EFFECTS OF PUBLIC HEALTH INTERVENTIONS ON INTESTINAL PARASITIC INFECTIONS AMONG SCHOOL-GOING CHILDREN IN MURANG’A COUNTY, KENYA

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A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN PUBLIC HEALTH (EPIDEMIOLOGY AND DISEASE CONTROL) IN THE SCHOOL OF PUBLIC HEALTH OF KENYATTA UNIVERSITY

JUNE 2016
DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

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I dedicate this work to my family who laboured with me all along this journey, my husband William Gitahi, my children Charles Finney Muriithi, Deborah Wanjiru and Caleb Clement Muiruri.
ACKNOWLEDGEMENT

I give thanks to the Lord God Almighty for enabling me to accomplish this task. I also wish appreciate several people who contributed to this study in various ways. I am sincerely grateful to my supervisors Prof. Ephantus W. Kabiru, Dr. George O. Otieno, and Dr. Harrysone E. Atieli, for their guidance and mentorship. I am grateful the Chairman Community Health Department, Dr. J. P. Oyore and my colleagues from the School of Public Health for their encouragement during the study. I wish to express my heartfelt gratitude to Dr. Nicholas T. Njuki for his immense support throughout the period of thesis writing.

I sincerely thank my loving mother for her encouragement throughout my academic pursuit. I’m also grateful to brothers and sister for their moral support.

I sincerely appreciate Universal Corporations, PRIME-K and AstraZeneca for their support.

I sincerely extend my profound gratitude to the head teachers, teachers, pupils and parents of the participating schools; Ichagaki, Kianjiru-ini, Kagaa, Kimorori, Matanya, and Peter Kariuki. Thanks to the MOH and the Public Health Officers, Maragua level 4 Hospital for their kind assistance.

I’m grateful to the examiners for helping me to refine my work further.

To these and others not mentioned here I pray for God’s blessings.
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DEFINITION OF OPERATIONAL TERMS

Casual labor
This is a form of occupation where one is not permanently employed but is hired on temporary basis to carry out supportive duties such as fetching water for restaurants, picking coffee or doing laundry for which they are paid per day.

Definitive hosts
The hosts in which sexual development of helminths occur.

Farming
Subsistence farming mainly of food crops.

Hygienic behavior
Washing hands with soap and water during the critical times.

Hygiene Practices
Ways of preventing intestinal parasitic infections including how to wash hands properly using soap and water, and critical times for hand washing.

Intestinal parasitic infections
Intestinal protozoan and helminthic infestations confirmed by stool examinations.

Public Health Interventions
This is a process of curtailing infections among the school going children by installing tippy taps, providing soap and water for hand washing, training children on proper sanitation and hygiene practices.
<table>
<thead>
<tr>
<th><strong>Sanitation practices</strong></th>
<th>Proper methods of using latrines and keeping them clean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tippy taps</strong></td>
<td>Jericans which have been fitted with water taps used for hand washing</td>
</tr>
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</table>
### Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>GAHI</td>
<td>Global Atlas of Helminths Infections</td>
</tr>
<tr>
<td>IEC</td>
<td>Information, Education and Communication</td>
</tr>
<tr>
<td>KDHS</td>
<td>Kenya Demographic and Health Survey</td>
</tr>
<tr>
<td>KNBS</td>
<td>Kenya National Bureau of Standards</td>
</tr>
<tr>
<td>MGDs</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>MOH</td>
<td>Medical Officer of Health</td>
</tr>
<tr>
<td>MOE</td>
<td>Ministry of Education</td>
</tr>
<tr>
<td>MPHS</td>
<td>Ministry of Public Health and Sanitation</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>STH</td>
<td>Soil-Transmitted Helminths</td>
</tr>
<tr>
<td>TB</td>
<td>Tuberculosis</td>
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<tr>
<td>UNICEF</td>
<td>United Nations Children's Fund</td>
</tr>
<tr>
<td>WASH</td>
<td>Water, Sanitation and Hygiene</td>
</tr>
<tr>
<td>WHA</td>
<td>World Health Assembly</td>
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<td>WHO</td>
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ABSTRACT

Intestinal parasitic infections have been found to form at least a quarter of all human infections globally. School-going children are the worst affected by these infections as it impairs their growth and cognitive development. Following the WHO recommendation, the Government of Kenya rolled out a school deworming programme under the School Health Programme in 2009. The study was embedded in the School Health Programme. The main objective of the study was to investigate the effects of public health interventions against intestinal parasitic infections among school going children in Murang’a County. It was a quasi-experimental study with schools assigned to intervention and control groups. The schools were selected through multi-stage sampling. Data was collected in three phases: baseline, intervention and post intervention evaluation. A total of 446 pupils from six primary schools provided stool samples for examination of intestinal parasitic infections. Structured interview guides and observation were used to collect more information on school sanitation, pupils’ hygiene practices and their level of knowledge of intestinal parasites. Qualitative data was collected through Key Informants Interviews and observations of school sanitation and hygiene practices compared with School Health Policy. Installation of tippy taps, provision of soap and water, and health education were some of the public health interventions which were implemented in intervention group. A post intervention evaluation was conducted to determine the effect of these interventions. Data was analyzed using SPSS version 20. Association of variables was tested using chi-square while t-test was used to compare means. At the baseline phase the overall prevalence of intestinal protozoan infections was 51.2% and 55.1% in the intervention and control group respectively. Prevalence of intestinal helminthic infections was 12% and 16.5% in intervention and control groups respectively. A comparison of mean percentage of infected pupils at baseline revealed that there was no statistically significant difference in the prevalence of intestinal parasites between intervention and control groups (t =0.32, P = 0.37). Level of knowledge of intestinal parasites was 52.3% and 48.8% in the intervention and control group respectively. The difference between the two was not statistically significant ($\chi^2$= 3.4, df = 5, P=0.13). There was a statistically significant relationship between protozoan infections and school sanitation ($\chi^2$= 10.3, df = 1, P = 0.001). Association between helminthic infections and school sanitation was also found to be significant ($\chi^2$= 2.4, df = 1, P=0.01). Key informants interview revealed that there were no health clubs at schools through which health promotion would be propagated among the pupils. After intervention a comparison of mean percentage of infected pupils revealed that there was a statistically significant reduction in intestinal protozoan infections in intervention group from 55.1% to 6.0% (t=12.6, P=0.001). There was also a statistically significant reduction in the prevalence of helminthic infections in the intervention group from 12.4% to 0.0% (t = -3.78, P<0.001). This has led to the conclusion that public health interventions influenced the reduction of the prevalence of intestinal parasites. The findings of this study are useful to the ministry of Education in formulating policies that will shape the future of the School Health Programme in Kenya. There is a suggestion to conduct a community based study to rule out the infections from the home environment.
CHAPTER ONE: INTRODUCTION

1.1. Background information

Intestinal parasitic infections comprise of both helminthic and protozoan which form the most common infections world-wide (Ouattara et. al., 2010). Helminths are worms with many cells while protozoa are parasites which have only one single cell and can multiply inside the human body (Hague, 2007). Intestinal helminths include *Ascaris lumbricoides*, *Trichinella spiralis*, *Trichuris trichiura*, *Enterobius vermicularis*, *Strongyloides stercoralis*, and *Ancylostoma duodenale* and *Necator americanus* (Murray, 2008). It is estimated that more than 2 billion people world-wide (24% of the world's population) are infected with soil-transmitted helminths (WHO, 2012). They are the main cause of disease burden in school-age children in developing countries as children bear the greater burden often resulting in anaemia, lethargy, growth stunting, and malnutrition. The WHO report (2012) further indicates that more than 280 million children in need of deworming (30% of the global total) live in the 42 countries of the African Region.

In 2001, delegates the World Health Assembly unanimously endorsed a resolution which urged endemic countries to start seriously addressing the health problem of soil-transmitted helminths (WHA54.19, 2001). The Kenyan government responded to this WHO recommendation by rolling out a school deworming programme in 2009. This was done under the school health policy jointly developed by the Ministry of Education (MOE) and the then Ministry of Public Health and Sanitation (MoPHS) in 2009. At the beginning of this programme the national prevalence of intestinal parasitic infections
among school going children was 56.8% (Stewart, 2011). The prevalence of intestinal helminthic infections in 2015 was found to be 32.4% (Brooker et al., 2015).

1.2. Problem Statement

Global Atlas for Helminthic Infections (GAHI) had indicated that there is high transmission of intestinal helminthic infections in Murang’a County (GAHI 2015). A laboratory report from Maragua level 4 hospital, one of the main hospital in the County, indicated a high prevalence of intestinal parasites in the study area. Laboratory tests data summary report for July 2011 showed that of all the stool tests done, 56% of them tested positive for Entamoeba histolytica cysts and 17% tested positive for intestinal worms (DPHO Maragua District Hospital Communication). This means that the prevalence of intestinal parasites is high in the study area. It was further reported that a boy aged 8 years had died as a result of helminthic obstruction complication in a neighbouring Ichagaki Mission Clinic (Communication from Disease surveillance officer from Murang’a South Sub-county, April 2012).

1.3. Justification

In Murang’a South Sub-County, regular school deworming programme had not commenced due to financial constrains, as indicated by the Medical Officer of Health Maragua Level 4 Hospital and Public Health Officer in charge of school health. School health policy has detailed the public health measures including improvement of Water Sanitation and Hygiene measures which should be implemented in schools to promote pupils’ health. Most of these measures have not been implemented in the schools in Murang’a County. This study aimed at implementing some of these measures as public
health interventions to evaluate their effects on intestinal helminthic and protozoan infections among the pupils.

1.4. **Research Questions**

1. What is the prevalence of intestinal helminthic among school going children in the Murang’a County?

2. What is the prevalence of intestinal protozoan infections among school going children in Murang’a County?

3. What is the level of knowledge on intestinal parasitic infections among the school going children in Murang’a County?

4. What is the level of hygiene practices and sanitation among the school going children in Murang’a County?

5. What are the effects of public health interventions on intestinal parasitic infections among the school going children in Murang’a County?

1.5. **Null hypothesis**

Public health interventions do not influence the prevalence of intestinal parasitic infections among school children in Murang’a County

1.6. **Main objective of the Study**

To determine the effects of public health interventions on intestinal parasitic infections among school-going children in Murang’a county.
1.7. **Specific Objectives**

1. To determine the prevalence of intestinal helminthic infections among school going children in Murang’a County.

2. To determine the prevalence of intestinal protozoan infections among school going children in Murang’a County.

3. To establish the level of knowledge on intestinal parasitic infections among the school going children in Murang’a County.

4. To determine the level of hygiene practices and school sanitation among the school going children in Murang’a County.

5. To establish the effects of public health interventions on intestinal parasitic infections among the school going children in Murang’a County.

1.8. **Assumptions of the study**

In assigning school to intervention and control, schools which had similar environmental conditions were paired with the assumption that they were comparable.

1.9. **Limitation of the study**

There were neither hand-washing stations nor tap water in the schools prior to the study. This posed a challenge to the training of pupils on proper hand washing methods.

1.10. **Delimitation**

Tippy taps were installed using locally available jericans which can easily be replaced, hence ensuring sustainability.
1.11. Output

This study has provided data on the prevalence and distribution of intestinal helminthic and protozoa among the school children who are the target of the school deworming programme. This data is especially useful to the Ministry of Education and the Ministry of Health in planning for school health programme. The public health interventions have increased pupils’ knowledge on hygienic practices which may have contributed to improvement of their health. This complements the Government of Kenya’s commitment to achieving education for all and improved health status in line with two key targets in the millennium development goals.

The public health interventions have been shown to reduce intestinal helminths and protozoan infections as shown in the results. This shows that should they be implemented in all the schools as spelt out in the school health policy, there would be a reduction of intestinal parasitic among school children. As noted in the National School Health Strategy Implementation Plan (MoPHS &MoEd, 2009), learners are positive change agents within their communities, and instilling habits early is the most effective way to change current practice. Therefore, the multiplier effect of appropriate and positive messages on hygiene promotion is likely to have an influence on the larger communities (MPHS and MOE, 2009).

1.12. Conceptual Framework

There are many factors which are in play contributing to the intestinal helminthic and protozoan infections among school going children. First, they are not in control of their physical and social environment where they find themselves, be it at home or at school.
These include sanitation and hygiene, which have been found to contribute significantly to these infections. Secondly, they generally have a low level of awareness of the need for appropriate hygiene behaviours such as washing hands to prevent infections. For those who may be aware, they might not know how to wash hands properly using soap and water.

