INTESTINAL PARASITIC INFECTIONS IN SCHOOL CHILDREN IN THE PERI-URBAN SUB COUNTY OF NJIRU, NAIROBI COUNTY, AND THE ASSOCIATED RISK FACTORS

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Intestinal Parasitic Infections in School Children in the Peri-Urban Sub County of Njiru, Nairobi County, and the Associated Risk Factors

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DECLARATION

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

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DEDICATION

I dedicate this work to my family, particularly my husband Stephen Onsomu, my children Martha Mosweta, Phillip Mosweta and Gabriella Mosweta, my parents Mr. Phillip and the Late Mrs. Lydia Ndoko for their financial and emotional support during my studies.

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LIST OF ABBREVIATIONS AND ACRONYMS

CBRD	Center for Biotechnology Research and Development
EPG	Eggs per gram
GEE	Generalized estimating equation
IPIs	Intestinal parasitic infections
IP	Intestinal parasite
ITROMID	Institute of Tropical Medicine and Infectious diseases
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KEMRI	Kenya Medical Research Institute
NTD's	Neglected tropical diseases
PPS	Probability Proportional to size allocation
PTA	Parent Teacher Association
SRS	Simple random sampling
STH	Soil transmitted helminths
WHO	World Health Organization

ABSTRACT

Enteric pathogens occur in high concentrations in untreated sewage water. In areas where untreated sewage water is used to irrigate agricultural land for cultivation of horticultural crops, it may pose a health risk to consumers, farm workers, handlers of the produce, and possibly, the community that lives within the vicinity of wastewater irrigated land. A cross-sectional survey, targeting 446 school children aged 6-12 years was conducted in 5 public primary schools in Njiru Sub-County, on the eastern side of Nairobi County. The objectives of the study were to determine the prevalence, intensity, and risk factors associated with the presence of intestinal parasitic infections (IPIs) in the study area. Fecal samples were collected from children whose parents or guardians had consented to their participation in the study. Ova and parasite detection was performed using both the formal-ether concentration and the Kato-Katz procedures. The intensity of infection was classified as light, moderate and heavy. Risk factors associated with the presence of IPIs such as education level of parents/guardians, hand washing habits, source of water for household use were assessed using a questionnaire, which was administered to parents/guardians. The overall prevalence of intestinal parasites was 37%, (95%CI 32.5-41.7%) with protozoan infections accounting for 26.7% and helminth infections, 15.1%. *Entamoeba histolytica/dispar* (39%) and *Giardia duodenalis* (8.1%) occurred in moderate to heavy intensities. Other protozoan parasites present were *Entamoeba coli* (2%), and *Pentatrichomonas hominis* (<1%).The most common helminth parasites were *Ascaris lumbricoides* (14.8%) and *Trichuris trichiura* (12.8%) with many children having light intensities of infection. Other common helminth infections present were hookworm (8.5%) and *Schistosoma mansoni* (5.8%). Other parasites detected were *Enterobius vermicularis* (4.3%), *Hymenolepis nana* (3.4%), *Taenia* species (1.6%), *Diphyllobothrium latum* (0.2%), *Fasciola hepatica* (0.2%) and *Hymenolepis dimunita* (0.2%). Children whose parents or guardians had primary education only (LR test=10.11, df=4, P=0.0386) and those who used the river as their main water source (P=0.027), were more likely to become infected. IPIs were common among the children in the Njiru area. Further investigations are needed to determine the impact of these infections on the children living in this locality. School-based interventions are recommended for control of these infections in the area.

CHAPTER ONE

INTRODUCTION

1.1 Background

Intestinal parasitic infections (IPIs) are common in both animals and humans. These infections are widespread all over the world, being most common in the least developed and developing nations. In most of these countries, the infections are associated with very high morbidity rates. According to Tyoalumun et al., (2016), IPIs are highly prevalent in developing nations, and lead to high incidences of malnutrition and morbidity. Parasitic infections are spread through the ingestion of foods and water infected with ova or larvae as well as coming into contact with soils contaminated with feces of infected individuals (Saki et al., 2012). IP are included in a group of diseases referred to as neglected tropical diseases (NTDs). These diseases persist in economically and socially deprived communities (Erismann et al., 2016). People at high risk of infections are those who languish in poverty, live in the urban slums, remote or rural areas, and those who live in the conflict zones (Gonçalves et al., 2016). In addition, intestinal worm infections take place where there is poor sanitation and poverty (Kumar et al., (2014). According to (Mbae et al., 2013), poverty is associated with parasitic infections. This is because poverty is measured in terms of lack of sanitation, low literacy, and overcrowding.

