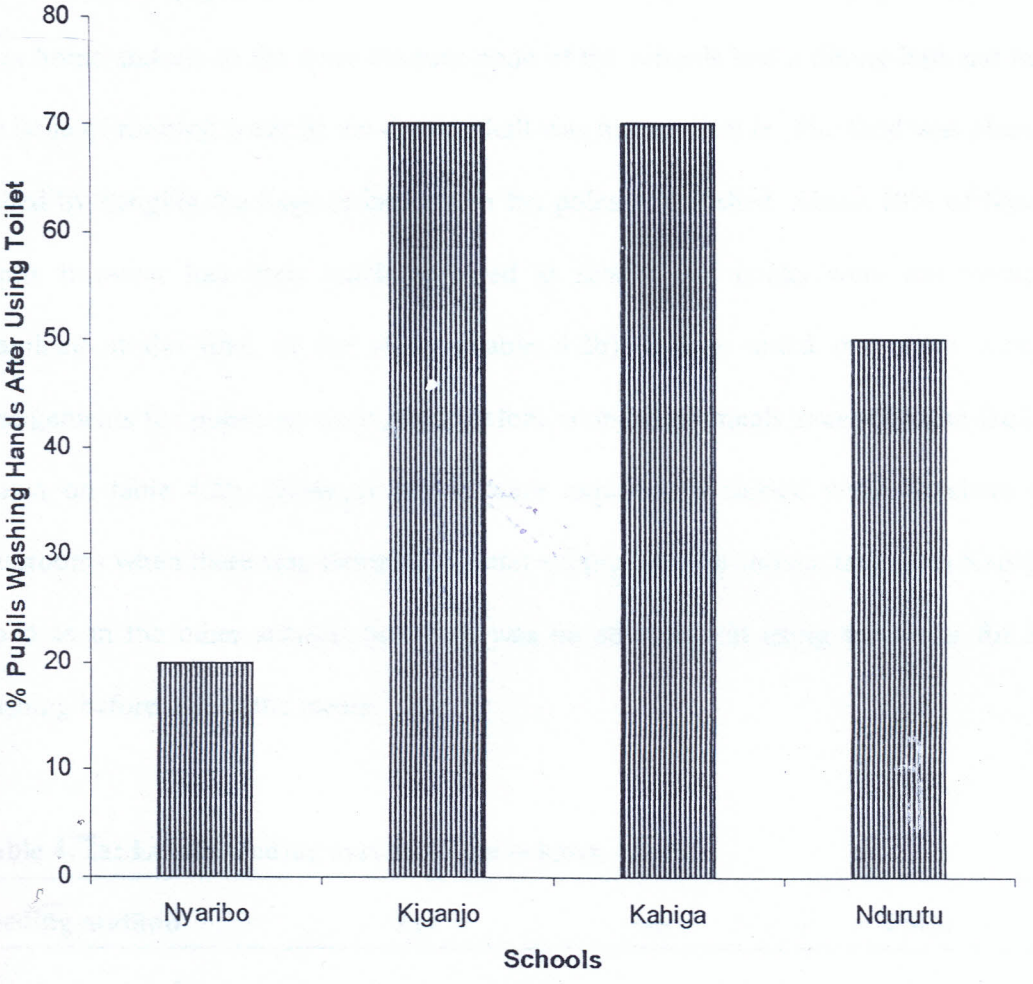

Figure 4.13: Washing of hands after using toilet. There was a significant correlation in washing hands after visiting toilet across the schools.

When feeding practices during lunch were examined it was observed that pupils from all the schools were carrying food from home. Nyaribo was optional in that while about 10%

carried food from home the rest were being fed by the school. With the varying infection rates in Nyaribo (13.3%), Kiganjo (7.7%), Ndurutu (10.7%), and Kahiga (8.5%), the feeding methods for lunch were the same in all the schools, with 4 of the schools carrying food from home and 1 school having both food carried from home, and food cooked at school for some pupils (Table 4. 2a; X^2 = 1.868, df =3, p = 0.5). The pupils carried food from home and ate in the open because none of the schools had a dining hall and hence the issue of running water in the dinning hall was not applicable. The food was placed in a shed by hanging the bags or baskets on the poles of the shed. About 10% of Nyaribo pupils however had their lunch prepared at school and cooks were not medically examined at the time of the study (Table 4.2b). It was noted that there were no arrangements for pupils to wash hands before taking their meals except for the facilities shown on table 4.2b. However pupils were required to carried water to clean their classrooms when there was shortage of water supply through storage tank as in Kahiga or piped as in the other schools but there was no stricuness in using the water for hand washing before taking the meals.