In this study, sanitation, hygiene practices including level of knowledge of hand washing were factors contributing to intestinal parasitic infections. As illustrated in figure 1.1., public health interventions were implemented to address these factors and empower the children towards preventing intestinal parasitic infections. The result was reduced intestinal parasitic infections as well as increased awareness of hygiene practices among the children.
INDEPENDENT VARIABLES
- Poor sanitation
- Poor hygienic practices
- Low level of knowledge on hand washing

DEPENDENT VARIABLES
- Intestinal protozoan infections
- Intestinal helminthic infections

INTERVENING VARIABLES
1. Health promotion using IEC materials
2. Training teachers on hygiene practices among the pupils
3. Training pupils on hand washing
4. Training pupils on proper sanitation
5. Provision of detergent for cleaning latrines

OUTCOMES
- Increased knowledge on hygiene practices
- Reduced Intestinal protozoan infections
- Reduced Intestinal helminthic infections


Figure 1.1 Conceptual framework
CHAPTER TWO: LITERATURE REVIEW

2.1 Intestinal Parasites

A parasite is a disease-causing organism that lives on or in a human or another animal and derives its nourishment from its host. Human parasites are separated into intestinal and blood-borne parasites. For a parasite to be defined as intestinal it must have an intestinal life-cycle stage, though it may have life-cycle stages in the heart, circulation, lung, tissue, other animals or the environment. These human intestinal parasites usually live in the small or large intestine and use the nutrients, stool or blood from intestinal wall as a source of food. Intestinal parasites are usually transmitted when someone comes in contact with infected feaces (for example, through contaminated soil, food, or water). This causes morbidity and malnutrition especially among the children. Parasites found in the intestines can be categorized into two groups namely protozoa and helminths (Matthys et. al., 2011). Intestinal helminths and protozoan infections are amongst the most common infections world-wide (Ouattara et. al., 2010).

2.2 Intestinal protozoan infections

Protozoa are unicellular organisms which infect and multiply inside the body of the host. Intestinal protozoa contribute significantly to the burden of infectious diseases worldwide especially diarrheal diseases. There are numerous protozoa which inhabit the gastro-intestinal tract of humans. They are classified into Flagellates, Amoebae, Apicomplexa, Microsporidia, and others (Wiser, 2015). Flagellates include *Giardia lamblia, Dientamoeba fragilis* and *Trichomonas hominis* among others. *Giardia lamblia* can cause severe acute diarrhea which may lead to a chronic diarrhea and nutritional
disorders. The most common amoebae include Entameoba histolytica, Entamoeba coli, and Iodamoeba bütschlii. All but Entamoeba histolytica are thought to be non-pathogenic (Wiser, 2015). There are two other species of intestinal amoebae with identical morphologic characteristics as Entamoeba histolytica. These are Entamoeba. dispers and Entamoeba moshkovskii (Peterson et al., 2011). Most symptomatic disease is caused by Entamoeba histolytica. It can become highly virulent and invasive causing liver abscess, a potentially lethal systemic disease (Karin &Weller 2015). Apicomplexa include Cryptosporidium parvum and Isospora belli. Microsporidia include Enterocytozoon bieneusi and Encephalitozoon intestinalis. Apicomplexa and Microsporidia species do not evoke severe disease, but can cause severe and life-threatening diarrhea in HIV/AIDS patients and other immunocompromised individuals. Other intestinal protozoa include Blastocystis hominis and Balantidium coli.

2.3 Distribution of intestinal protozoa

Intestinal protozoan infections are distributed worldwide (Wiser, 2015). While most infections and death from these parasitic diseases affect people in developing countries, they also cause significant illness in developed countries (Ortega et. al, 2008). Pathogenic intestinal protozoa infections are common in school-aged children in the developing world. They are frequently associated with nutrition malabsorption syndromes and gastrointestinal morbidity. They are responsible for clinically important infections such as acute and chronic diarrhea in both the developed and the developing world. Entamoeba histolytica, which affects the colon, can spread to involve the liver if left untreated for a long period. Liver abscesses and resultant complications account for
approximately 40% of deaths from amoebiasis, followed in frequency by invasive colitis and associated complications (Enrique, 2012).

It is estimated that 12% of the population of the world are infected with Entamoeba histolytica, 10% of whom are likely to have symptoms (Mathhys et al., 2011). These infections occur worldwide with the prevalence disproportionately increased in developing countries. This has been associated with poor socioeconomic conditions and sanitation levels which facilitates contamination of food or water by E. histolytica cysts. Infection with E. dispar occurs approximately 10 times more frequently than infection with E. histolytica (Peterson et al., 2011). A higher prevalence of E. histolytica infection is also observed in institutions, such as mental hospitals, orphanages and prisons, where crowding and problems with faecal contamination are contributing factors. Humans are the only host of E. histolytica and there are no animal reservoirs.

Intestinal protozoan infections have been found in across the globe. According to Bercu et al., (2007), Amoebiasis affects more than 50 million people worldwide, with over 100,000 deaths annually. Areas with high rates of amoebic infection include India, Africa, Mexico, and parts of Central and South America (Karin & Weller 2015). In India, prevalence of Entamoeba histolytica ranges from 2 – 27% (Sehgal et al., 2010). Another study in India by Jeevitha et al., (2014) reported prevalence of Entamoeba coli (23%), Cyclospora sp. (22.2%), Entamoeba histolytica (21.8%), and Giardia intestinalis (14.4%). These were found among the dwellers of low socioeconomic areas. In Mexico a prevalence of 13.8% of Giardia intestinalis has been recorded (Ramos et al., 2005).
According to the World Health Organization (WHO) reports, *Giardia lamblia* is one of the most common parasites which affects nearly two thirds of people worldwide (WHO, 2010). Giardiasis has a worldwide distribution, but it is more common in areas with poor sanitary conditions and insufficient water treatment facilities (WHO 2010). In developed countries, nearly 2% of adults and 6-8% of children get infected (McCullough, 2015). The prevalence is significantly higher in developing regions of the world where nearly 33% are infected (McCullough, 2015). Giardiasis is a common cause of diarrheal disease in all age groups, especially in children. In early childhood, *Giardia* may result in stunting of growth and poor cognitive function (Wiser 2015).

Spore-forming protozoa (Apicomplexa) are also common worldwide, their frequency being related to the inadequacy of sanitation. Prevalence of *Cryptosporidia* in Asia and Africa ranges from 5-10%, but antibodies to *Cryptosporidia* have been found in 32-58% of adults (Enrique, 2012). *Isospora* and *Cyclospora* are endemic in many parts of Africa, Asia, and South America (Enrique, 2012). The prevalence rates are higher among immunocompromised populations, particularly with HIV.

*Blastocystis hominis* is a common protozoan of large intestine. Its prevalence is 1.6% - 16% and up to 60% in the developed and developing countries, respectively (Woodhall, 2014). It has two forms namely cyst and trophozoite in its life cycle. The cyst is the transmissible stage, which is transmitted directly or indirectly via the fecal-oral route. The symptoms are diarrhea, vomiting, abdominal cramps and bloating. *Entamoeba coli* are a non-pathogenic amoeba with worldwide distribution.
2.4 Intestinal protozoan infections in Africa

It is reported that up to 10% of the population may be infected with intestinal protozoa in Africa (Escobedo, 2009). Several studies have indicated a high prevalence of intestinal protozoan infections in Ethiopia, Egypt, and Cote D’ivoire. In Ethiopia, the prevalence of *Entamoeba histolytica* was found to be 13.8% (Gelaw *et al.*, 2013). In Egypt there was a prevalence of >21% (Stauffer *et al.*, 2009). In Cote D’Ivoire the prevalence of *Entamoeba histolytica* and *Giardia lamblia* was 18.8% and 13.9% respectively. These infections are related to low socio-economic status which contributes to poor sanitation and unsafe water. In developed countries, amoebiasis is generally seen in migrants from and travellers to endemic areas. Institutionalized patients and sexually active homosexuals are also at increased risk of these infections (Salit *et al.*, 2009).

2.5 Intestinal protozoan Infections in Kenya

In Kenya, there is scanty information on the prevalence of intestinal protozoan infections as most of the studies have investigated them amongst other parasites. However the available literature shows a widespread intestinal protozoan infections in many parts of the country. A study by Nguhiu *et al.*, (2009) reported intestinal protozoan parasitic prevalence of 12.6% in Kitui. Kisavi *et al.*, (2014) later reported a higher prevalence of 38.6% in the same County. Nyarang’o *et al.*, (2008) reported a prevalence of 11.9% of *Entamoeba histolytica* among the food handlers attending Kisii hospital. Another prospective study among children age less than six years found a prevalence of 4% of cryptosporidium (Gatei *et al.*, 2006). Another study in Thika by
Ngonjo et al. (2012) found an overall prevalence of protozoan infections was 46.3%, 38.9%, 34.8% and 28.7% for peri-urban, rural, slum and urban schools respectively. The Kenya Demographic and Health Survey (KDHS) report (2008-2009) indicates 14.4% of diarrheal cases among children under 5 years in Central region of Kenya (KNBS, 2010). Diarrhea has often been associated with intestinal parasitic infections.

2.6 Transmission of Intestinal Protozoan infections

Feecal-oral contamination of water and food is generally the main mode of transmission of intestinal protozoan infections (Shrihari et. al., 2011). Transmission of Balantidium coli is associated with pigs. Feacally contaminated food or water is the most frequently route of transmission of Giardia lamblia, through drinking contaminated tap water or recreational exposures in lakes, rivers, or swimming pools (Wiser 2015). Since Giardia lamblia also infects birds, cows, sheep, deer, dogs and cats, transmission can also occur through contact with pets and domestic animals (Wiser 2015).

2.6.1 Life cycle of Intestinal Protozoa

According to Wiser (2015), intestinal protozoa are transmitted by the feacal-oral route which involves the ingestion of food or water contaminated with cysts (Figure 2.1).
After ingestion by an appropriate host, the cysts transform into trophozoites which exhibit an active metabolism and are usually motile. The parasite takes up nutrients and undergoes asexual replication during the trophic phase. Some of the trophozoites develop into cysts instead of undergoing replication. Cysts are characterized by a resistant wall and are excreted with the feces. In general, situations involving close human-human contact and unhygienic conditions promote transmission.

*Giardia lamblia* colonizes the upper portions of the small intestine. The infection is acquired through the ingestion of cysts. The ingested cyst passes through the stomach and excystation takes place in the duodenum due to the conducive acidic environment of pH<2 (Wiser 2015). The trophozoites are predominantly found attached to epithelial cells of the small intestine and are rarely found in stools, except in the cases of severe diarrhea. The trophozoite stage is characterized by an asexual replication and eventually develops into the cyst stage. The cysts are passed in the feces and can survive for up to
three months under appropriate temperature and moisture conditions. Mature cysts are infective to the next host that happens to ingest them, thus completing the life cycle.

According to Wiser (2015), *E. histolytica* exhibits a typical feecal-oral life cycle consisting of infectious cysts passed in the feaces and trophozoites which replicate within the large intestine. Upon ingestion the cysts pass through the stomach and excyst in the lower portion of the small intestine. The amoeba undergoes another round of nuclear division followed by three successive rounds of cell division to produce eight small uninucleated trophozoites, also called amebulae. These immature trophozoites colonize the large intestine where they feed on bacteria and cellular debris and undergo repeated rounds of binary fission. As an alternative to asexual replication trophozoites can also encyst. Cyst maturation involves two rounds of nuclear replication without cell division and cysts are found in feaces. Cysts are immediately infective upon excretion with the feaces and remain viable for weeks-to-months depending on environmental conditions.

### 2.7 Symptoms of intestinal protozoan infections

The spectrum of intestinal protozoan infections can range from asymptomatic to invasive disease (in the cases of *E histolytica*) to severe and/or chronic and protracted diarrhea (in the cases of giardiasis or in individuals who are severely immunosuppressed with spore-forming protozoan infections). Amoebiasis can manifest in non-invasive intestinal infection whose symptoms include alternating periods of mild diarrhea and constipation, with or without mild abdominal pain (Enrique, 2014).
Invasive forms of amoebiasis include intestinal amoebiasis or amoebic colitis, acute fulminant or necrotizing colitis, ameboma, and liver abscess. Symptoms of intestinal Amoebiasis can range from 1-3 weeks of diarrhea to grossly bloody dysenteric stools with abdominal pain and weight loss in some cases.