Haque (2007) stresses that in the endemic regions of developing nations, soil-transmitted helminth infections are consistently more widespread, particularly in the poorest segments of the populations. The intestinal parasitic infections, especially the hookworms, cause anemia in both children and expectant women, which leads to various health related complications (Hotez et al., 2009). In essence, infections from hookworms cause iron-deficiency anemia, retarded growth in children, and can also result in physical and cognitive problems (Evans & Stephenson, 1995). In some places, IPIs may be predominant in informal settlements (slums), especially those located in urban areas where there is overcrowding, and inadequate supply of clean water. Mbae et al., (2013) insists that these infections are prevalent in the urban informal settlements' environment.

The use of sewage water for agricultural irrigation plays a huge role in the spread of IPIs (Tomass & Kidane, 2012). Helminths such as *A. lumbricoide*s, hookworms, *T. trichiura*, and protozoan parasites such as *E. histolytica/dispar* are known to cause infections in more than 48 million people worldwide (Houmsou et al., 2010). IPIs are also known to thrive in areas where there is inadequate sanitation as well as poor health care, and this explains why high incidences of infection are reported in these areas. As asserted by Shobha et al., (2013), low health status, a lack of personal hygiene, and unavailability of potable water offer optimal conditions for the transmission and growth of intestinal parasites. According to Kotian et al., (2014), poor personal hygiene and environmental sanitation are among the factors related to intestinal parasitic infections. In slums where there is no proper sanitation due to inadequate facilities of fecal disposal, there are high incidences of intestinal parasite infection since the lack of adequate sanitation provides a conducive environment for these pathogens to thrive (Crompton & Savioli, 1993).

In sub-Saharan Africa, IPIs are a current health constraint owing to the high levels of poverty, malnutrition due to food insecurity, and poor sanitation resulting to many people being susceptible to these infections (Ijagbone & Olagunju, 2006; Montressor et al., 1998). It is imperative to emphasize that most children in sub-Saharan Africa live in poorly sanitized environments, which increases the level of risk of exposure to the pathogens. For example, eating raw food such as vegetables, fruits, and under cooked meat increases the levels of transmission of these infections (Montressor et al., 2002). In many underdeveloped countries where there are problems of food shortage and malnourishment, it is reported that there are high incidences of infection levels and excess morbidity passed from one generation to the next (Saki et al., 2012). In these countries, the access to clean drinking water is a common problem hence many people are likely to consume untreated water.

In most developing countries, including Kenya, IPIs are common infections in children under the age of 15 years and expectant women. IPIs if not treated in children lead to complicated health issues such as malnutrition, iron deficiency anemias, stunted growth, delayed cognitive development. In addition, children infected with an IP may have poor test scores, poor school attendance leading to lower wage earning in adulthood (Lynn et al., 2021). Notably, in the expectant women, especially those who have a helminth infection, high infant mortality rates have been reported owing to anemia during pregnancy, which may lead to low birth weight (Blackwell, 2016). In Africa, most incidences of anemia reported are as a result of hookworm infection, which accelerates the rates of tropical diseases such as malaria that are known to infect expectant mothers and children (Hotez et al., 2009). There are also high levels of schistosomiasis and other helminth parasitic infections, particularly in children aged 10-12 years, because they are likely to come in contact with water contaminated with human feces through various activities such as playing. These children also play in soils contaminated with human feces, and in most cases, they may not wash their hands before having a meal. Without a doubt, children are most susceptible to intestinal parasites, and, for this reason, it is vital to study intestinal parasitic infection in them.

Most developing countries in Africa are located in the tropics. As a result, the high levels of infection in these nations might be attributed to the favorable environmental conditions that favor intestinal parasite development**.** Civil wars have and are continuing to cause most people to live in refugee camps that are known to have low levels of sanitation. As a result, many individuals in these camps are at high risk of IPIs. In most of the developing nations, inadequate funding is allocated to the control of vectors using chemical pesticides hence it becomes difficult to monitor the spread of these parasites (Barnabas et al., 2011).