Table 4. 2a: Lunch feeding system in the schools

Feeding method	Yes	No	Total
No of schools where food was carried from home	4	0	4
No of schools where food was cooked at school	1	3	4

Table 4. 2b: Feeding facilities across the school

School	Nyaribo	Kiganjo	Kahiga	Ndurutu
Food carried from home	Yes	Yes	Yes	Yes
Food cooked at school	Yes	No	No	No
Dinning hall provided	No	No	No	No
Running water in the kitchen	No	N/A	N/A	N/A
Cooks medically examined	No	N/A	N/A	N/A

N/A – Not applicable

4.6 Sanitation

The study revealed that most of the schools had toilets that met the standard requirement ratio of 1:30 toilet: pupil (CAP. 211 LOK). However 25% did not meet the required standards. The ratios were 1: 40 (Nyaribo), 1:19 (Kiganjo), 1: 20 (Kahiga), and 1:23 (Ndurutu). When toilet: pupil ratio was considered, it was observed that Nyaribo did not meet the standard requirements for toilet/pupil ratio set at 1: 30 and it had a higher infection of the water borne diseases in Kiganjo location (Fig 4.16). There was a significant negative correlation in toilet: pupil ratio and infection (Figure 4.14; $r = -0.9765$, $p = 0.005$). In 75% of the schools pit latrines were in use. Generally the cleanliness of the toilets was not maintained in the schools and there were cases of soiled toilets.

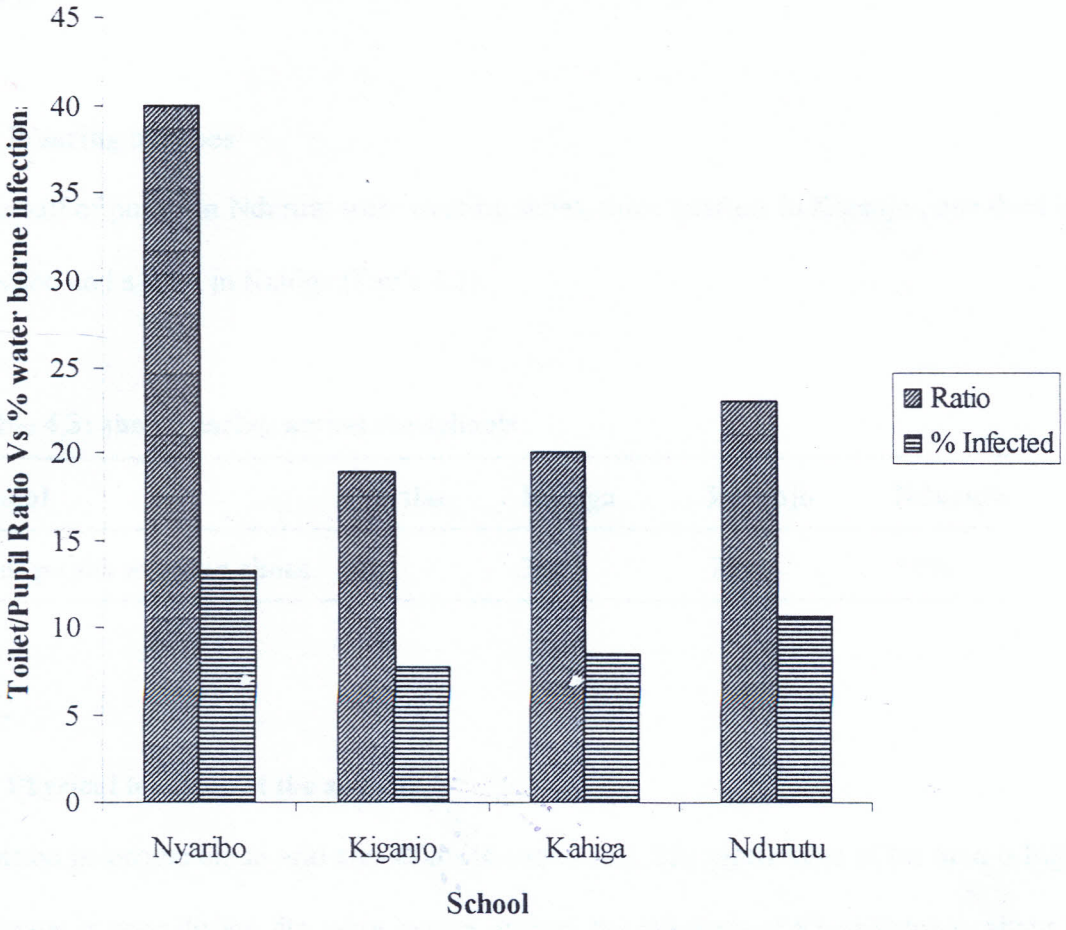

Figure 4.14: Infection versus toilet: pupil ratio

4.7 Refuse disposal

Schools were found to be disposing their refuse in pits. Burning took place to reduce the volume in these pits but this was not done on daily basis. This gave chance to presence of flies round the refuse damping place (pits). Overfilling was observed across the schools. There were sections of long vegetation in Ndurutu primary school during the time of the

study.

4.8 Wearing of shoes

One half of pupils in Ndurutu were wearing shoes, three quarters in Kiganjo , one third in Nyaribo and a third in Kahiga (Table 4.3).

Table 4.3: shoe wearing across the schools

School	Nyaribo	Kahiga	Kiganjo	Ndurutu
% of pupils wearing shoes	30%	30%	75%	50%

4.9 Physical features of the schools

Nyaribo is located on an arid area of black cotton soil. The water table of the area is high drainage is poor during the rainy season. It is in the outskirts of Kiganjo town, about 9 km from the town. The water services have not been extended to the school and a water pan is provided to supply the school and neighbouring homes with water. Kiganjo primary school is about 1 km from the town. Some of the town facilities like the water supply and the sewerage system are extended to the school, hence the reason why Kiganjo had been provided with tap water. Ndurutu is near a coffee plantation, and therefore benefited from the untreated water supply from the plantation. Kahiga is about 6km from Kiganjo town. This distance was not covered by the water supply from NYEWASCO.