For giardiasis, asymptomatic carriers exhibit no symptoms at all. Symptomatic infections are noted more frequently in children than in adults. They include acute infectious diarrhea characterized by short-lasting acute diarrhea, nausea, abdominal distension, greasy stools, and anorexia. Chronic giardiasis is usually associated with intermittent, loose, foul-smelling stools that resemble those of malabsorption states. In some cases, abdominal distension, sulfurous belching, flatulence, epigastric pain, substernal burning, nausea, anorexia, and failure to thrive may occur.

### 2.8 Diagnosis of Intestinal Protozoa

Diagnosis is confirmed by microscopically finding cysts or trophozoites in feaces or in duodenojejunal aspirates or biopsies (Wiser, 2015). For Giardiasis watery or loose stools may contain motile trophozoites which are detectable by the immediate examination of wet smears. Definitive diagnosis of amoebiasis requires the demonstration of *E. histolytica* cysts or trophozoites in feaces or tissues. Stool specimens should be preserved and stained and microscopically examined. Cysts tend to predominate in formed stools and trophozoites in diarrheic stools. Fresh stools can also be immediately examined for motile trophozoites which exhibit a progressive motility.

### 2.9 Treatment of Protozoan infections

Treatment of intestinal protozoa is parasitic specific. Medicine used includes Metronidazole whose recommended dosage is 400 mg three times per day for five days.
(or at least >3 days). For children 15 mg/kg/d in three doses is recommended (Wiser 2015). Tinidazole is also used in treatment of non-dysenteric colitis, dysentery, and extra-intestinal infections caused by *Entamoeba histolytica*. The recommended dose is 2gm start. For serious infections, Tinidazole is administered for three days, 2gm taken twice a day.

### 2.10 Prevention and control of Intestinal Protozoa

The infection is acquired through the ingestion of cysts through contaminated food and water. Control is based on avoiding the contamination of food or water with feecal material. Health promotion and education aimed at improving personal hygiene, and emphasizing hand washing with soap and water, proper sanitation and food handling, are effective control activities for the reduction of person-to-person transmission. Special attention to personal hygiene in high-risk situations such as day-care centres and other institutions is needed. Treatment of asymptomatic household members prevents reinfection in non-endemic areas. There are no safe or effective chemoprophylaxis drugs for intestinal protozoa. Protecting water supplies can also lower endemicity and epidemics. *Giardia* and *Entamoeba* cysts are resistant to standard chlorine treatment, but are killed by iodine or boiling. Sedimentation and filtration processes are quite effective at removing *Entamoeba* cysts.

### 2.11 Intestinal helminths

Helminths, unlike protozoa, are metazoan parasites. Worms develop slowly compared to other infectious pathogens so any resultant diseases are slow in onset and chronic in nature. According to O’Donoghue, (2010), two major phyla of parasitic helminths are
recognized: the Nemathelminths (nematodes) and the Platyhelminths (flatworms). Nematodes are clearly separated into male and female while flatworms are mostly hermaphroditic. The phylum Platyhelminths is further subdivided into the Cestoda (tapeworms) and the Trematoda (flukes). Nematodes include *Ascaris lumbricoides, Trichuris trichiura, Enterobius vermicularis* (pinworms), *Strongyloides stercoralis, Ancylostoma duodenale* and *Necator americanus* (Hookworms). Cestodes include *Taenia solium, Taenia saginata, Hymenolepis nana, Hymenolepis diminuta* and others. Trematodes include *Fasciolopsis buski, Echinostoma ilocanum,* and *Heterophyes heterophyes.*

2.12 Distribution of Intestinal Helminthic Infections

The WHO (2012) estimates indicate that more than 2 billion people are infected with soil transmitted parasites. The WHO (2012) estimates 25% of humans are infected with *Ascaris lumbricoides,* while *Necator americanus* and *Ancylostoma duodenale* (hookworms) infects over a billion people. Over 270 million preschool-age children and over 600 million school-age children live in areas where these parasites are intensively transmitted, and are in need of treatment and preventive interventions. Pre-school and school-age children and women of childbearing age, including adolescent girls, tend to have the higher proportion of worm infections (UNICEF, 2002). Although intestinal worms can infect all members of a population, these specific groups are at greater risk of heavy infections than others and are more vulnerable to the harmful effects of chronic infections.
The highest prevalence occurs in areas where sanitation is inadequate and water supplies are unsafe. They are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia. In South America, a systematic review and geostatistical meta-analysis by Chammartins et al., (2013) found that a population-adjusted prevalence of infection with *Ascaris lumbricoides* was 15.6%, with *Trichiuris trichiura* was 12.5%, and with hookworms was 11.9% from 2005 onwards. Wang et al., (2009), noted that the common soil-transmitted helminths including *Ascaris lumbricoides*, hookworms and *Trichuris trichiura*; were endemic in China. In India, a study by Jeevitha et al., (2014) found the prevalence of *Ascaris lumbricoides* to be 6.2%, *Trichuris trichiura* 1.1%, and *Hymenolepis nana* 2.7%. These were found in the dwellers of low socioeconomic areas.

### 2.13 Intestinal Helminthic Burden in Africa

The WHO (2012) report indicates that in Africa, the number of children at risk of infection by soil transmitted helminths is 280 million in 42 countries. In 2001, the Fifty Fourth World Health Assembly resolved to attain by 2010 a minimum target of regular administration of chemotherapy to at least 75% and up to 100% of all school-age children at risk of morbidity from the disease. The school preventive chemotherapy has covered 25% of the school age children in the period between 2006 and 2009 (WHO, 2012). A study by Abate et al., (2013) in Ethiopia found *Ascaris lumbricoides* to be the most predominant parasite (23.2%) followed by hookworms (6.6%), *Hymenolepis nana* (1.5%), *Enterobius vermicularis* (0.4%), and *Strongyloides stercoralis* (0.2%). The
study found that absence of toilet and lack of hand washing after toilet contributed to these infections.

2.14 Helminthic infections in Kenya

In Kenya the prevalence of helminthic infections varies with regions (Andereck et al., 2014). Kenya is considered to have a high burden of soil transmitted helminths with the proportion of pre-school age children and school age children population requiring preventive chemotherapy at 2/3 or more (WHO, 2012). The national coverage of preventive chemotherapy is currently at 36%, hence the WHO call to scale up the preventive chemotherapy to reach the 75% target. A study by Brooker et.al. (2008) showed that intestinal parasitic worms affected an estimated five million (56.8%) of schoolchildren in Kenya before the rolling out of school deworming programme. Children aged 13-14 years old exhibited the highest prevalence of worm infection (70%), with *Ascaris lumbricoides* being the commonest infection (75%), followed by *Trichuris Trichiura* (51%), hookworms (40.5%) and *Schistosomiasis Mansoni* (8.1%).

The school health programme under which the school deworming programme was initiated was aimed at addressing issues of health concerns in all public schools between the year 2010 and 2014. These issues include inadequate safe water in schools, lack of adequate toilets for boys and girls, lack appropriate of disposal mechanism for sanitary towels in school, and lack of effective control of vectors, vermin and rodents (MOH and MOE, 2009). In Central Kenya, a study conducted by Ngonjo et.al (2012) in four public primary in Thika District, indicates prevalence of helminthic infections to be 38.9%, 48.9%, 48.9% and 31% for Peri-urban, rural, slum, and urban school respectively. The
common infections were *Ascaris lumbricoides*, hookworm, *Trichiuris trichiura* and *Schistosoma mansoni*.

### 2.15 Transmission of intestinal Helminths

Intestinal helminthic infections are mostly spread by faecal-oral contact or contamination of water or food, due to poor sanitation and hygiene practices. They are acquired by ingestion or penetration of skin by infective forms (Tariq, 2006).

People become infected with *A. lumbricoides* and *T. trichiura* by ingesting infective parasite eggs. The eggs which may be attached to vegetables are ingested when the vegetables are not carefully cooked, washed or peeled. Eggs may also be ingested from contaminated water sources. Children may ingest eggs when they play in soil and then put their hands in their mouths without washing them. Since these worms do not multiply in the human host, reinfection occurs only as a result of contact with infective stages in the environment (Yap, 2012).

In the case of *Enterobius vermicularis* eggs are deposited on perianal folds and self-infection occurs by transferring infective eggs to the mouth with hands that have scratched the perianal area (Murray, 2008). Person-to-person transmission can also occur through handling of contaminated clothes or bed linens. Enterobiasis may also be acquired through surfaces in the environment that are contaminated with pinworm eggs (e.g., curtains, carpeting). Some small number of eggs may become airborne and inhaled. These would be swallowed and follow the same development as ingested eggs.
*Taenia solium* and *Taenia saginata* are transmitted to humans by ingesting undercooked infected pork and beef respectively.

**2.15.1 Life Cycles of Intestinal Helminths**

Helminths form three main life-cycle stages: eggs, larvae and adults. Adult worms infect definitive hosts (those in which sexual development occurs) whereas larval stages may be free-living or parasitize invertebrate vectors, which are their intermediate hosts.

Nematodes produce eggs that embryonate in utero or outside the host. The infection starts with the invasion of larvae into the human body, either orally or through skin penetration. The parasite matures within the human body and produce eggs which are disposed with the faecal matter. The length of time taken to complete the cycle is approximately three months depending on the specific organism (Murray, 2008). The emergent larvae undergo 4 metamorphoses before they mature as adult male or female worms.

Cestode eggs released from gravid segments embryonate to produce embryos which are ingested by intermediate hosts, then later penetrate host tissues where they excyst and form adult tapeworms.

Trematodes have more complex life-cycles where ‘larval’ stages undergo asexual amplification in snail intermediate hosts. Eggs hatch to release free-swimming miracidia which actively infect snails and multiply in sac-like sporocysts to produce numerous rediae. These stages mature to cercariae which are released from the snails
and either actively infect new definitive hosts. Some species form encysted metacercariae on aquatic vegetation which is eaten by definitive hosts.

The life cycle of *Ascaris lumbricoides* takes about three months. When eggs are swallowed the larvae hatch from the eggs, penetrate the intestinal wall and enter the bloodstream. They stop at pulmonary arteries and stay in the lungs for two weeks. They break into the alveoli and travel up the respiratory system to the throat to be swallowed again. The migration is needed for the larvae to develop into adults. Adult worms attach themselves to the intestinal wall ready to mate. A female produces about 200,000 microscopic eggs per day that are passed in feces. The eggs fertilize into infective stage within a few weeks in the right conditions in the soil. Unfertilized eggs are not infective. Whipworm (*Trichuris trichiura*) and pinworms (*Enterobius vermicularis*) have almost similar lifecycle with the roundworms, except that they do not get into the lungs at any one time (Murray, 2008).

*Necator americanus* and *Ancylostoma duodenale* are widespread in the tropical region. The lifecycle of hookworm starts when filariform larva penetrates the skin, burrows through tissue until it reaches a blood vessel or lymphatic duct. It travels in the bloodstream to the small pulmonary capillaries. It breaks into the lung alveoli and is taken towards the bronchus and trachea by the movement of microvilli. It is coughed up to the throat and swallowed through the oesophagus to the stomach where it hooks into the intestinal mucosa in the small intestine and starts sucking blood. The arrival to the small intestine takes about a week. Then within a few weeks it develops into an adult and is ready to mate. The produced eggs exit the body in the feces. Rhabditiform
larvae hatch in the feaces or in warm, moist, sandy soil within two days. They feed on organic matter and grow rapidly. They molt twice within 10 days to become filariform larvae that are infective. Filariform larvae can survive up to four weeks in a warmth, moist, shady conditions (Murray, 2008).

Although most hookworm larvae travel straight to the small intestine, sometimes larval *Strongyloides stercoralis* infestation is similar to that of hookworms but it has a heterogenic life cycle. According to O’Dologhue (2010), *Strongyloides stercoralis* are unique in that they may exhibit either a direct (homogenic) exclusively parasitic life cycle, or an indirect (heterogenic) life cycle in which free living generations may be interrupted by parasitic generations, depending on the environmental conditions. Both the homogenic life cycle and the parasitic phase of the heterogenic life cycle involve only parthenogenic females, while the free-living life cycle involves both males and females *Strongyloides stercoralis* can auto infect the same host over and over without any intermediate host. This happens when the rhabitoid larvae undergo transformation into infestational strongyloid larvae without leaving the human host (O’Dologhue, 2010). After transcutaneous penetration, the larvae enters circulation, then the lungs, from where it passes down again into the stomach then to the duodenum, where they become adult females for the purpose of laying eggs. This makes strongyloidiasis a very persistent disease (Murray, 2008).