Intestinal parasitic infections are successful in most developing countries including many African nations because they can also be transmitted by eating contaminated raw foodstuffs sold by vendors. In the slum areas, these vendors operate in polluted environments and have no access to clean water to wash their foodstuffs before selling them (Ayeh-kumi et al., 2009; Omalu et al., 2013; Suriptiatuti and Widiastuti, 2011). As a result, this leads to one of many challenges encountered in controlling infections caused by intestinal parasites. Therefore, it is necessary to carry out the prevalence and evaluation of these parasites in school children in most developing countries.

1.2 Statement of the Problem

In the Njiru sub county of Nairobi County in Kenya, very little information is available on intestinal parasitic infections among school children. Intestinal parasitic infections are common especially in children six to twelve years old. Untreated sewage is a common sight in the Njiru area, and the farmers in the area are known to use the untreated sewage water to irrigate their crops. The present study was undertaken to determine the prevalence and intensity of intestinal parasitic infections among school children in the area and examine some of the factors associated with the presence of these infections.

The information generated from this study will be useful to policy makers and other stakeholders to inform them of the need to establish an integrated prevention and control program for the IPIs and other public health issues affecting the people in this area, and especially, the children, who are the most vulnerable.

1.3 Justification of the study

Njiru Sub County in Nairobi County was selected for this study primarily because it harbored major sewer lines en-route the Dandora Sewage Treatment Plant. This sub-County had vast spaces of land; which farmers utilized for farming using untreated wastewater from the main sewers. Studies elsewhere showed that untreated wastewater could be a source of enteric pathogens of public health significance including but not limited to *G. duodenalis, E. histolytica/dispar,* and soil transmitted helminthes (STHs) (Adebote et al., 2004). The use of the wastewater for irrigation in Njiru potentially exposes both farm workers and consumers of the farm products, mostly horticultural produce, to the risks of intestinal parasites that may cause ill health such as intestinal parasitic infections. School children are at a greater risk of infection compared to adults due to their less developed immune systems (Arora & Arora, 2011). This study targeted all the five public primary schools in the area namely, Kayole North, Jehovah Jire, Maua, Mihango, and New Njiru. The study will generate new knowledge that can be adopted when it comes to controlling intestinal parasites.

1.4 Research questions

1. What is the prevalence of intestinal parasites in school children between the ages of 6 to 12 in Njiru Sub County?
2. What are the intensity profiles of intestinal parasites in school children between the ages of 6 and 12 in Njiru sub county?
3. What are the risk factors associated with the presence of intestinal parasites in school children between the ages of 6 and 12 in Njiru Sub County?

1.5 Broad Objectives

To determine the public health significance of intestinal parasite infections in school children in Njiru area of Nairobi County, and risk factors associated with these infections in this age group

1.5.1 Specific Objectives

1. To determine the prevalence of intestinal parasitic infections among school children in peri urban Njiru sub county in Nairobi County.
2. To determine the intensity of intestinal parasitic infections among school children in peri urban Njiru sub county in Nairobi County.
3. To determine the risk factors associated with intestinal parasitic infections among school children in the peri-urban sub-County of Njiru in Nairobi County.

1.6 Conceptual Framework

The conceptual framework in figure 1.1 below was used to determine how various factors associated with the presence of intestinal parasite infections such as demographics, knowledge, and practices of the school children influence the chances of school children being vulnerable to IPIs. The factors associated with IPIs will be the independent variables, and the IPIs will be the dependent variable.