4.10 Bacteriological quality of water in different schools

Recommended values for total and faecal coliforms in drinking water are 0 (zero) in both total and faecal coliforms. The presence of coliforms in water shows contamination. All the water sources analyzed except the Kiganjo water which is supplied by NYEWASCO water supply, were found to be contaminated. The presence of coliforms was more than 2400 counts per ml in all the others. It was noted that Kahiga primary school also had one source of water from NYEWASCO which is first stored in a tank before consumption. This stored water was found to be contaminated by only total coliforms and no faecal coliforms. In Nyaribo primary school all the water sources had total and faecal coliforms. Total coliforms indicate contamination through the flow of water over surfaces containing humus while faecal coliforms indicate contamination of water by human faeces (Saidi *et al.* 2004). The treated source of water for Kiganjo primary did not have any contaminants. Infection was seen to be more in schools where the water sources had more contaminants in form of faecal coliforms and total coliforms (Table 4.3). In terms of quality the water was rated as follows: very good (at least with a source without faecal and total coliforms), good (with only total coliforms in the supply), and bad (with all sources with faecal and total coliforms). Infections tended to be more according to the water quality where for example Kiganjo had a good rating from one of the sources and showed the least infection rate of water borne diseases (Table 4.4).

Table 4.4: Bacteriological quality analysis of water used in the schools vs infection

School	Source of water	Total coliforms	Faecal coliforms	quality of water	% Pupils infected by water borne diseases in the school
Nyaribo	Njengu river	≥ 2,400	10	Bad	13.3%
	Mweiga River	≥ 2,400	9	Bad	
	Amboni River	≥ 2,400	20	Bad	
Kiganjo	Kiganjo water supply	Nil	Nil	Good	7.7%
	Nairobi river	≥2,400	470	Bad	
Ndurutu	Amboni river-lower Part near school	≥2,400	350	Bad	10.7%
	Untreated tap water	≥2,400	350	Bad	
Kahiga	Stored tank water from the water supply	425	Nil	Good	8.5%
	Nairobi river near Kahiga primary	2,400	350	Bad	

4.11 Secondary data from health facilities

When records of water borne infections for a 5 year period was looked at in the health facility that serves the entire population of Kiganjo location it was observed that 36.6% of the patients above 5years reported to the health facility for treatment of water borne infections. Of these patients 12.59% were pupils (Table 4.5).The top ten diseases in the order of prevalence were upper respiratory tract infections, intestinal worms (inclusive of protozoa), skin diseases, malaria, diarrhoeal diseases, eye infections, rheumatism, chicken pox, urinary tract infections and pneumonia. Among these diseases the water

borne infections were intestinal worms (inclusive of protozoa), skin diseases, diarrhoeal diseases and eye infections, all contributing to 60% of the top ten diseases in the facility.

Table 4.5: 5 year morbidity records on waterborne diseases in health facility

Year	2006	2005	2004	2003	2002	Total	Average
Water borne Infections	2208	5831	8288	8013	5904	30244	6049
All diseases	7606	12051	18836	23809	20111	82413	16483

Secondary data from Kiganjo health centre

Cases of diarrhoea were noted and it was observed that in the year 2006 there were a total of 90 diarrhoea cases in the under 5 years and 21 cases in the school going age. There were 158 cases of intestinal worms in the under fives and 153 in the school going age in the same year (Table 4. 6). Cases of typhoid were also noted in the health centre. These diseases are an indication of water borne infections among the under 5 years and pupils

Table 4.6: Water borne infections for school going age and under 5 years in Kiganjo health centre in the year 2006.

Infection	Under 5yrs	pupils (above 5yrs)
Diarhoea/Gastroenteritis	90	21
Intestinal parasites	158	153
Typhoid	15	1

Adapted from Kiganjo health centre

CHAPTER FIVE: DISCUSSION

The study revealed that infection of the respondents by the water borne diseases was observed across all the schools. The infection of *E. histolytica* was observed in all the schools but in different rates. It was also revealed that the distribution of *E. histolytica* in schools was more where the water sources had higher bacterial contamination level especially in Nyaribo where there was no single source of wholesome water. A study in Nigeria revealed that *E. histolytica* was the most frequent pathogen associated with diarrhoea (Okeke *et al.*, 2003). The study suggests that the factors contributing to its prevalence are common between the sexes. It was further revealed that age 11-15 years was more infected by *E histolytica* (prevalence 21.8%) than age 5-10 years (prevalence 14.9%) therefore suggesting that age was a contributing factor to the infection of *F. histolytica*. A study in Nyeri municipality revealed that age 11-13 years had more infection of diarrhoea in the primary schools (Rukwaro, 2005). In this study the group found to have more infections of *E. histolytica* (11-15 years) is among those carrying food to school for lunch in the upper class category. Again there were no food storage facilities in the schools and no dinning halls to give a safe eating place free of food contamination. Studies in Vietnam found that poor food hygiene was a cause of diarrhoeal diseases (Winbad, 1996).