### 2.16 Clinical Manifestations of Intestinal Helminths

Although most helminthic infections are well tolerated by their hosts and are often asymptomatic, subclinical infections have been associated with significant loss of
condition in infected hosts. According to O’Donoghue (2010), clinical signs of infection vary considerably depending on the site and duration of infection. Symptoms are determined largely by the worm burden: less than 10 worms are asymptomatic. Heavier helminthic infections cause a range of symptoms including diarrhoea, abdominal pain, general malaise and weakness, and impaired cognitive and physical development. Hookworms can further cause anaemia, constipation, congestive heart failure, dizziness, dyspnea (shortness of breath), excessive coughing during larvae migration, fatigue (tiredness), fever, loss of appetite, nausea, rash or sore and itchy feet after larval invasion, stomach or chest pain, vomiting, and weight loss (Enrique, 2012).

For hookworms and strongyloids, transcutaneous penetration results in a macul-erythematous pruritic reaction which spontaneously disappear in 1 or 2 days. The pulmonary transist gives rise to a slight discomfort, pharyngitis with a hoarse voice and as dry cough. The overt phase gives rise to epigastric pain and diarrhoea or sometimes an alternating diarrhoea and constipation, along with nausea and vomiting resulting to weight loss and weakness (Murray 2008). These symptoms appear a month after infestation. In the case of hookworms, massive infestation may result in intestinal haemorrhage, anaemia and bodily weakness. This can cause psychomotor developmental retardation in children. In pregnancy it can contribute to prematurity or maternal-fetal mortality (Enrique, 2012).

Whipworms leave open wounds which cause inflammation of the intestinal wall. Heavier infections are cause chronic profuse mucus and bloody diarrhea with abdominal pains and oedematous prolapsed rectum, resulting in malnutrition, weight loss and anaemia and sometimes death (Murray, 2008).
According to O’Dologhue (2010), larval and adult nematodes can lodge, migrate or encyst within tissues resulting in obstruction, inflammation, oedema, anaemia, lesions and granuloma formation. Infections by adult Cestodes are generally benign as they are not invasive, but the larval stages penetrate and encyst within tissues leading to inflammation, space-occupying lesions and organ malfunction.

2.17 Diagnosis of Intestinal Helminths

Given the diversity of adaptation of different types of helminths, at least three diagnostic methods have been identified.

2.17.1 Microscopic stool examination

For most helminths, direct observation of the parasite from stools is the confirmatory diagnostic method (Enrique, 2012). According to Regis et al., (2012) there are several methods for parasitological diagnosis, such as spontaneous sedimentation method of Hofmman and Lutz; centrifugal-flotation method of Faust; staining methods of Ziehl Neelzen and Kato Katz and sedimentation and centrifugation method of Ritchie. Among the methods mentioned above, Ritchie’s method (1948) is highlighted, which is based on a methodology of acknowledged efficiency for the diagnosis of helminths and protozoa in stool through centrifugal-sedimentation in a formaldehyde ether system. This is because it makes it possible for the parasites to be concentrated in a small volume of faeces by removing the maximum amount of debris.
2.17.2 Collection of eggs on cellophane

Diagnosis of pinworms is made by identifying pinworms or their eggs. Worms can sometimes be seen on the skin around the anus 2–3 hours after falling asleep. Eggs can be collected using a transparent cellophane tape by pressing the sticky side of the tape to the anal skin. The eggs stick to the tape which can be placed on a slide and examined under a microscope. Bathing or having a bowel movement can remove eggs from the skin. So this test should be done immediately after waking up. It needs to be repeated on the following two mornings to increase the chance of finding pinworm eggs (Murray, 2008).

2.17.3 Examination of segments and embryophores

Diagnosis of taeniasis is based upon identification of segments and embryophores in the stool which are observed microscopically. Segments of *Taenia saginata* can be mobile and actively discharged from the anus. Embryophores of *Taenia saginata* can also be collected using the anal cellophane technique.

2.18 Treatment of Intestinal Helminths

The WHO (2012) has recommended a single tablet of albendazole (400mg) and mebendazole (500mg) for the treatment of soil transmitted helminths (WHO, 2012). In the case of hookworms, the infection is usually treated for 1–3 days and a confirmatory stool test is required after treatment to make sure all hookworms are dead. Treatment of taeniasis can be done by administering niclosamide carefully adhering to the dosage. This requires fasting in the morning and slowly chewing the tablets with a spoonful of
water. Albendazole can also be administered for three days, a tablet taken daily. A single dose of praziquantel can be administered at the dosage of 10mg/kg.

### 2.19 Public Health Importance of Intestinal Helminths

Helminthic infections of heavy intensity impair physical growth and cognitive development. They are a cause of micronutrient deficiencies including iron deficiency anaemia leading to poor school performance and absenteeism in children, reduced work productivity in adults and adverse pregnancy outcomes (Hall, 2008). According to Absar et al., (2008), parasitic infections can cause deficiencies in vitamins (A, B6, and B12) and minerals (iron, calcium, and magnesium), block nutrient absorption, and diminish immunity, predisposing those infected to serious diseases. Hookworm infections cause anaemia in women and children due to loss of blood, while acute roundworm obstruction of the gut can result to death among children.

Among school age children, these infections lead to nutritional deficiency, anaemia, growth retardation, and impaired learning ability (Baragundi et. al., 2011). Heavy or long-term infection can result in death, if treatment is not given in time. Stunting of children’s growth due to worm infections is not easily recognized because it occurs almost imperceptibly over time.

Infestation with *Taenia saginata* can result in intestinal obstruction and in rare cases appendicitis. Complications associated with *Taenia solium* infestation include cysticercosis, the development of numerous vesicle which destroy different organs, eyes, nervous system and skin.
2.20 Control of intestinal helminths

The aim of control initiatives should be to interrupt the transmission cycle of the parasites (WHO, 1999). They include chemotherapy, (aimed at reducing worm burden and decreasing transmission), improvement in sanitation, (aimed at reducing soil or water contamination), and health education (aimed at encouraging healthy behavior). Spread of intestinal helminthic infections can be controlled by deworming and treating asymptomatic carriers. Prevention of *Taenia saginata* and *Taenia solium* consist of thoroughly cooking beef and pork respectively. Prevention of hookworms and strongyloids infestation includes avoiding walking bare foot to reduce chances of transcutaneous penetration of the larvae.

Source: WHO 1999

Figure 2.3: Control of transmission of soil-transmitted helminths
According Harhay et al., (2010), the ideal prevention and control methods for these intestinal parasites is typical public-health interventions such as the provision of clean water, community health education, observation of food hygiene, and maintenance of functioning sanitation systems. He further noted that the implementation and sustainability of interventions is complex, and variable between local contexts such as urban and rural setting, as well as learning institutions like schools and day cares.

Health education should discourage open defecation and emphasize hygienic measures such as washing hands with soap and water during the critical times. Cleaning vegetables and fruits as well as proper cooking of beef and pork should also be emphasized. Prevention of pinworms requires hygiene measures such as cutting the nails short and brushing the nails. It is important to reduce eggs in the environment by cleaning bed rooms and beddings. This study aimed at interrupting the transmission cycle of the intestinal parasites using the Public Health Interventions to reduce re-infections after deworming.

2.21 Summary

From the above literature, intestinal helminthic and protozoan infections have far reaching in the health of children. There have been efforts to control these infections through school deworming program. Factors associated with transmission of these intestinal parasitic infections include poor hygiene practices and sanitation. Should these factors be addressed, this would be prevent intestinal parasitic infections. This study therefore aims to address this gap by instituting public health interventions to test the effect it would have on the intestinal parasitic infections.
CHAPTER THREE: MATERIALS AND METHODS

3.1 Research Design

This was a quasi-experimental study conducted in three phases. Data collection was done using mixed methods namely stool examinations, structured interviews, observations and Key Informants Interviews. Phase one provided baseline data before intervention. The second phase was public health interventions and the third one was post intervention evaluation. This design was preferred to facilitate testing of the effectiveness of the public health interventions by comparing the prevalence of intestinal parasitic infections before and after the intervention. The participating schools were divided into intervention and control groups for further comparison.

3.2 Variables

3.2.1 Dependent Variables

Dependent variable was the prevalence of intestinal helminthic and protozoan infections among school-going children in Murang’a County. These infections were examined pre and post intervention.

3.2.2 Independent variables

Independent variables investigated were level of knowledge on intestinal parasitic infections, school sanitation, hygienic practices (measured through level of knowledge on hand washing), and public health interventions.
3.3 Study Area

The study was conducted in Murang’a South Sub-County, Murang’a County as shown in appendix I. The Global Atlas for Helminthic Infections (GAHI 2015) has shown Murang’a County to be one of the areas with high rate of intestinal helminthic infections at 10% – 50%. The Sub-County had a total of 100 primary schools, 67 of which are public schools and 33 private. The study was conducted in public schools. According to the MOH Maragua Level 4 Hospital, there was no data at the commencement of this study showing the prevalence of intestinal helminthic infections in Murang’a South Sub-County. However the July 2011 laboratory reports in the hospital indicated intestinal helminthic and protozoan infection of 17% and 56% respectively.

3.4 Study Population

This included pupils from six public primary schools namely Kianjiru-ini, Ichagaki, Kagaa, Matanya, Kimorori and Peter Kariuki. These were randomly sampled from the 67 public schools in Murang’a South Sub-County. Also included in the study population were the school heads and teachers in charge of health in the schools.

3.4.1 Inclusion criteria

All pupils in the sampled school from class 1 to class 8 who assented to take part in the study and those whose parents gave consent were eligible for the study.

3.4.2 Exclusion criteria

The following were not included in the study:

- Pupils who were in the special units of the schools
• Pupils who were sick at the time of the study

• Pupils who were under any form of medication

3.5 Sampling procedure

Murang’a County was selected due to the high rate of intestinal helminthic infections (GAHI 2015). There are 7 Sub-Counties in the County namely Kiharu, Mathioya, Gatanga, Kigumo, Kandara and Murang’a South. Murang’a Sub-County was randomly sampled from the seven, and six schools proportionately sampled from the two Divisions of the Sub-County. Schools which participated in the study were randomly sampled through multi-stage sampling procedure. Schools from the same geographical region with comparable environmental conditions were paired and intervention and control. The reason for selecting six schools was to allow for sufficient sample size per school for the purposes of data analysis. Pupils were sampled randomly proportionate to size of the school. In each school pupils were randomly sampled from every class using the class registers. The sampling was done proportionate to class sizes. The selected pupils were assigned numbers for identification which were used to identify them throughout the three phases of the study.

3.6 Sample Size Calculation

Sample size was obtained using the formula used by Fisher et al. (2003), as used in other health related studies.

\[ n = \frac{Z^2 \cdot pq}{d^2} \]

\[ Z = 1.96 \] at 95% confidence interval (C.I).
p=0.586, the percentage of school going children estimated to have intestinal parasitic 
worms in Kenya, according to Brooker et al., (2008)

Hence q= 1-0.586 = 0.414

Therefore n = (1.96$^2$ * 0.586*0.414/0.05$^2$

= (3.8416*0.242604)/0.0025 = 372

The minimum sample size required for the study was 372. However this sample size 
was increased by 20% to take care of attrition.

372 + (20% of 372) = 446. These were proportionately sampled from the six school 
randomly sampled as shown in table 3.1.

Table 3.1: Summary of proportionate sampling of the schools and pupils

<table>
<thead>
<tr>
<th>Division</th>
<th>Total No. of Schools</th>
<th>No. of schools sampled</th>
<th>Total No. of Pupils</th>
<th>No. of pupils sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maragua</td>
<td>18</td>
<td>1. Kianjiru-ini</td>
<td>1037</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Ichagaki</td>
<td>737</td>
<td>59</td>
</tr>
<tr>
<td>Makuyu</td>
<td>49</td>
<td>1. Kimorori</td>
<td>987</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Kagaai</td>
<td>912</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Matanya</td>
<td>900</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Peter Kariuki</td>
<td>1000</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>6</td>
<td>5573</td>
<td>446</td>
</tr>
</tbody>
</table>

3.7 Pilot study

A pilot study was conducted in a primary school in the neighbouring Kiambu County. 
This was a day public school in a rural setting similar to the schools where the study 
was done.
3.7.1 Reliability

Examination of stool samples was done using Ritchie formol-ether concentration technique which has been used in other similar studies (Ritchie 1948). Interview schedules were pretested during the pilot study. In both the pilot and the actual study, Kiswahili was used to explain the questions in the lower classes.