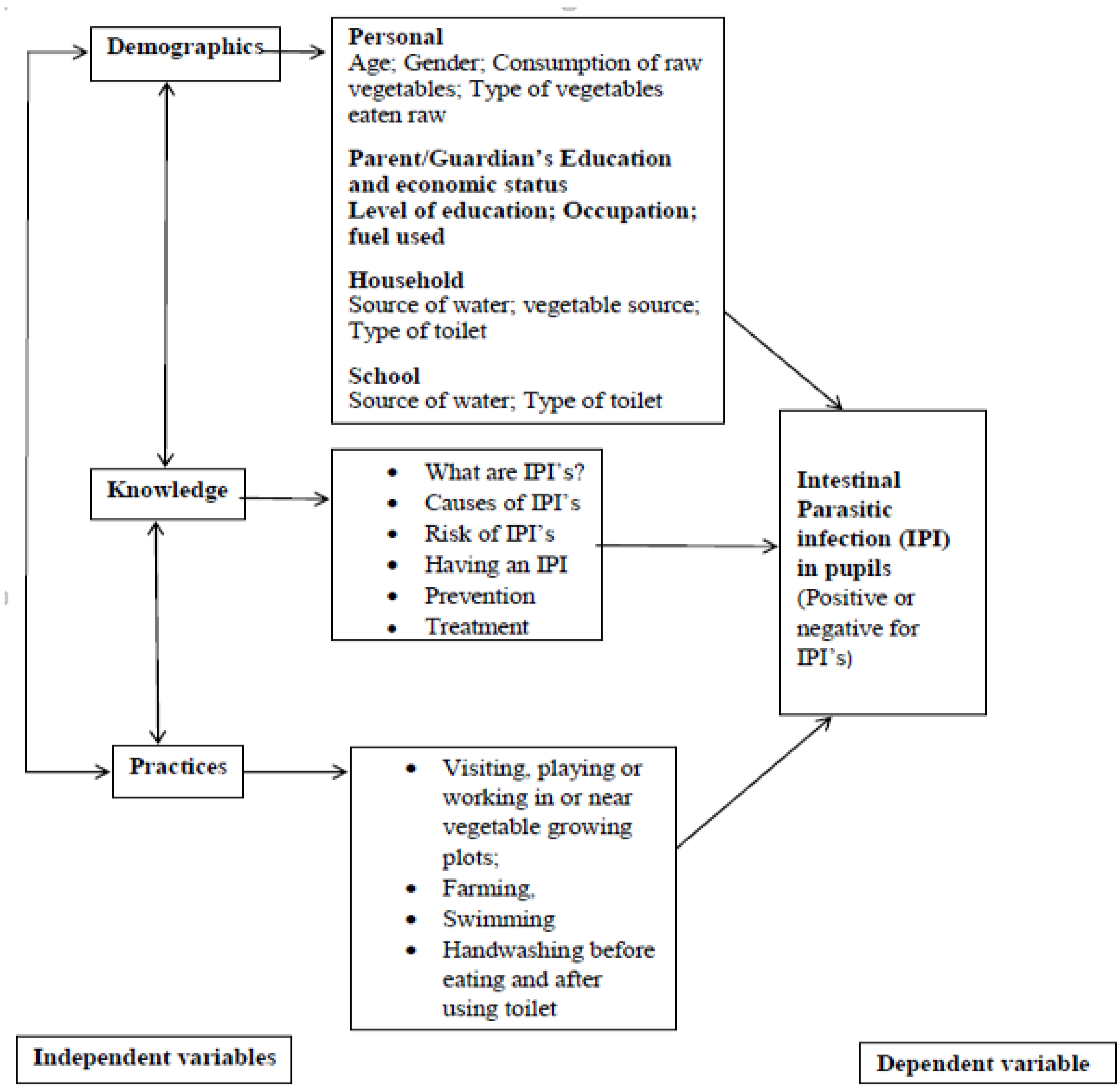

Figure 0.1: Conceptual Framework for a structured questionnaire administered to pupils and guardians to determine factors associated with intestinal parasitic infections (IPIs).

CHAPTER TWO

LITERATURE REVIEW

2.1 Human Intestinal Parasites

A parasite is an organism that solely depends on another organism (host) for survival (Arora & Arora, 2011; Jordan & Verma, 2010). According to Gerald and Larry (2010), a parasite is described as an organism that lives on or within another living organism (host) where it obtains nutrients required for its growth and development. Several parasites thrive only in specific habitats and in the presence of extremely specific human behaviors, are solely reliant on us, and have evolved with us for a long time (Perry, 2014). Many of the organisms classified as protozoa and helminths live parasitic lives (Arora & Arora, 2011) with many species being pathogens in humans therefore, causing ill-health in their hosts. As asserted by Walochnik et al., (2017), parasites belong to several unrelated taxa, mainly helminths, arthropods, and protozoa. As pathogens in their hosts, parasites inflict injury and cause disease, a condition whereby a pathogen causes physiological disorder to their host.

Both protozoans and helminths can inhabit the intestines of many vertebrate hosts including humans. Protozoan intestinal parasites for example, include the amoeba, flagellates, ciliates, and sporozoans (Arora & Arora, 2011). Examples of common intestinal protozoan parasites are *Entamoeba histolytica/dispar, Entamoeba hartmani, Entamoeba coli, Iodamoeba butschlii, Endolimax nana, Giardia duodenalis, Cryptosporidium parvum and Isospora belli.* Examples of intestinal helminthes, on the other hand, include the nematodes *Trichinella spiralis* (trachina worm), *Ancylostoma duodenale* (hookworm), *Strongyloides stercoralis* (threadworm), *Ascaris lumbricoides* (round worm), *Enterobius vermicularis* (pinworm), and *Trichuris trichiura* (whipworm). Examples of trematodes are *Schistosoma japonicum* and *Schistosoma mansoni*, and the cestodes (tapeworms), *Taenia saginata* (Beef tapeworm), *Taenia solium* (pork tape worm), and *Hymenolepis nana* (Kathleen & Arthur, 2002).