The infection by *G. lamblia* between the sexes was the same. Boys and girls were equally infected by water borne diseases. Infection of *G. lamblia* is associated with contaminated water and food for example vegetables and salads that are eaten raw (Effler *et al.*, 1992). The infection cut across all the schools but where the hand washing facilities were

lacking, the study revealed more infections by *G. lamblia*. Schools like Nyaribo had more infections by *G. lamblia* and the same school was shown to have only one hand washing facility. Proper hygiene and sanitation are key issues in preventing water borne diseases as witnessed by a study done in Malawi (Jabu, 2004). *Gambia lamblia* is one of the major causes of gastro intestinal tract (GIT) illnesses (http/www.epa.gov/safewater/contaminants/index.html). In Sweden it was found that in an outbreak of *G. lamblia* was due to contaminated water (Ljungstrom and Caster, 2007). Water borne giardiasis was linked to leaking sewage and insufficient treated water in Norway (Nygard *et al.*, 2004). This study therefore suggests that presence of *G. lamblia* in the schools was due to contaminated water.

Faecal coliforms were identified in most water sources indicating contamination of water by faecal matter. This suggests that the sanitation standards were not adequately observed resulting to spread of the bacteria into the water sources. The recommended toilet: pupil ratio was faulted in Nyaribo primary school. The quality of water at Nyaribo primary school scored the poorest, with all the sources showing large numbers of total coliforms (over 2400 organisms per ml) and also faecal coliforms. These are indicators of water contamination, hence the infection of the water borne diseases can be associated with the use of contaminated water. It agrees with the study done by Bruce- Grey-Owen (2002) South Health unit countries showed that the outbreak of gastroenteritis in Walkerton was due to drinking contaminated water.

The study revealed that only the children of Kiganjo primary school had access to clean

treated water and therefore chances of using untreated water were therefore limited. Kahiga primary had a treated water source but it was found to be contaminated after storage in a tank. The presence of water borne diseases among the pupils was less frequent where the water had less numbers of microbial contaminants (Table 4.4). This agrees with the study by Ayeko (1990) which showed that in some areas of Nyeri Municipality people depended on untreated river water for domestic purposes and were at a greater risk to water borne disease than those who used treated water. The study revealed that there was a higher infection by gastrointestinal parasites in general among the pupils where the water quality was poor. The study revealed that about 80% of the water sources in Kiganjo location were contaminated with bacteria and protozoa which are disease causing agents in nature. The bacteriological water analysis results revealed that faecal contamination was evident in most of the water sources accessible to the pupils as indicated by the presence of faecal coliforms. It is known that most widespread contamination of water is from human disease bearing waste (WHO and UNEP, 1991). Presence of *E. histolytica* and *G. lamblia* are evidence of drinking contaminated water by the pupils (http/www.epa.go v/safewater/contaminants/index.html).

Some of the schools in the location lacked adequate hand washing facilities. These required the pupils to carry water from home which was used to clean the classrooms and not for personal hygiene. Where hand washing facilities are lacking the hygiene standards are low (Mcgranaham and Songsore, 1996). None of the schools met the full recommendations of the hand washing facilities that is a ratio of one wash-hand basin to 30 pupils (MOEST, 2001). Lack of hand washing facilities may have resulted to poor

hygiene as revealed by the study done by Rukwaro (2005). It was noted that the washing of hands was going on despite the few provided hand washing facilities. The few facilities were utilized so long as the water was available. Failure to wash hands by some pupils was due to lack of enough washing facilities. The results agree with a study done in Ghana (WHO, 2002) which reported that hand washing with soap reduces diarrhoea and water borne diseases. It can therefore be suggested that lack of hand washing facilities contributed to presence of water borne diseases among the school children in Kiganjo location.

Twenty five per cent of schools did not meet the standard requirements for school sanitation. However 75% met the required standard and had a toilet pupil ratio of 1: 30 and below. This agrees with the school health policy guidelines (MOEST, 2004) which revealed that many schools in Kenya did not have adequate toilet facilities. It suggests that most of the schools in the location under study had adequate toilet facilities as compared to those which did not have. The cleanliness of these toilets was however noted in 50% of the schools selected in the study. Inadequate sanitary facilities are a cause of intestinal worms (Esrey *et al.,* 2004). Schools which had a lower toilet: pupil ratio tended to have more infection of the helminthes. The results are in agreement with the findings by Rukwaro (2005) that there were more cases of intestinal worms and diarrhoea where the sanitary facilities were inadequate or poorly maintained.

The hand washing facilities were inadequately provided in all the schools. The study conducted in Vietnam by UNICEF (1998) showed that the number of hand washing

facilities provided in schools was used by more pupils than they were designed for. When water for washing hands was not available the pupils brought water from home. This water was in most cases untreated. Inadequate hand washing facilities encourage poor hygiene leading to spread of water borne diseases as indicated by Network for Water and Sanitation (2003). A study in Maragua showed that the residents with good practices of water and sanitation use had better health status than those with poor practices (Njomo, 2003).