3.7.2 Validity

Construction of interview schedules and observation checklist was guided by the specific objectives in order to answer the research questions. These tools were field tested during the pretest of the study to ensure their validity. The stool samples were examined by qualified clinical laboratory technicians in well-established medical laboratory.

3.8 Data collection Techniques

3.8.1 Phase one – Baseline data collection:

i. Selected pupils were invited to provide stool samples for examination of intestinal parasites. They were provided with labelled poly pots and toilet papers. The poly pots were labelled with the same numbers used in the interview schedules. Pupils were trained on how to safely collect the stool samples into the poly pots. Those who required assistance were aided through the process by the research assistant.

ii. Using the already pretested interview schedules, pupils were interviewed on their knowledge on intestinal helminths and protozoan infections (Appendix IV).
iii. Qualitative data was collected through key informant interviews which were conducted among the School Heads and the Teachers in charge of school health (Appendix II).

iv. Observations check list was used to collect further qualitative data on school sanitation and pupils hygiene practice including hand washing (Appendix III).

v. Pupils’ knowledge on how to wash hands was used to gauge the level of hygiene as described in Appendix V. Knowledge on how to wash hands was categorized as adequate or inadequate. Adequate knowledge consisted of knowledge of use of soap and water in hand washing, and at least three of the critical times of hand washing. Level of school sanitation was measured in terms ratio of latrine to pupils, as well as how the latrines were maintained, cleaned and disinfected as stipulated in the school health policy.

3.8.2 Phase two – intervention phase

i. Among the sampled schools, all the respondents who had intestinal parasitic infections were treated by the pharmacist who was part of the research team. Two respondents from Ichagaki and Matanya primary schools were referred for further treatment to Ichagaki Mission Clinic and Maragua ridge health centre respectively.

ii. In all schools tippy taps were set up in strategic positions for hand washing.

iii. In intervention schools teachers were sensitized about intestinal parasites among the pupils and the intervention measures to be put in place.

iv. In intervention schools soap was provided for hand washing and detergent for cleaning latrines.
v. In intervention schools, hygiene lessons were conducted twice a week in each school for a period of three months. The lessons included, among other things, demonstration of how to wash hands using songs and role plays.

vi. Intervention schools also received Information Education and Communication (IEC) materials such as flyers and posters.

Figure 3.4: Summary of the data collection
3.8.3 Phase three – post intervention evaluation

i. This was done three months after the intervention. The same pupils whose stool samples had been examined at baseline were again invited to provide stool samples for examination of intestinal parasites. They were provided with labelled poly pots and toilet papers. The poly pots were labelled with the same numbers used in the baseline survey and in the interview schedules. Pupils were again trained on how to safely collect the stool samples into the poly pots. Those who required assistance were assisted.

ii. Data collection tools used in the baseline study were used in to collect data post intervention. Using the interview schedules, pupils were interviewed on their knowledge on intestinal parasitic infections.

iii. Observations were made on the pupils’ hand washing behavior.

iv. Qualitative data was collected from key informant interviews which were again conducted among the School Heads and the Teachers in charge of school health.

v. Observations check list was used to collect further qualitative data on school sanitation and hygiene practice.

vi. Level of school sanitation was measured in terms of how the latrines were maintained, cleaned and disinfected as stipulated in the school health policy.

3.9 Data Analysis

Each of the respondents was allocated an identifier number which was used throughout the study. Data was analyzed using SPSS version 20. Data was entered and cleaned at
the end of each data collection exercise. To determine the prevalence of intestinal helminthic infections, stool sample results were analyzed by computing percentage of infected pupils from each school. The same procedure was followed to determine the prevalence of intestinal protozoan infections. To establish the level of knowledge on intestinal parasitic infections among the respondents, the responses given were summarized and computed in percentages for each school. The same procedure was used to analyses data on level of hygiene practices and school sanitation. Chi-square tests were used to test significance of association between intestinal parasitic infections and hygiene practices as well as school sanitation. Odds ratio was used to test the strength of association of these variables. To establish the effects of public health interventions on parasitic infections t-test was used to compare prevalence of infections before and after interventions, in both intervention and control groups. Knowledge on how to wash hands was measured as recommended in the working paper on Water and Sanitation Programme (2010). Thematic data analysis was used to analyze qualitative data.

3.10 Logistic and Ethical Considerations

The study was approved by Graduate School, Kenyatta University Ethical Review Committee and authorized by National Commission for Science, Technology and Innovation (Appendices VI and VII respectively). Clearance for the study was provided by Murang’a South Sub-County Education Office. Informed consent was obtained for school heads and parents. Pupils assented for the study. Two pupils whose conditions required further treatment were referred to the nearby health facilities with the
involvement of their parents. Anonymity of respondents and confidentiality of their information was ensured.
CHAPTER FOUR: RESULTS

4.1 Socio-demographic information of respondents

The total number of pupils who participated up to the end of the study was 400, the attrition rate being 10.31%. Out of these 48.8% were male and 51.2% female.

4.1.1 Age of respondents

Pupils who participated in the intervention group of the study were aged between 5 and 15 years as summarized in figure 4.1.

![Figure 4.1: Age of respondents in intervention group](image)

4.1.2 Guardianship

Pupils who lived with both of their parents were 70.6% and 67.3% in the intervention and control groups respectively (figures 4.2). Those
4.1.3 Guardians’ Occupation

In both the intervention and control groups, more than half the guardians were farmers at 61.2% and 52.3%, respectively. Those who had a formal employment in the intervention and control groups were 3.5% and 7.0% respectively (figures 4.3).
4.2 Baseline Prevalence of Intestinal Protozoan and helminthic infections

4.2.1 Intestinal protozoan infections

In the intervention group, baseline prevalence of protozoan infections ranged between 68.6% in Peter Kariuki and 46.3% in Kagaa (figure 4.4). The overall prevalence was 51.1%. 

Figure 4.3 Guardians occupation in intervention group

Figure 4.4 Baseline intestinal protozoan infections in intervention group
In the control group, the baseline prevalence of intestinal protozoan infections ranged between 60.3% in Kianjiru-ini and 37.7% in Kimorori as shown in figure 4.5. The overall prevalence was 55.2%. A comparison of mean percentage of infected pupils revealed that there was no statistically significant difference in the prevalence of intestinal parasites between intervention and control groups (t = 0.32, P = 0.37).

![Figure 4.5 Baseline intestinal protozoan infections in the control group](image)

4.2.2 Intestinal helminthic infections

Baseline prevalence of intestinal helminthic infections in the intervention group was 14.3% in Ichagaki and Peter Kariuki (figure 4.6) and 7.4% in Kagaa. The overall prevalence was 12.0%.
In the control group the highest prevalence of intestinal helminthic infections was 23.1% in Kianjur-ini as shown in figure 4.7. The prevalence in Matanya and Kimorori was 13.5% and 13.0% respectively. The overall prevalence was 16.5%.
Figure 4.7 Baseline intestinal helminthic infections in the control group

A comparison of mean percentage of infected pupils revealed that there was no statistically significant difference in intestinal helminthic infections between the two groups ($t = 1.31, P = 0.191$).

4.2.3 Types of Protozoan Infections

The type of protozoa with the highest prevalence in the intervention and control groups was *Entamoeba coli* with 29.9% and 23.1% respectively. As shown in figure 4.8, the prevalence of *Entamoeba histolytica* was 23.4% and 14.1% in the intervention and control groups respectively.
4.2.4 Types of Helminthic Infections

*Ascaris lumbricoides* was found to be the highest form of infections in intervention as well as in the control groups at 6.5% and 5.5% respectively (figures 4.9). This was followed by hookworms at 1.0% and 5.5% in intervention and control groups respectively.
Figure 4.9: Types of intestinal helminthic infection

4.2.5 Distribution of infections across gender

Analysis of distribution of the infections across gender was done for all the respondents together. As shown in figure 4.10, girls had higher prevalence of helminthic infections compared to boys at 61.0% and 39.1% respectively.

![Figure 4.10: Distribution of infections across gender](image)

Gender was neither statistically significantly associated with intestinal protozoa nor with intestinal helminths infections ($\chi^2 = 0.87$, df = 1, P = 0.34) and ($\chi^2 = 2.6$, df = 1, P = 0.83) respectively.

4.2.6 Distribution of intestinal parasitic infections across ages

Analysis of distribution of infections across ages was also done for all the respondents together. Both protozoan and helminthic infections were found to be higher among pupils aged 11 – 13 years as summarized in Figure 4.11. Prevalence of helminthic infections among 11 year olds was 12% and 16% among the 13 year olds. Protozoan infections prevalence was 20% among pupils aged 13 years. Chi-square analysis
showed a statistically significant association between age and intestinal helminthic infection ($\chi^2 = 18.3$, df = 10, $P = 0.049$). Intestinal protozoan infections had no association with age of the respondents ($\chi^2 = 9.3$, df = 10, $P = 0.5$).

Figure 4.11 Distribution of parasitic infections across age

4.2.7 Level of knowledge of intestinal parasitic infections

In the intervention group, pupils’ knowledge of intestinal parasitic infections was 58% in Ichagaki and 54.3% in Peter Kariuki (figure 4.12). In Kagaa the level of knowledge was slightly less than half at 44.4%.
In the control group, the level of knowledge of intestinal parasites ranged between 51.5% in Kimorori to 44.2% in Matanya. As shown in figure 4.13, in Kianjiru-ini, the knowledge was at 50.8%. The difference in the knowledge of intestinal parasite in the intervention group and that in the control group was not statistically significant ($\chi^2 = 3.4, \text{df} = 5, P=0.13$).
4.2.8 Level of Hygienic Practices and School Sanitation

These included school sanitation practices and school hygienic practices which were assessed based on the school health policy.

4.2.8.1 Level of school sanitation

In both the intervention and control groups latrines were found to be cleaned daily but with water only, without any form of soap or disinfectant. This was confirmed in the KII where one school head reported:

“Pupils just pour water on the floor of the latrines and drain it using tree branches since there are no brooms.”
As summarized in table 4.1, only one school had a health education book while the rest of the schools had no health education IEC materials.

Table 4.1 School Sanitation Practices

<table>
<thead>
<tr>
<th></th>
<th>School health policy requirement</th>
<th>Ichagaki</th>
<th>Kagaa</th>
<th>Peter Kariuki</th>
<th>Kianjiru-ini</th>
<th>Matanya</th>
<th>Kimorori</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning materials</td>
<td>Water, soap, brooms</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>Disinfection</td>
<td>Daily</td>
<td>No schedule</td>
<td>Monthly</td>
<td>Termly</td>
<td>No regular schedule</td>
<td>No regular schedule</td>
<td>Termly</td>
</tr>
<tr>
<td>IEC materials</td>
<td>Books, posters, and fliers</td>
<td>None</td>
<td>1 book</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

There was a statistically significant relationship between protozoan infections and school sanitation ($\chi^2 = 10.3$, df = 1, P = 0.001). Association between helminthic infections and school sanitation was also found to be significant, ($\chi^2 = 2.4$, df = 1, P=0.01) as summarized in table 4.2. This meant that school sanitation could be a contributing factor the prevalence of intestinal protozoan and helminthic infections.
Table 4.2: Association between school sanitation and intestinal parasitic infections

<table>
<thead>
<tr>
<th>Variables associated with sanitation</th>
<th>P value</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protozoan infestations</td>
<td>&lt;0.001</td>
<td>2.2 (1.5 - 3.2)</td>
</tr>
<tr>
<td>Helminthic infestations</td>
<td>&lt;0.001</td>
<td>2.1 (1.1 – 4.0)</td>
</tr>
</tbody>
</table>

4.2.8.2 School Hygiene

In intervention and control schools pupils who were found to have adequate knowledge on how and when to wash hands were at 8% and 12% respectively (figure 4.14). This was further confirmed in the KII where one of the teachers in charge of school health reported:

“The pupils are never taught on how to wash hands, and even hand washing facilities are not available.”