2.2 Transmission of Intestinal Parasitic Infections

The transmission of parasite stages might be nutritional, environmental, or vector borne (Walochnik et al., 2017). According to (Ochei & Kolhatkar, 2007) parasites can gain access into the human body via the fecal-oral route and penetration through intact skin. The fecal-oral route is the most common way in which the intestinal parasites enter the human body through ingestion of food such as meat, vegetables or water contaminated with ova. Intestinal parasites may also penetrate the human body when humans come into contact with water and soil contaminated with parasite infected human feces. Examples of the intestinal parasites transmitted through the fecal oral route include nematodes such as *E. vermicularis* and *T. trichiura* and among the protozoan parasites include *G. duodenalis* and *E. histolytica/dispar* (Cheesbrough, 2005; Ochei & Kolhatkar, 2007) just to mention a few. The accidental ingestion of the parasite intermediate host in contaminated water can also result in infection, for example, drinking water contaminated with an infected *Cyclops*, the arthropod intermediate host of *Dracunculus medinensis* may result to infection (Ochei & Kolhatkar, 2007). The infective stages of a few intestine-based parasites can infect humans through penetration of intact skin, and examples, are the nematode, hookworm (through the soil) and schistosomes (through water) (Cheesbrough, 2005; Ochei & Kolhatkar, 2007).

2.3 Geographical Distribution of Human Intestinal Parasites

There is a significant variation in the profile and infections of IPs in different continents as well as sub-regions. There are about 50 species of helminths reported in the literature that can inhabit the human intestines (Antunes, et al., 2011). In some instances, some worms are restricted to given geographical regions, and they are highly prevalent in the tropical areas (Kathleen & Arthur, 2002). It is reported that more than 1.5 billion people have a soil transmitted helminth (STH) infection with many cases found in underdeveloped and developing nations (WHO, 2019). In general, individuals who are at high risk of infections are malnourished children (WHO, 2019).

The protozoan parasite *E. histolytica/dispar* is responsible for *amoebiasis*, a parasitic infection ranked third as a cause of death worldwide after malaria and schistosomiasis (Ouattara et al., 2010). *E. histoytica/dispar* is reported to affect approximately 50 million people every year, and it is estimated to cause 40,000-100,000 deaths annually (Olubunmi, 2013). The parasite is much more widespread in the tropics including Southeast Asia in countries such as the Philippines and Thailand (Mahmud et al., 2013). It is endemic in the tropical and subtropical regions. Other endemic countries are the Republic of Korea in the North and South and Bangladesh (Jordan & Verma, 2010).

Giardia duodenalis has been reported to have a high incidence in the tropical and subtropical regions and is often associated with poor sanitation. According to Arora & Arora (2011), the high-risk areas for giardiasis include South-East Asia, Southwestern America, Mexico, Russia, and Tropical Africa. The authors further insist that more than 200 million people worldwide are affected, and associated symptoms are seen in at least 500,000 individuals every year. *Balantidium coli* is reported to occur worldwide since pigs are the animal reservoirs of the parasite, and people who live in areas where pigs are reared are at high risk of getting infected. Rodents also serve as reservoirs for the parasite.

A. lumbricoides, another of the intestinal parasites, is known to have a worldwide distribution and is prevalent in in China, Southeast Asia, Africa, India (Arora & Arora, 2011) and Southeastern of United States (Kathleen & Arthur, 2002). More than 1.47 billion individuals worldwide are reported to be infected with *A. lumbricoides* (Chiodini et al., 2005). In particular, the parasite is endemic in resource poor countries, where many people are poor, malnourished, and waste management is inadequate, with increased risk of exposure to parasite eggs. Other intestinal worms include the hookworms, *A. duodenale* and *Necator americanus. A. duodenale* is endemic in Africa, Japan, Pacific Island, China, and Europe, whereas *N. americanus* occurs in the Caribbean area, and the Americas, but has also, been reported in Asia, the Pacific, and parts of Africa (Jordan & Verma, 2010; Kathleen & Arthur, 2002). Reports indicate that about 25% of the world's population is infected with hookworms. The other intestinal nematodes frequently reported in the tropics is *T. trichiura*. *T. trichiura* is cosmopolitan in distribution but most common in the warm, moist regions of the world including India (Arora & Arora, 2011), more than 1.3 billion people worldwide are reported to be infected (Chiodini et al., 2005).