Burning of refuse and burial when the refuse pits are full was evident in all the schools. This was fairy done although overfilling of the refuse pits was evident. Poor refuse disposal may result to transmission of diseases as earlier observed (DFID, 1998). Poor disposal may lead to stagnant water encouraging mosquito breeding, fly breeding and vermin attraction. Diarrhoea and intestinal worms were also among other infections identified at the facility. These are diseases of poor sanitation and hygiene (UNICEF, 1998). It may therefore be suggested that part of the infections by the helminthes could have been due to unsatisfactory disposal of refuse.

None of the schools had a well designed food storage facilities There were no hands washing facilities for washing hands before taking meals because dinning halls were not available. When pupils could not access these facilities they ate without washing their hands. In the study the inadequate hand washing facilities in the schools was noted.

Other related water borne infections included the helminthes of which ascariasis was

more common. A study by UNEP (2002) showed that intestinal worms were a common problem among school age children in developing countries. In this study there were higher infection rates with intestinal worms where sanitary and hygiene facilities were inadequate. This agrees with the findings of Vynckt and Nkinyangi (1991) who reported higher incidences of diarrhoea and intestinal worms in areas where hygiene practices were low. This study suggests that pupils were getting contact to unclean foods such as vegetables contaminated by faeces so as to be infected by intestinal worms. The most common helminth found was ascariasis. Access to safe water and sanitation facilities and better hygiene practice can reduce morbidity from ascariasis by 29% and hookworm by 4% (WHO, 2004).

The study revealed that the general presence of the waterborne disease causing agents was more common among the younger children and above 15 years, the infection reduced to 2.45%. The lower class category that represented the younger age group was more infected. This concurs with the study by Rukwaro (2005) that age 11- 13 years suffered more disease related to sanitation and water supply. This confirms the positive infection of water borne diseases as common in stools and may contaminate of drinking water as found on the bacteriological quality of water in this study.

There were no infections by hookworms which are attributed to open feet on contaminated soil except in Kahiga where there was only one case of the hookworms. The shoe wearing in Kiganjo was however noted to be higher than in the other schools. Shoe wearing is a way of having improved hygiene and reducing the chances of having

infections such as hookworms and schistosomiasis (Morgan, 1990).

The secondary data frame in health facilities confirmed presence of water borne diseases. It is assumed that Kiganjo health centre is not a referral hospital and therefore most of the patients are from within Kiganjo location. It applies that pupils from within the location sort for treatment in Kiganjo health centre. This conforms to what was practically achieved through stool examination that water borne diseases were found among the pupils in the location. The water borne diseases in the health facilities were diarrhoea and gastro enteritis. Intestinal worms were found to be the second most common cause of morbidity in the health centre. The water borne infections contribute to 36.6% of the morbidity and are the highest in the health facility. This agrees with the WHO (1987) that there is high prevalence of water and sanitation related diseases in developing countries. Pupils in the facility had an infection rate of 12.59% hence being more infected than the others in the same health facilities. This agrees with the findings by DFID (1998) that children are the main victims of sickness as a result of inadequate water supply, poor hygiene and sanitation services.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

a) Prevalence of common water borne infections among the pupils

The common water borne infections among the pupils were found to be protozoa and intestinal worms. It was found that prevalence of water borne diseases among pupils in Kiganjo location was 54.4%. The prevalence of *E. histolytica* was 38%; *G. lamblia* was 7.2% while prevalence of intestinal worms identified as *A. lumbricoides* was 21.7%. The rest was *E. coli* as normal flora in the gut. Presence of water borne diseases was highest in Nyaribo primary school with prevalence 13.3%, followed by Ndurutu with 10.7%, Kahiga with 8.5% and Kiganjo with 7.7% in that order.

b) Factors associated with the spread of water borne diseases in the study area

The highest ranked factor contributing to presence of water borne diseases was found to be hygiene, followed by sanitation.

The study observed that there was a relationship between hand washing and infection by water borne diseases ($r = -0.986$, $p<0.05$). In the schools where hand washing was observed the general infection of water borne diseases was less than where pupils did not practice hand washing after using the toilet and before taking meals.

The study observed that there was a relationship between toilet/pupil ratio and infection by the water borne diseases ($r = -0.9765$, $p<0.05$). In Nyaribo where toilet/pupil ratio was

low (1:40) infection of water borne diseases was higher than Kiganjo where toilet pupil ratio was 1:19.

Where water high levels of contamination by faecal coliforms and total coliforms was observed, infections by water borne diseases were equally evident in higher percentages as observed in Nyaribo and Ndurutu.

6.2 Recommendations

a) There should be prompt treatment when the children come down with symptoms of water borne diseases and regular deworming to avoid spread of the disease and other consequences. Treatment of pupils who come down with infections of water borne diseases should be sort from Kiganjo health centre where laboratory facilities are provided to confirm presence of disease, or any other facility where pupils may get assistance in identifying diseases and treatment. Public health staff should engage in regular deworming of pupils in all the primary schools.

b) All the schools should practice sanitation and hygiene as recommended by Ministry of Education Science and Technology, and the Public Health Act CAP. 242. This should be enforced by the public health staff.

c) It is recommended that the schools seek treated water supply for use by pupils. Schools in Kiganjo location should connect to Nyeri Water and Sanitation Cooperation, a local water system in Nyeri Municipality for clean water supply.