None of the schools had participated in health education days as confirmed in KII with one school head:

“We have never health any health education days. Some of the requirements indicated in the school policy are never really followed up. We do not even have health clubs”.”
A comparison of mean percentage of infected pupils revealed that the difference in the level of knowledge of how to wash hands between the intervention and control groups was not statistically significant ($t = 0.5, P = 0.23$).

There was however a significant association between level of knowledge on hand washing and the intestinal parasitic infections as summarized in table 4.3.

<table>
<thead>
<tr>
<th>Variables associated with knowledge of how to wash hands</th>
<th>$\chi^2$</th>
<th>df</th>
<th>P value</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intestinal Protozoan infections</td>
<td>44.03</td>
<td>2</td>
<td>&lt;0.001</td>
<td>0.370 (0.239 – 0.573)</td>
</tr>
<tr>
<td>Intestinal Helminths Infections</td>
<td>12.1</td>
<td>4</td>
<td>0.017</td>
<td>0.343 (0.160 – 0.860)</td>
</tr>
</tbody>
</table>

Figure 4.14: Knowledge on how to wash hands in intervention schools
4.3 Post Intervention Results

4.3.1 Prevalence of Protozoa Post Intervention

In the intervention group, the overall prevalence of protozoan infections reduced from 55.1% to 6.0% before and after intervention respectively. The highest reduction was found in Peter Kariuki from 68.6% to 4.3% before and after intervention respectively (Figure 4.15). There was statistically significant association between the intervention and prevalence of intestinal protozoan infections after intervention ($\chi^2 = 114.6$, df = 1, P <0.001).

![Figure 4.15: Prevalence of intestinal protozoan infections post intervention](image)

In the control group the overall prevalence of intestinal protozoan infections reduced from 51.3% to 49.3% before and after intervention respectively as summarized in figure
4.16. This difference in the prevalence was not statistically significant ($t = 5.2, P = 0.91$).

![Bar chart showing prevalence of intestinal protozoan infections in control schools post intervention.](image)

**Figure 4.16: Intestinal protozoan infections in control schools post intervention**

### 4.3.2 Types of protozoan infections post intervention

In the intervention group, there was a general reduction in the prevalence of all the types of intestinal protozoan infections. The prevalence of *Entamoeba histolytica* reduced from 23.4% pre intervention to 6.0% post intervention while that of *Giardia lamblia* reduced from 6.0% to 2.0% (figure 4.17).
In the control group there was a slight reduction of *Entamoeba histolytica* from 14.1% to 13.3% and that of *Entamoeba coli* reduced from 23.1% to 9.0%. As shown in figure 4.18, *Giardia lamblia* increased from 7.0% to 7.5.0%.

**Figure 4.17: Intestinal protozoan infections in intervention group post intervention**
In the intervention group, the overall prevalence of intestinal helminthic infections reduced from 12.0% to 0.0 (figure 4.19) before and after intervention respectively. The association between intervention and the prevalence of intestinal helminthic infections after intervention was statistically significant ($\chi^2 = 114.6$, df = 1, $P < 0.001$).
In the control schools there was an overall reduction of the prevalence of intestinal helminthic infections from 16.5% to 10.6% before and after intervention as summarized in figure 4.20. A comparison of mean percentage of infected pupils revealed that the difference in the prevalence pre and post intervention was not statistically significant (t = 6.1, P = 0.74).

**Figure 4.19: Intestinal helminthic infections in intervention group post intervention**
4.3.4 Types of Intestinal Helminthic Infections in Control Schools

There was a reduction in the prevalence of hookworms from 5.5% pre intervention to 4.5% post intervention. As summarized in figure 4.21, Ascaris lumbricoides also reduced from 4.5% to 3.5% pre and post intervention respectively.
4.3.5 Level of knowledge on intestinal parasitic infection

In the intervention group, there was an overall increase in the knowledge on intestinal helminths from 52.2% to 89.0% before and after intervention respectively (Figure 4.22). A comparison of mean percentage of infected pupils pre and post intervention revealed that this increase was statistically significant ($t = -4.1$, $P = 0.002$). Chi-square tests indicated a statistically significant association between intervention and the increase in adequate knowledge on intestinal parasites ($\chi^2 = 54.1$, df = 2, $P < 0.001$).
In control group there was an overall increase in the knowledge on intestinal parasites from 48.8% to 64.8% as summarized in figure 4.23. This increase was not statistically significant ($t = 6.2, P = 0.43$)
Figure 4.23: Knowledge on intestinal parasites post intervention - control group

4.3.6 Level of Hygienic Practices and School Sanitation

This was measured in terms of school sanitation and health education as stipulated in the school health policy.

4.3.6.1 Level of school sanitation

After the intervention, cleaning of latrine was done using water and detergents in the intervention schools as opposed to water only during the pre-intervention phase. Disinfection was done at least once monthly on a regular basis, different from the pre-intervention phase where there was no schedule for disinfection pre-intervention. This was observed and later confirmed in the KII where the school head in one of the intervention schools reported:
“Since your training on how to maintain cleanliness of our latrines, the pupils wash them daily using the liquid soap, water and brooms. I ensure the latrines are disinfected weekly using kel (a local disinfectant which is poured on the surfaces and the pits of the pit latrines).”

Health promotion materials were made available in all the schools in intervention group as summarized in table 4.4.

<table>
<thead>
<tr>
<th>Table 4.4: Post intervention school sanitation practices in intervention schools</th>
</tr>
</thead>
</table>
| ![Table Image](image)

There was no change in the school sanitation practices in the control group as shown in table 4.5. At post intervention phase, cleaning of latrines was still being done using water and homemade brooms, and disinfection was not done on a regular basis.
**Table 4.5: Post intervention school sanitation in control schools**

<table>
<thead>
<tr>
<th>Cleaning materials</th>
<th>School health policy requirement</th>
<th>Kianjiru-ini</th>
<th>Matanya</th>
<th>Kimorori</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning materials</td>
<td>Water, soap, brooms</td>
<td>Water and brooms</td>
<td>Water and brooms</td>
<td>Water and brooms</td>
</tr>
<tr>
<td>Disinfection</td>
<td>Daily</td>
<td>No regular schedule</td>
<td>Termly</td>
<td>No regular schedule</td>
</tr>
<tr>
<td>IEC materials</td>
<td>Books, posters, and fliers</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

**4.3.6.2 Hygiene at school**

In intervention group, the overall level of adequate knowledge on hand washing increased from 7.6% to 81.7% before and after intervention respectively. This was observed and further confirmed by the school head in one of the intervention school who reported:

“The pupils have embraced the hand washing practice and they ensure they follow the steps you have trained them. There is actually a noticeable improvement in the general cleanliness”.

A comparison of mean percentage of infected pupils pre and post intervention revealed that this increase was statistically significant ($t = -3.1$, $P = 0.002$) as summarized in Figure 4.24. Chi-square test further showed a significant relationship between intervention and the increased level of adequate knowledge in hand washing post intervention ($\chi^2 = 134.1$, df = 2, $P < 0.001$).
Figure 4.24: Knowledge on hand washing in intervention group post intervention

The overall increase in the knowledge on hand washing in control group was 24.4% to 55.4% as summarized in figure 4.25. A comparison of mean percentage of infected pupils pre and post intervention revealed that this increase was not statistically (t = -6.2, P = 0.73).
Figure 4.25: Knowledge on hand washing in control groups post intervention

4.4 The effects of public health interventions on intestinal parasitic infections.

In the intervention group, the prevalence of intestinal protozoan infections reduces from 55.1% to 6.0% before and after intervention respectively. A comparison of mean percentage of infected pupils revealed that there was a statistically significant difference in the prevalence of intestinal protozoan infections before and after intervention ($t = 12.6$, $P<0.001$). As summarized in figure 4.26, the change of prevalence of intestinal protozoan infections in the control group was from 51.3% to 49.3% before and after intervention respectively. A comparison of mean percentage of infected pupils pre and post intervention revealed that this change in the control group was not statistically significant ($t = 0.894$, $P = 0.97$). Further tests showed a statistically significant association between intervention and the prevalence of intestinal protozoan infections.
\( \chi^2 = 23.5, \text{ df } = 1, P < 0.001 \). Odds ratio tests showed this to be a strong relationship 
\( R = 0.051 (0.027 - 0.098) \).

Figure 4.26: Effects of interventions on intestinal protozoan infections

There was also a reduction in the prevalence of helminthic infections in the intervention group from 12.4% to 0.0% before and after intervention respectively. A comparison of mean percentage of infected pupils pre and post intervention revealed that this difference in the prevalence was statistically significant \( t = -3.78, \text{ df } = 398, P<0.001 \). This change was also statistically significantly associated with intervention \( \chi^2 = 23.5, \text{ df } = 1, P<0.001 \). In the control group the reduction was from 17% to 11.1% as summarized in figure 4.27.
Therefore the null hypothesis is rejected and an alternative hypothesis adopted that public health interventions have effects on the intestinal parasitic infections.

**4.5. Thematic analysis of the Key Informant Interviews**

In all the schools in both intervention and control groups, cleaning of latrines is done by the pupils as there are no support staff to do that work. None of the pupils in either group had been trained on Water Sanitation and Hygiene (WASH), neither were there any manuals for training learners on WASH. There were reports indicating annual inspection of the schools by the public health officers.
Interviews with teachers in charge of health revealed that none of the schools in the intervention or in the control group held health education days. None of the teachers in either intervention or control groups had been trained on health promotion as recommended in the school health policy. There were no health clubs in the intervention group, nor in the control group, thus were no health related activities going on among the pupils. Hand washing campaigns had not been conducted in any of the school in the intervention groups nor in the control group.
CHAPTER FIVE: DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

5.1 Discussion

5.1.1 Socio-demographic information of respondents

The ages of respondents ranging between 6 and 15 is slightly outside the bracket of the normal range of 6 to 13 years. In the Kenyan education system, children are enrolled in class 1 at the age of 6 years, and spend the eight years in primary school (UNICEF 2009). Most of the pupils therefore leave class eight at the age of 13 or latest 14 years. In the study area, 0.6% of the respondents were underage while nearly 3.5% of them were aged 15 years meaning they may have repeated in one or more classes. However there was no statistically significant difference between the ages of respondents in the intervention and control groups (P = 0.18).

According to Kenya National Bureau of Standards, children aged 0-14 years old constitute 37% of Murang’a County population (KNBS, 2013). KNBS (2013) further states that Murang’a County has a transitional population structure due to a shrinking child population and an increasing youthful population, where 15-34 year olds constitute 32% of the total population. This is due to declining fertility rates among women as shown by the highest percentage household size of 0-3 members at 50%.

Majority of the respondents were living with both of their parents, followed by those who lived with only their mothers. It is notable that 4.0% and 7.5% of the respondents in the intervention and control groups respectively live under the care of their grandparents. Murang’a County has the highest proportion of old people in the country (65+ years) who form 6.9% of the total Country population.
The study area was a rural setting; farming was the highest form of occupation among the respondents’ guardians. This is consistent with the socioeconomic status of the population of Murang’a County where nearly half of the population (43.3%) have a family agricultural holding (KNBS, 2013). Those who had formal employment were a mere 3.5% and 7.0% in the intervention and control group respectively. According to KNBS (2013), individuals with who work for pay in Murang’a County form less than a quarter of the population, 22.5%. There was no significant association between guardians occupation and intestinal protozoan infection (P = 0.23) nor helminthic infection (P = 0.79). This is an indication that the occupation of the respondents’ guardian was not necessarily a determinant of intestinal parasitic infections.

### 5.1.2 Prevalence of Intestinal helminthic infections

The overall prevalence of intestinal helminthic infections was 12% and 16.2% in the intervention and control groups respectively. The presence of intestinal parasites in a child cannot be taken lightly given the adverse health effects they are likely to causes including anaemia and gastrointestinal bleeding (UNICEF 2002). A similar study in Kitui Kenya has shown higher prevalence of 38.6% (Kisavi et al., 2014). In Elbourgon, Mokua et al., (2014) found a much higher prevalence of 86% among pre-school children aged 6 months to 10 years. Elsewhere in Asia the prevalence of helminths has been found to be lower at 8.6% (Matthys et al., 2011).