Other intestinal worms of humans are *E. vermicularis* and *S. stercoralis*. *E. vermicularis* is a cosmopolitan parasite, most common in temperate and cold climates (Arora & Arora, 2011). It is one of the most widespread nematodes in the United States of America according to the Centers for Disease Control and Prevention (Wolfram et al., 2016), and it is estimated that more than 209 million people are infected worldwide. *S. stercoralis* on the other hand, has a global distribution, but it is most common in the tropical and subtropical regions of the world, primarily, in Africa, South America, and India. Current records show 80-100 million people worldwide are infected with the parasite (Arora & Arora, 2011).

Other intestinal helminths of humans include tapeworms, and the most common ones are *T. saginata*, *T. solium, and H. nana*. *T. saginata* has a worldwide distribution and is most common in areas where cattle are reared for beef. *T. solium*, on the other hand, is mostly found in areas where pork is consumed in large quantities, and occurs in Asia, Central America, India, Chile, Brazil, Southern Africa, and Papua New Guinea, but generally, tends to have a restricted distribution, unlike *T. saginata*. More than 100 million people are known to harbor the *Taenia spp* (Arora & Arora, 2011). *H. nana* occurs throughout the world, with a high incidence in the temperate regions, particularly among children (Alruzug et al., 2016).

Blood flukes (or schistosomes) are digenean trematodes that inhabit the bloodstreams of their definitive vertebrate hosts, usually mammals and birds. Schistosomes require aquatic snails as intermediate hosts to complete their life cycles. Schistosomes in the genus *Schistosoma* are medically significant. *S. mansoni*, whose ova have a lateral spine, lives in the mesenteric veins of its definitive hosts usually, humans, non-human primates, and rodents, and causes human intestinal schistosomiasis, and its ova leaves the human body via feces. It is one of the most common of the human schistosomes, and the most widespread, occurring in sub-Saharan Africa, Egypt, the Middle East, Madagascar, the Caribbean region, and South America (Ismail et al., 2016). *S. mansoni* occurs in 36 countries in sub-Saharan Africa, 7 in the East Mediterranean, and 9 in South America and the neighboring regions. *Schistosoma intercalatum*, a terminal spined egg human intestinal schistosomiasis endemic in West and Central Africa, primarily, in Zaire and Cameroon (Ismail et al., 2016).

2.4 Epidemiology and Public Health Significance of Human Intestinal Parasites

Studies conducted have shown prevalence of IPs differs from one continent to another worldwide. In Pakistan, Shaikh et al., (2009), researched 3,000 stool samples from all age groups and both sexes on the prevalence of helminth parasites and protozoans. Shaikh et al., (2009), recorded *G. duodenalis* in 36.19% of the study population, *E. histolytica/dispar* in 18.57%, *H. nana* in 16.19%, *A. lumbricoides* in 14.19%, *T. trichiura* in 1.81%, and *T. Saginata* in 1.05%.

Ten-year research conducted by Saki et al., (2012) among food handlers in Southwest Iran, showed 8.8% and 25.4% of the study population were infected with the pathogenic and non-pathogenic parasite or eggs respectively. From this research, it is evident that there are continuous contaminations from helminths and protozoans in different areas worldwide. Mehraj et al., (2008), conducted a study in Karachi, Pakistan on children aged between 1-5 years. The studies revealed there is an overall intestinal parasitic infection prevalence of 52.8%. *G. duodenalis* had the highest prevalence of 28.9% and the second highest prevalence IPs were *A. lumbricoides* with 16.5%, *B. hominis* (10.1%), *I. butschlii* (3.2%), *E. coli* (2.3%), *E. nana*, (1.8%) and *H. nana* (0.9%).

In Indonesia, a study by Suriptiastuti and Widiastuti S.M (2011) reported that there was a total of 83.9% of IPs on the fingernails of food vendors. *A. lumbricoides* had 6.8%, 36.2% mixed infections and *G. duodenalis* had 17.89%.