REFERENCES

Ayeko B. (1990). *International Food and Agriculture Development. Dry area small holder Community services Development Project Nyeri District.* Final Design paper. Government printer. Nairobi

Barllet E.(2009). Attack on water Brings Crisis. Interpress service. Gaza City

Bauer J. D., Ackerman P. G. and Toro G. (1974). Clinical Laboratory methods. Eighth Edition. C. V. Mosby Company, St. Louis USA. 550 – 556.

Berkow R.J. and Beers M.H. (1997). Merck Manual of Medical Information. Home Edition. New Jersey USA, Pg 896 – 897.

Black R. E., Morris S.S., Bryce J. (2003). *Where and why are10 million children dying every year?* The Lancet 2003, 361: 2226 – 34.

Bruce-Grey Owen South Health Unit (2002). The Investigative Report of the Walkerton Outbreak of Water Borne Gastroenteritis in 2002. Walkerton. Canada.

Central Bureau of Statistics (2002). Kenya National 1999. Population and Housing Census. Government Printer. Nairobi, Kenya.

Caincross S. (1992). Sanitation and water supply: Practical Lesson from The Decade. LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE. London.

Chabalala H. P. and Mamo, H. (2001). Prevalence of waterborne diseases within the health facilities in Nakuru District, Kenya. Dissertation. Nairobi University.

Department for International Development (1998). Water supply and sanitation programs. Well water and environmental health. London.

District Medical Officer of Health (2003). *Integrated Diseases Surveillance Report,* Nyeri.

District Medical Officer of Health (2004). *Lab. Reference No cp/ ph lab/H_2 O/Vol.1/ 161.*

Effler P., Isaacson M., Arntzen L., Heenan R., Canter P., Barrett T., Lee L., Mambo C., Levine W., Zaidi A. and Griffin P. M. (1992). Factors contributing to the emergence of *Escherichia coli* 0157 in Africa. Centres for Disease Control and Prevention. Johannesburg South Africa.

Esrey S A., Potash J B., Roberts L. Shiff C. (2004). Effects of improved water supply and sanitation on diarrhoea drancunculiasis, hookworm infection, schistosomiasis, and trachoma. McGill University. Ste-Anne-de Bellevue. Canada.

Government of Kenya (1996). *The Public Health Act- Cap 242.* Revised 1996.

Government Printer, Nairobi, Kenya.

Government of Kenya (1998). Master Plan on Education and Training 1997-2010. Government printer. Nairobi. Kenya.

Government of Kenya (1999). National Environment Management Act Government Printer. Nairobi, Kenya.

Government of Kenya (1999). School Management guide. Ministry of Education and Human Resource Development Kenya. Jomo Kenyatta Foundation. Nairobi.

Government of Kenya (2002). The Water Act Cap. 272. Government Printer. Nairobi.

Government of Kenya (2002). National Development Plan 2002-2008. Government Printer. Nairobi.

Government of Kenya (2006). Baseline survey in Nyamira, Rachuonyo, Homabay, Migori, Kuria and Suba Districts. Log Associates. Nairobi

Hinrichsen D. (1998). Solutions for water short world, Population reports series M, Nc. 14. 1998. John Hopkins. USA.

Hunter P R. (1997). Water borne diseases. Epidemiology and Ecology. John Wiley and sons. Chichester, United Kingdom.

Jabu G. C. (2004). Assessment and comparison of microbial quality of drinking water in Chakawa, Malawi. University of Strathclyde. Department of Civil Engineering. Glasgow G4 ONG.

Kiongo J.M. (2005). The Millennium Development Goal on poverty and links with water supply, sanitation, Hygiene and HIV/AIDS. Nakuru. Kenya. Kenya Medical Research Institute.

Kirimi M. (2004). Toilet Shortage and Poor Hygiene Hamper Kenya's Free Education. Government Printers. Nairobi.

Kothari C. R. (2003). Research Methodology. Methods and Techniques. Wishwa Prakashan. New Delhi. pg 75

Ljungsrom I. And Castor B. (2007). Disease Surveillance and Water Borne Outbreaks. BMC Microbiology. 1471 – 2180.

Majtenyi C. (2007). Kenya Experiencing Effects of Deforestation, Climate Change. UOA. Nairobi. Kenya.

Magnussen P. M. E., Mungai P., Ndzovu M., Ouma J., Tosha S. (1997). A school based approach to th control of urinary schistosomiasis and intestinal infections in Matuga Kenya: Impact of a two year chemotherapy programme on prevalence and intensity of infections. Tropical Medicine and International Health, 2: 825-31.

Mcgranaham G., Songore J. (1996). Women and environmental care in the greater Accra Metropolitan area report No. 2. *Stockholm with Sida*. Ghana.

Ministry of Education Science and Technology (2001). Health and Safety Standards in Education Institutions. Ref No. 9/1/169. Nairobi.

Ministry of Education Science and Technology (2003). Public Primary School Enrolment. Free Primary Education Data Capture. Nairobi.

Ministry of Education Science and Technology & JICA (2004). A study on the development of school Health Policy guidelines and implementation strategies in Kenya 2004. MOEST. Nairobi.

Morgan P. (1990). Rural water Supplies and sanitation. Macmillan. Hong Kong.

Murage E. W. (2006). Quality of water the Slum dwellers use: The case of a Kenyan slum *Journal of Urban Health*. Springer, New York.