*Ascaris lumbricoides* formed the highest form of infections in both intervention and control groups (7.0% and 6.0% respectively) followed by hookworms (1.5% and 6.0% respectively). This agrees with the findings of Kisavi (2014) in Kitui where *Ascaris lumbricoides* formed 25.9% followed by hookworms at 10.4%. It was however
different from the study in Asia where *Ascaris lumbricoides* and hookworms formed 4.4% and 3.5% respectively (Mathys et al., 2011). The other types of helminths including *Hymenolepis diminuta* and *Hymenolepis nana* formed 0.5 and 1.8% respectively and were found among respondents in the intervention group. Certain helminthic infections such as *hymenolepis diminuta* and *hymenolepis nana* were only found among respondents in the intervention group but not in the control group. This was not similar to the findings of Matthys et al., (2011) in Asia where *hymenolepis nana* was the highest form of infection (25.8%) followed by *Ascaris lumbricoides* and *hookworms*.

Intestinal helminthic infections were highest among the pupils aged between 11 and 13 years at 16%. This finding is similar to the Ethiopia study where pupils aged 10 – 12 years had the highest levels of intestinal parasitic infections (Gelaw et al., 2013). Age was significantly associated with intestinal helminthic infections (*P = 0.049*). These findings were similar to a study by of Abera & Nibret (2014) in a study in Ethiopia where age was significantly associated with prevalence of helminthic infections.

Prevalence of helminthic infections was higher in females than in males while the prevalence of protozoan infections was higher among males than females. This was not similar to the findings of Abera and Nibret (2014), in a study in Northwest Ethiopia, where males were found to have a slightly higher intestinal parasitic infections than females. There was however no statistically significant difference in prevalence of helminthic across gender (*P = 0.348*). This was found to be similar with the findings by
Kisavi et al., (2014) in a study conducted in Kitui Kenya where gender was not significantly associated with helminthic infections.

5.1.3 Prevalence of Intestinal protozoan infections

The overall prevalence of intestinal protozoan infections before intervention was 55.1% and 51.2% in the intervention and control group respectively. This close to the prevalence of intestinal parasites reported by Stewart (2011) (56.8%), before the rolling out of the school health programme in Kenya in 2009. This high prevalence of intestinal protozoan infections seem to have persisted all these five years despite the school deworming programme whereby pupils are supposed to be dewormed every six months (WHO 2012). This may be due to the fact that the deworming exercise only targets intestinal helminthic infections and not the protozoan infections. Intestinal protozoan infections were highest among pupils age 11 and 13 years at 21%. Age was not significantly associated with intestinal protozoan infections ($P = 0.53$).

Intestinal protozoan infection was much higher than intestinal helminthic infections whose overall prevalence was 12% and 16.5% in the intervention and control groups respectively. This is quite notable given that intestinal protozoan infections are not addressed in the school deworming programme, more emphasis having been given to intestinal helminthic infections. The latter has also been considered to be a major contributor to disease burden among the school going children. This shows that deworming alone is not a solution to the problem of intestinal parasitic infection as the pupils continue to be susceptible. These findings are similar to those of a study in Tajikistan Asia which showed a much higher prevalence of pathogenic protozoa
infections at 47.1 % (Matthys et al. 2011). The findings however differ from a study conducted in Ethiopia by Gelaw et al.,(2013) where intestinal helminthic infections were higher than protozoan infections. The higher prevalence of helminthic infections in Ethiopia can be attributed the culture of consumption of raw meat as noted by Dadi and Astrar (2008).

The highest form of infection was *Entamoeba coli* which was found in 29.9% and 23.1% of the pupils in the intervention and control group respectively. Though this is not a pathogenic parasitic infection, its presence is an indication of the level of risks of intestinal parasitic infections. This is similar to the findings of Mathhys et al., (2011) where prevalence of *Entamoeba coli* was the highest at 65.7%. Nearly a quarter (23.4%) of the pupils in the intervention group and 14.1% in control group were found to be infected with pathogenic protozoa *Entamoeba histolytica*. This is much higher that was found in a study by Gelaw et al., in Ethiopia among pupils from a private school where 9.2% of the pupils were found to be infected.

5.1.4 Level of knowledge on intestinal parasitic infections

In both the intervention and control groups on average 52.2% and 48.8% of the pupils respectively were aware of intestinal parasitic infections, especially helminths which they refered to as *Njoka* in the local dialect. Half of them (50.1% and 50.4% in intervention and control groups respectively) held a lay perception that ingesting was the main risk factor associated with intestinal helminthic infections. This portrayed a high level of ignorance on the risk factors of intestian parasitic infections. Of these, only 21.1% and 27.2% in intervention and control groups respectively were aware of
intestinal protozoan infections which they referred to as *tugunyu twa nda*. These findings are similar to a study in Ethiopia where nearly half of the respondents were ignorant about intestinal parasites (Liza et al., 2014).

There was no statistically significant difference in awareness between intervention and control group (*P*=0.92). After intervention, there was a statistically significant difference in the level of knowledge on intestinal parasites pre and post intervention (*P* = 0.012) in the intervention group. This was attributed to the health promotion done in these schools with fliers and posters being provided to the pupils and teachers.

These IEC materials provided details on what are intestinal parasites, ways in which they are transmitted as well as prevention measures. This explains why, in the control group the increase in the awareness on intestinal parasitic infections was much lower than in the intervention group. The posters and flyers became cues to action, as indicated in the health belief model, which activated their readiness to take up the health behavior of hand washing. This is because they provided constant reminders to the pupils on how to wash hands properly with soap and water, a hygiene practice which reduced the rate of reinfection with intestinal parasites among the pupils in intervention schools.

5.1.5 **Level of hygienic practices and school sanitation**

This was assessed by observing whether or not the school had attained to the requirements of the school health policy in their health promotion activities. In both intervention and control schools, there was at least one teacher responsible for school
health though none had been trained on health promotion. Pupils’ knowledge on how to wash hands was used to gauge the level of hygiene.

At the baseline study, school sanitation was statistically significantly associated with intestinal protozoan infections ($P < 0.001$). Pupils whose school had poor sanitation were found to be more than twice likely to have intestinal protozoan compared to those whose schools’ sanitation was good. The association between helminthic infections and school sanitation was also found to be significant ($P<0.001$). Dumba et al., (2008) in a study in Uganda described poor sanitation as a risk factor contributing to intestinal parasitic infections. Poor sanitation confers intestinal parasitic infections through the faecal oral route which can only be broken by proper hand washing with soap and water.

Level of adequate knowledge on how to wash hands in this study was low in both intervention and control groups respectively. This was lower compared to a study by Vivas et al., (2010) in Ethiopia where 36.2% of respondents had adequate knowledge hand washing. This low level was attributed to lack of hygiene training reported among the pupils by the teachers in charge of health. This was due to the low training and IEC materials provide to the teachers in charge of health in the schools.

Association between knowledge on how to wash hands and intestinal parasitic infections was statistically significant, implying that this was a risk factor associated with the infections. This concurs with several studies done in Ethiopia (Vivas et al., 2010), Asia (Matthys 2011), Kitui Kenya (Kisavi 2014), and India (Dongre et al., 2007).
Part of the public health intervention was provision of detergent for cleaning latrines as well as training pupils on how to clean latrines. This improved sanitation in the intervention schools significantly (P<0.001). This means that pupils in the schools where sanitation was not improved were three times likely to contract intestinal parasitic infections compared to their counterparts whose sanitation was improved. This agrees with review by Ziegelbauer K. et al.,(2012) which reported that improved sanitation combined with chemotherapy and other control measures had an impact on reducing intestinal parasitic infections.

The increase in knowledge on how to wash hands among pupils in intervention school was attributed to the way in which health promotion was done. Apart from IEC materials provided, training on how to wash hands was done using demonstration songs which were easy for pupils to remember. This contributed to the reduction of intestinal parasitic infections among pupils in intervention group. This agrees with the study by Vivas et al.,(2011) where students with a higher level of adequate knowledge on how to wash hands had a lower risk of intestinal parasitic infections.

5.1.6 Effects of public health interventions on intestinal parasitic infections

In the intervention group, there was a statistically significant difference in the prevalence of intestinal protozoan infections before and after intervention (P<0.001). This reduction was significantly associated with public health interventions (P < 0.001). There was also a difference in the prevalence of helminthic infections from 12.4% to 0.0%, before and after intervention respectively in the intervention group. This difference in the prevalence was statistically significant (P<0.001). This change was
significantly associated with the public health intervention (P<0.001). The reduction in intestinal parasitic infections was attributed to the public health interventions which included chemotherapy, provision of soap and water for hand washing, public health education and training on proper hand washing as well as improved sanitation.

These findings agree with a similar interventional study in Ethiopia by Abdulkader et al.,(2015) where children who washed hands with soap and water at the critical times were 68% less likely to contract intestinal parasitic infections. Several observational studies have indicated the impact of hand washing on the prevention of intestinal parasitic infections (Gungorena B. et al., 2007, Gelaw 2013 and Absar 2008). A case-control study conducted in Viet Nam demonstrated a significantly reduced risk of E. histolytica infection among individuals who frequently washed their hands with soap (Duc PP et al.,2011). A longitudinal cohort study by Monse et al.,(2013) demonstrated decreased rates of reinfection with soil-transmitted helminths among school children who washed their hands with soap. A study by Hosain et al.,(2013) demonstrated that health education combined with improved sanitation helped to reduce intestinal parasitic infections.

This reduction of intestinal parasitic infections post intervention is an indication that public health interventions were effective in reducing the rate of these infections. These public health interventions were drawn from the school health policy which has been in place since 2009. It therefore means that should the policy have been implemented as required, prevalence of these infections would have not remained the same as it was at the commencement of the school health programme in Kenya. In control group, the
difference in the prevalence of intestinal protozoan infections from 51.3% to 49.3% and infections helminthic infections from 17% to 11.1% was not statistically significant (P = 0.97). The slight reduction in intestinal protozoan infections was attributed to the possible reinfection after the treatment given during the baseline study. This is an indication that chemotherapy alone without training pupils on the other ways of preventing intestinal parasitic infections does not confer long term prevention against these infections. This explains the reason why UNICEF (2002) had recommended hygiene and improved sanitation for prevention of intestinal parasites.

Comparing the reduction of intestinal protozoan infections with that of helminthic infections, results showed that in the latter, the reduction was more than in the former. The reason for this is that the scope of the intervention in this study could not address some of the factors which contributes to protozoan infections such as water safety. This is however provided for in the school health policy and all it requires is implementation.

5.2 Conclusion

From the above results and discussion, the following conclusions have been made:

1. There was no statistically significant difference between the prevalence of intestinal helminthic in intervention and that of control group at the baseline study. In the intervention group, the prevalence of intestinal helminthic infections reduced after intervention.

2. At baseline, prevalence of intestinal protozoan infections was higher than that of intestinal helminthic infections in both intervention and control groups. In the
intervention group, the prevalence of intestinal parasitic infections reduced after intervention.

3. In both intervention and control groups, pupils’ level of knowledge of intestinal parasites is below what is expected as per the school health policy.

4. Poor sanitation and low hygienic practices were some of the factors predisposing the pupils to intestinal helminthic and protozoan infections.

5. The public health interventions were effective in reducing the prevalence of intestinal parasitic infections in intervention group.

5.3 Recommendations

1. The teachers in charge of school health should liaise with the County Public Health Officer in charge of school health to ensure regular deworming of pupils as recommended in the school health policy.

2. It is recommended that Ministry of Education in partnership with that Ministry of Health considers addressing intestinal protozoan infections among the school going children.

3. It is recommended that the Ministry of Education provides the hygiene training IEC materials in order to enhance health promotion as recommended in the school health policy, so as to increase the level of knowledge of hand washing.
4. In order to improve hygiene and sanitation in schools, it is recommended that the County Education Office provides water and cleaning materials as indicated in the school health policy.

5. It is recommended that school management committees provide hand washing stations in schools in order to sustain the hygiene and sanitation behavior learnt.

5.4 Recommendation for Further Study:

It is recommended that a community based study on intestinal parasitic infections be conducted to rule out the infections from home environment.
REFERENCES


Brooker S. K., Artemis and Estambale, Benson and Kiambo Njagi, J., Cundill,

Chammartins F., Scholte R.G., Guimarães L.H., Tanner M., Utzinger J.