In Africa, studies carried out by Coulibaly et al., (2012) in school children in Cote d` Ivore showed prevalence of *S. mansoni* in three selected areas were 16%, 33%, and 78%. *Schistosoma haematobium* prevalence was 0.8%, 4%, and 65%. The intensity and prevalence of *Schistosoma* sp., intestinal protozoan, and soil-transmitted helminths showed specific patterns. Disease complex was recorded to be high in rural settings at 84% followed by the peri-urban (28%), and in an urban setting where it was at 18%.

Retrospective studies conducted by Mazigo et al., (2011) to determine the prevalence of IPs infection among patients at Bugando Medical Centre in Mwanza, North-western Tanzania, from January 2008 to March 2010, showed there was 57.1 % of IPs infection of all the stool samples examined. Samples that had hookworm eggs recorded in 25.2%, helminth eggs were observed in 36.6% of the samples and *S. mansoni* in 5.6% of the samples. 20.5% of stool samples had protozoan ova in which 6.9% was *G. duodenalis* and 13.6% had *E. histolytica/dispar*. *A. lumbricoides, T. trichiura, S. mansoni,* in a single infection was detected in 5.8%, 16.4%, and 1.5% respectively. The levels of polyparasitism were very high at 56.7% of all the samples analyzed. In some individuals, as many as five parasites were detected in the population that participated in this study. *S. mansoni, T. trichiura* and *A. lumbricoides* constituted 2.2%, 4.3%, and 13.5% respectively of all double infections. *S. mansoni* and *H. nana* were more prevalent in males. *H. nana* and *Giardia* trophozoites were significantly higher in pre-school children than all the other age groups. Most teenagers were found to be infected with *S. mansoni, A. lumbricoides* and Taeniasis.

In South Africa, Peter (2011) examined stool samples from the individuals ranging from 11 months to 82 years. In all the samples analyzed from this study, the infection by IPs was recorded in 36.06% of all samples analyzed. Protozoan parasites detected include *G. duodenalis* (5.90%), *E.* coli (22.51%), and *E. histolytica/dispar* (7.67%). *T. trichiura* (0.51%), *A. duodenale* (1.28%) and *H. nana* (2.30%), were also isolated from the sample.

2.5 Intestinal Parasitic Infections in Kenya

In Kenya, different surveys have been conducted in various counties to determine the prevalence of IPIs. According to Ngonjo et al., (2012), research conducted in Thika, Kiambu County, showed total prevalence of helminthic infection was 31%, 48.9%, 38.9%, and 48.9%, for urban, slum, peri-urban, and rural schools correspondingly**.** The total prevalence of protozoan infections was 28.7%, 34.8%,38.9%, 46.3% for urban, slum, rural, and peri-urban schools correspondingly. Infections by *A. lumbricoides*, *T. trichiura*, and *S. mansoni* were most common. In the slum and rural areas, *A. lumbricoides* infection was significantly higher as compared to urban and peri-urban schools. Hookworm infections were significantly higher in rural and peri-urban slums as compared to urban and slum schools. There were significant differences in the infection of *E. histolytica/dispar* in which the infections were high in rural and slum areas compared to urban and peri-urban schools. Ten *S. mansoni* cases were possibly obtained from the Mwea irrigation scheme since there is no active transmission in Thika District. In this research, it is evident that parasitic infections by protozoa and helminths are a concern in the peri-urban, slums, rural, and urban communities especially school children.

Mulambalah and Ruto (2016) conducted a six-month cross-section research in Nandi County, Kenya, to evaluate the prevalence as well as the intensity of intestinal geohelminthiases in school children. A total of 2,000 stool samples were analyzed to make a variable comparison. Ascariasis was most widespread, accounting for 42-74% compared to trichuriasis 16-38% and hookworm disease 6-41%. The analysis of sex-specific prevalence showed males had a higher prevalence compared to the females ($P < 0.05$). The infection intensities were light in all the sites and sexes.

Kamau et al., (2012) carried out a study on the prevalence of IPIs in licensed food-handlers working in the eatery places in Nairobi City, Kenya. The researchers observed *G. duodenalis*, *E. histolytica/dispar*, and *A. lumbricoides* in licensed food-handlers and concluded that the prevalence of the Ips in the city may have deteriorated due to inadequate health services, ignorance of health-promotion practices, poor hygiene practices, shortage of safe water, and inconsistency in socioeconomic status.