Mustafa U. (2006). Community perception of school based deworming program in Sanluurfa Turkey. J.Trop Med hyg., 75: 1063-1065.

Mwandawiro C. (2003). School-based helminthe control (Deworming). Eastern and Southern Africa Centre of International Parasite control. Nairobi.

Network for water and sanitation (2003). Study on sustaining changes in hygiene behaviours. Kenya.

(Njomo D., 2003). The influence of water and sanitation use: knowledge and perceptions on health status of residents of Maragua town, Kenya. Kenya Medical Research Institute

Nyeri Water and Sewerage Company Cooperation (2003). Facts and Figures. Nyeri.

Nygard K., Schimmer B., Sobstad Q., Walde A., Tueit I., Langerhand N., Hansken T. and Aavitsland P. (2004). A large community outbreak of water borne giardiasis delayed detection in a non-endemic urban area in Norway. BMC 1471-2458/6/141.

Ochiewo J. (2004) Socio-economic aspects of water management along the coast of Kenya. Kenya Marine and Fisheries Research Institute study report. Mombasa. Kenya

Okeke I. N., Ojo O., Lamikama A and Kaper J. B. (2003). Etiology of acute diarrhoea in adults in south western Nigeria. J Clin microbiology, 41: 4525-4530.

O'Reilly C. E., Freeman., Ravani., Ombeki S., Migele J., Mwaki A., Ayalo M. and Quick R. (2006). Evaluation of the Role of School Children in the Adoption of a School Based Water and Hygiene Intervention in Their Households – Nyanza Province, Western Kenya. Care Kenya study report.

Power R. (2008). *Climate Crisis & Sustainability update. What Global Warming will cause and what we are spending*. Blog Archive.

Pruss A., Kay, D., Fewtrell L. and Bartram, J. (2002). Estimating the burden of disease due to water, sanitation and hygiene at global level. *Environmental Health Perspectives*. WHO. Geneva.

Radford J., Maheswaran R. (2007). Standards in School toilets: Do extra resources make a diffence? *Journal of public health*. Pg. 294.

Rukunga G. (2001). Environmental Health for Eastern Africa. *Africa Medical Research Foundation*. 1st Edition. Nairobi.

Rukwaro M. (2005). Sanitation practices among public primary school within Nyeri Municipality, Nyeri District, Kenya. MPH Thesis. Kenyatta University.

Saidi S., Kang'ethe S., Waweru I., Michelins G and Applford G. (2004). Microbiological analysis of water obtained from shallow wells in Wajir. Centre for Microbiological Research, Institute of Tropical Medicine and Infectious Diseases, Kenya Medical Research Institute, Medical Emergency Relief International (Merlin).

Southern Nyanza Community Development Project (2007). IFAD LOAN NO. 620KE. *Project Brief*. Vol. I : 7. Homabay.

Strina A., Caincross s, Barret M. L., Larrea C. and Prado M. S. (2002). Child Diarrhoea and Observed Hygiene Behavior in Salvador, Brazil. John Hopkins School of Public Health. USA.

Swaddinwudipong W., Karintrarara S. and Kavinum S. (1995). A common source outbreak of shigellosis involving a piped public water supply in northern Thaicommunities. J Trop Med hyg. 1995 Jun, 98 (3): 145-50.

UNEP; UNICEF and WHO (2002). Children in Millennium environmental impact of health. Republic of Malta. UNESCO. Paris.

UNICEF, (1998). A Manual on School Sanitation and Hygiene Technical guidelines series NO 5. Geneva.

UNICEF (2003). Water and Environmental Sanitation situation Analysis. Nairobi.

UNICEF (2006). Report on Child Survival. Maputo. Mozambique

Vynckt V. and Nkinyangi J.A. (1995). Child Health Nutrition and Education. Government of Kenya and UNESCO. National Planning Workshop Report. Paris.

Whitlock E.A. (1954). The waterborne diseases of microbiological origin. Paper presented at the annual conf. of the nat. Assoc. of Bath Superintendents 1954, Anderson ltd, Stepney Green, United Kingdom.

Winbad U. (1996). Towards an ecological approach to sanitation No. 5. Water resources. Toyoma, Japan.

WHO (1987). Technology for water supply and sanitation in developing countries. Report of a WHO Studies group technical report series. 742. WHO. Geneva.

WHO (1999). Environmental Health Indicators: framework and methodologies. Geneva.

WHO and UNEP (1991). Water quality. Report of WHO (Geneva) and UNEP (Nairobi).

WHO (2000). The World Health Report. WHO. Geneva.

WHO (2002). World health report. Reducing Risks Promoting Health Life. Geneva.

WHO (2004). Water, Sanitation and Hygiene links to health.

WHO (2005). National Profiles on Children's Environmental health *Angola-Botswana Cameroon-Kenya-Mali-Zambia.* WHO. Regional Office for Africa.

Zwane A. P. and Kremer M. (2007). What works in fighting diarrhoeal diseases in developing countries? A critical review. Oxford University Press.

Appendix I

Laboratory request form

Date

Location.....

Name of pupil.....

Class.....

Age.....

Request on.....

Results.....

.....

Doctors signature.....

Appendix II

A: PUPILS DEMOGRAPHY

Name……..

School……..