Enrique C., (2012). Intestinal Protozoal Diseases, Tijuana, Mexico


clinical trials. Statistical Medicine, 17:1551-1562.

**Fifty-Fourth World Health Assembly** (2001). Schistosomiasis and soil-transmitted helminth infections. *Agenda item 13,3*


**Global Atlas of Helminth Infections 2015**, London School of Hygiene and Tropical Medicine, Keppel Street, London, WC1E 7HT, UK


**Karin L. and P. F. Weller** (2015). Intestinal Entamoeba histolytica Amoebiasis. *Up to Date 23.7–C23.156*


Kisavi M. P., Ng’ang’a Z., Mutai J. (2014). Prevalence and factors associated with soil transmitted helminth infection among primary school children in Kikumuni sub-location, Machakos County, Kenya (Published Thesis)


UNICEF (2002). Prevention of Intestinal Worm Infections Through Improved Sanitation and Hygiene East Asia and Pacific Regional Office Bangkok, Thailand


APPENDIX I: MURANG'A COUNTY
APPENDIX II: KEY INFORMERS INTERVIEW GUIDE

A. Sanitation:

1. What is the pupils: toilets ratio?
2. How many support staff members have been trained on operation and maintenance of the toilets?
3. How often are the toilets cleaned?
4. Are they disinfected?
5. Who cleans the toilets?
6. How many pupils have been trained on Water Sanitation and Hygiene (WASH)?
7. Are there any manuals for training learners on WASH?
8. Reports on school sanitations inspection by the public health officers
9. Are there cleaning materials for the toilets?

B: School hygiene:

1. Are there any IEC materials used in schools for health promotion?
2. Do the schools hold health days, education days or competition days?
3. How many members of staff have been trained on health promotion?
4. Are there pupils’ health clubs?
5. If yes, what activities do they do?
6. Are there hand washing campaigns in these schools?
APPENDIX III: OBSERVATION CHECKLIST

A: Sanitation: No. of toilets for boys and girls

1. Design of the toilet (covered? Has a breather? Distance from the classrooms?)
2. Are there toilets for special needs (disabilities) in the school?
3. Cleanliness of the toilets: are they maggot infested?
4. Are there designated places for hand washing after visiting toilet?
5. Do the children wear shoes?

B: School hygiene and health promotion:

1. Observe pupils’ hand washing behavior after visiting toilet.
2. Visit the schools during health club days and observe their activities
3. Have they been trained?
4. If yes, by whom?
5. What training have they received?
APPENDIX IV: CHILDREN HYGIENE INTERVIEW SCHEDULE

1. Personal Information: (Tick the right answer) Boy ____ Girl ____
   Age____ Class ______

2. Whom do you live with? (Tick the right answer) Mother & Father ____
   Mother only ___ Father only___ Others guardian(s) (specify) ____________

3. What work do your parents/guardians do for a living?
Mother ____________________ Father __________________________
Guardian(s) ______________________

4. Do you wash your hands after visiting the toilet at school? Yes ____ No ___

5. Explain why _________________________________

6. Do you wash your hands after visiting the toilet at home? Yes____ No___

7. Explain why _________________________________

8. Describe other times which are critical for hand washing
   ____________________________________________________________________
   ____________________________________________________________________
   ____________________________________________________________________

9. How do you wash your hands ____________________________
   ____________________________________________________________________
   ____________________________________________________________________
   ____________________________________________________________________

10. Are you aware of any intestinal worms? Yes___ No___

If yes answer the following questions:

11. Name any intestinal worms you are aware of __________________________
12. Who is at risk of infection?

13. What are some of the preventive measures


14. Is there any health message you tell other people at home (___) or at school (___)? Yes ____ No _____

15. If yes

   a. What __________________________

   b. Who taught you ______________________

16. Evaluation of level of knowledge on hand washing

   i. Are there certain critical times for washing hand? Yes_____ No_______

   ii. If yes, which are they? ______________ ______________

   iii. Washing hands with water alone makes one clean. Yes _____ No _____

   iv. Hand washing should be done using soap and water Yes ___________ No ______

   v. Demonstrate how we should wash our hands (In answering this question, pupils were supposed to demonstrate how they washed their hands practically. Observations were made against the recommendation by school health policy)
### APPENDIX V: TOOL FOR ANALYSIS OF KNOWLEDGE ON HAND WASHING

<table>
<thead>
<tr>
<th>Level of Knowledge</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>No knowledge</td>
<td>No knowledge on any of the critical times of washing hands</td>
</tr>
<tr>
<td></td>
<td>Know only about use of water in hand washing, and does not mention soap</td>
</tr>
<tr>
<td></td>
<td>No knowledge on the systematic steps of washing hands</td>
</tr>
<tr>
<td>Inadequate knowledge</td>
<td>No knowledge of the critical times of washing hands</td>
</tr>
<tr>
<td></td>
<td>Knows about use of soap and water in hand washing</td>
</tr>
<tr>
<td></td>
<td>Has an idea about a systematic way to wash hands</td>
</tr>
<tr>
<td>Adequate knowledge</td>
<td>Knows at least three of the critical times of hand washing</td>
</tr>
<tr>
<td></td>
<td>Knows about use of soap and water in washing hands</td>
</tr>
<tr>
<td></td>
<td>Has an idea about a systematic way to wash hands</td>
</tr>
</tbody>
</table>
APPENDIX VI: GRADUATE SCHOOL APPROVAL

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

INternal Memo

FROM: Dean, Graduate School  DATE: 11th May, 2013
TO: Mary Goret Wanjui Muiruri  REF: P97/21293/10
C/o Community Health Department

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that Graduate School Board, at its meeting of 8th May, 2013, approved your Research Proposal for the Ph.D Degree Entitled, “Effects of Public Health Interventions on Intestinal Helminths and Protozoan Infections among School Children in Murang’a South District, Murang’a County, Kenya.”

Thank you.

DAVID NJORoge
FOR: DEAN, GRADUATE SCHOOL

C.C. Chairman, Department of Community Health

Supervisors:

1. Prof. Ephantus W. Kabiru
   School of Public Health
   KENYATTA UNIVERSITY

2. Dr. Harrysone E. Atieli
   C/o Department of Environmental Health
   KENYATTA UNIVERSITY

3. Dr. George O. Otieno
   Department of Health Management and Informatics
   KENYATTA UNIVERSITY
APPENDIX VII: ETHICAL APPROVAL

Our Ref: KU/R/COMM/51/186

Date: June 21st, 2013

Mary Goret Wangui Muiruri
School of Public Health
Kenyatta University
P. O. Box 43844-00100, Nairobi,

Dear Ms. Goret,

APPLICATION NUMBER PKU/123/II08 OF 2013 - 'EFFECTS OF PUBLIC HEALTH INTERVENTIONS ON INTESTINAL HELMINTHS AND PROTOZOAN INFECTIONS AMONG SCHOOL CHILDREN IN MURANG'A SOUTH DISTRICT, MURANG'A COUNTY, KENYA'.

1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic 'Effects Of Public Health Interventions On Intestinal Helminths And Protozoan Infections Among School Children In Murang'a South District, Murang'a County, Kenya' received on 27th May 2013.

2. APPLICANT

Mary Goret Wangui Muiruri
School of Public Health
Kenyatta University
P. O. Box 43844-00100, Nairobi

3. SITE

Murang'a South District, Murang'a County, Kenya

4. DECISION

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines, and is of the view that against the following elements of review,

(i) Scientific design and conduct of study,

(ii) Recruitment of research participant,

(iii) Care and protection of research participants,

(iv) Protection of research participant's confidentiality,

(v) Informed consent process,

(vi) Community considerations.

AND APPROVED that the research may proceed for a period of ONE year from 21st June, 2013
5. **ADVICE/CONDITIONS**

   i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.

   ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.

   iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.

   iv. Submit an electronic copy of the revised proposal to KU-ERC.

If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of this letter.

[Signature]

**Z1 JUN 2013**

PROF. NICHOLAS K. GIKONJO
CHAIRMAN: KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE

I accept the advice given and will fulfill the conditions therein.

Signature .......................... Dated this day 24 of January, 2013.

cc. Vice-Chancellor
    Director: Institute for Research Science and Technology
APPENDIX III: STUDY PERMIT FROM NACOSTI

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254 020 2213471, 2241349, 254-020-2073550
Mobile: 0713 708 787, 0735 404 245
Fax: 254-020 2213115
When replying please quote
secretary@ncst.go.ke

Our Ref: NCST/RCD/12A/013/103

Date: 3rd July 2013

Mary Goret Wangui Muiruri
Kenyatta University
P.O Box 43844-00110
Nairobi,

RE: RESEARCH AUTHORIZATION

Following your application dated 28th June, 2013 for authority to carry out research on “Effects of public health interventions on intestinal helminths and protozoan infections among school children in Murang’a South District, Murang’a County, Kenya.” I am pleased to inform you that you have been authorized to undertake research in Murang’a South District for a period ending 31st July, 2015.

You are advised to report to the District Commissioner, District Education Officer and Medical Officer of Health, Murang’a South District before embarking on the research project.

On completion of the research, you are expected to submit four hard copies and one soft copy in pdf of the research report/thesis to our office.

DR. M. K. RUGUTTI, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:

The District Commissioner
The District Education Officer
The Medical Officer of Health
Murang’a South District.

‘The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development’
APPENDIX VIII: RESEARCH PERMIT

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.

2. Government Officers will not be interviewed without prior appointment.

3. No questionnaire will be used unless it has been approved.

4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.

5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.

6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice.

GPK6056324110/2011

PAGE 2

THIS IS TO CERTIFY THAT:

Dr. [Name]/Institution:
Wangui Maina
P.O. Box 99048-00100,
Nairobi.

has been permitted to conduct research in

Murang’a South District

on the topic: Effects of public health interventions on intestinal helminth and protozoan infections among school children in Murang’a South District, Murang’a County, Kenya.

Date of issue: 3rd July, 2013

(Applicant's Signature)

Date received: X341, 2005

(PER)
APPENDIX IX: INFORMATION EDUCATION AND COMMUNICATION MATERIALS – BROCHURE

STEPS TO FOLLOW PREVENTION OF INTESTINAL HELMINTHS (5Fs)

F1: FINGERS

Fingers of our hands carry a lot of dirt and germs from all the work we do everyday. Even when they look clean, they are not to be trusted. We end up eating all these dirt and germs if we do not wash our hands appropriately.

We should always wash our hands:
- After visiting the toilet
- Before eating food
- After changing baby nappy

F2: FEACES

Feaces is human waste. It may contain helminths eggs. These eggs can be transmitted if the feaces is not properly disposed.

All feaces should be disposed in the toilet. It is wrong to defecate in the bushes, shamba, river, or behind the house. Always use the toilet!!! And wash your hands after using the toilet.

F3: FLIES

Flies transmit germs from one place to another. They fetch dirt and germs from the toilet to uncovered foods. They also fetch germs from garbage and transmit to food.

The toilets should always be cleaned to reduce flies.

All garbage should be properly disposed to keep flies away.

Food should be well covered to reduce access by the flies. Left over

F4: FOOD

Fruits and vegetables from the market or from the shamba are not always clean.

All fruits should be washed using clean water before eating them.

Vegetables should also be cleaned before eating or cooking them.

Raw meat may contain eggs of helminths such as tapeworms.

Meat should therefore be cooked properly.

Milk should be properly boiled to kill all germs

F5: FLUIDS

Fluids are all the things we drink such as water, tea, juices, porridge, milk among others.

Dirty water may contain germs which can cause diseases. It may even contain eggs of intestinal worms.

All drinking water should be boiled or treated with water guard to kill germs.

A HEALTHY NATION IS WEALTHY

AFYA BORA HULETA UTAJIRI

FIGHTING AGAINST INTESTINAL WORMS IS EVERYBODY’S RESPONSIBILITY

By Mary Muiruri
Email: goretwangui@yahoo.com
APPENDIX X: INFORMATION EDUCATION COMMUNICATION - MATERIALS POSTER

7 STEPS IN HAND WASHING

1. WET HANDS AND SCRUB WITH SOAP AND WATER
2. WASH BETWEEN THE FINGERS
3. SCRUB BACK OF YOUR HANDS
4. WASH THE THUMBS
5. WASH THE NAILS
6. WASH THE WRIST
7. RINSE YOUR HANDS WITH CLEAN WATER

GERMS HATUNA URUFIKI