Class……

Sub-location……..

Age in years……..

Category- Upper ☐

Lower ☐

Appendix III

OBSERVATION CHECKLIST

A: WATER SPPLY

1. Does the school have a means of water supply? Yes ☐ No ☐

2. If yes state the type of supply.....

.....

3. If no how, do pupils get water for use in school?

a) School provides

b) They carry from home

c) There is no provision of water at all

B. SANITATION

4. How is the distribution of toilets in the school?

b) No of male's toilets.....

c) No of female's toilets.....

d) No of staff toilets.....

e) No of urinals.....

5. If water closets, is there a drainage system Yes ☐ No ☐

6. Are there any blockages? Yes ☐ No ☐

7. If pit latrines, are they soiled? Yes ☐ No ☐

8. Are hand washing facilities provided? Yes ☐ No ☐

9. What are the facilities in place for hand washing? .....

10. Is there evidence of surface overflow?

Yes ☐ No ☐

11. How is refuse disposed?

(a) Burying in a compost pit

(b) Burning in a refuse pit

(c) Disposing in the school garden

(d) Collection by the municipal council

C. PERSONAL HYGIENE

12. Are pupils wearing shoes? Yes ☐ No ☐

13. Are pupils washing hands after visiting the toilet? Yes ☐ No ☐

14. Are pupils washing hands before taking their meals? Yes ☐ No ☐

15. Is there any sign of faecal contamination in the school field?

Yes ☐ No ☐

D. HYGIENE AND FEEDING METHODS

16. Food is cooked in the school Yes ☐ No ☐

17. Food is carried from home Yes ☐ No ☐

18. Children feed at home Yes ☐ No ☐

19 A dining hall is present Yes ☐ No ☐

20. There is running water in the kitchen Yes ☐ No ☐

21. Cooks are medically examined Yes ☐ No ☐

22. Are pupils washing hands before eating Yes ☐ No ☐

E. DISEASE RECORDS

23. What are the ten top most common diseases in the location?

24. What is the infection percentage of water borne diseases is reported in the location's Health centre annually?

25. What percentage affects school going age children annually

(a). Percentage of boys.....

(b) Percentage of girls.....

26. Are there any precautions being undertaken to control water borne diseases in the health facility? Yes ☐ No ☐

27. If yes what are the precautions

.....

.....

28. Has there been any outbreak related to water borne diseases in the last one year?

Yes ☐ No ☐

29. If yes, what type of outbreak?

.....

.....

30. How many students fell sick after the outbreak?

31. Which diseases were diagnosed?

F DATA FROM THE DISPENSARY

32. What are the water borne diseases that have been recorded for the last five years?

33. What are the water borne diseases that have been recorded in the last one year?

34. Which part of the location have the diseases been reported from?

35. What are the numbers of each water borne disease reported in the last on year?

36. Who are the affected in terms of age and sex?

Appendix IV

Approval from University

KENYATTA UNIVERSITY
GRADUATE SCHOOL
INTERNAL MEMO

FROM: Dean, Graduate School

TO: Ngari Pauline
Department of Zoological Sciences

REF: I57/0254/03

DATE: 25th September, 2007

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that the Graduate School Board, at its meeting of 19th September, 2007 approved your M.Sc. research proposal titled "Factors Influencing Prevalence of Waterborne Diseases Among School Children in Kiganjo Location of Nyeri District, Kenya".

Thank you

M. C. MAKOKHA
FOR: DEAN, GRADUATE SCHOOL

c.c. Dean, School of Pure and Applied Sciences
Chairman, Department of Zoological Sciences

MCM/jfo

Appendix V

Permission from District Education Officer Nyeri

MINISTRY OF EDUCATION

Telegrams: "Schooling", Nyeri
Telephone: Nyeri 2030518, 2030540
When replying please quote
Fax 0612030535

District Education Office
P O Box 208
NYERI.

Ref: GEN/RES/42/239

Date: 4/7/2007

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION
PAULINE NGARI

The above named has been granted authority to carry out research to investigate waterborne disease in public secondary and primary schools in Nyeri District.

This is therefore to request you to accord him all the necessary assistance.

FRANCIS MUNENE
For: DISTRICT EDUCATION OFFICER
NYERI

Appendix VI

Permission from Ministry of Health

MINISTRY HEALTH

Telegrams: "MEDICAL", Nyeri
Telephone: Nyeri (061) 30819/30993
Fax No. 061-2185
When replying please quote

OFFICE OF DISTRICT MEDICAL OFFICER
NYERI SOUTH DISTRICT
P.O. BOX 27
NYERI

Ref :MOH/NYI/T 21 VOL I/2

Date: 30th April 2007

TO WHOM IT MAY CONCERN,

Dear Sir/Madam,

RE: AUTHORITY TO CARRY OUT RESEARCH ON WATER BORNE DISEASES IN KIGANJO LOCATION, AND KIGANJO HEALTH CENTRE.

Pauline .K. Ngari a student at Kenyatta University is permitted to carry out research on water borne disease in Kiganjo Location and Kiganjo Health Centre.

Please accord her the necessary assistance.

Dr. P. M. Munyua
District Medical Officer of Health
NYERI SOUTH DISTRICT

Copy to: **PHO i/c**
Municipality Division