The existing literature relevant to the current study does not to a large extent look at the prevalence of the IPIs in Nairobi County, Kenya, particularly in school children. Mbae et al., (2013) insists that to the best of their knowledge, there is no available data on the prevalence of the IPIs in the informal settlements in Nairobi. There exists a research gap since previous researchers have not investigated the intestinal parasitic infections in school children, particularly in Njiru sub-county. Besides, previous researchers have not investigated the factors which are related to the presence of intestinal parasites among school children in the Njiru area.

CHAPTER THREE

MATERIALS AND METHODOLOGY

3.1 Study design

This was a descriptive, cross-sectional study targeting school children aged between 6 and 12 years in 5 public primary schools.

3.2 Study area

The study was undertaken in Njiru Sub County, located in the eastern part of Nairobi County, approximately 16 km from the Nairobi city center. Njiru sub- county covered an area of approximately 108 sq.km and had a population of 318,228 (Kenya Population census, 2009). The Dandora sewerage treatment works in Ruai, treated about 80,000m^3/day, equivalent to about 80% of wastewater generated from Nairobi city. (Nairobi City Water and Sewerage Company). Njiru sub-county has several major open and closed sewers running through the area en route to the Dandora sewerage treatment works.

Table 0.1: Demographic Characteristics of Njiru Sub County in Nairobi County

Description	Population
Total catchment population	318,228
Children under 1 year (12 months)	9,547
Children under 5 years (60 months)	40,415
Under 15-year population	96,423
Women of childbearing age (15 – 49 Years)	99,924
Estimated Number of Pregnant Women	15,911
Total number of Adolescent (15-24)	42,006
Adults (24-59)	77,329
Elderly (60+)	2,228

Also, the area has a large piece of land in which small-scale farmers utilize to grow a variety of horticultural crops, primarily vegetable crops (such as kale, spinach, *Amaranthus*, coriander, tomatoes, onions), bananas, maize, sugarcane, and arrowroots. The area is cosmopolitan, and the residents depend on farming, small businesses, or employment as sources of their livelihood. There were five public primary schools in Njiru Sub County (the study area), namely, Jehovah Jire, New Njiru, Kayole North, Maua, and Mihango, two of which were located very close to the open sewers (New Njiru and Kayole North). The study children came from the schools mentioned above.

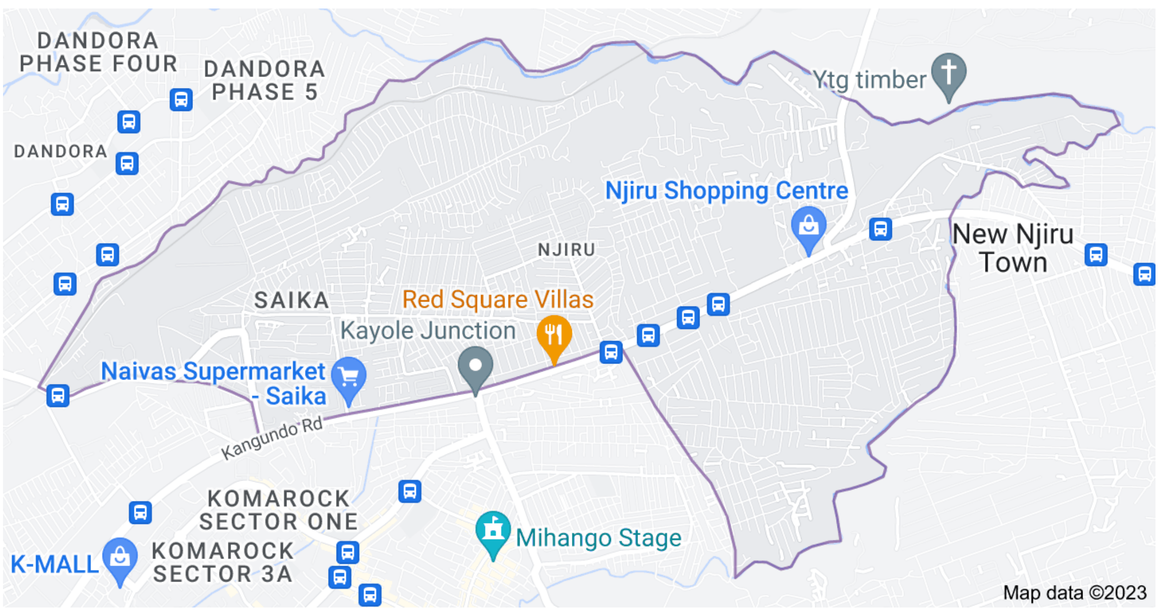

Figure 0.1: Map of Njiru sub county, Nairobi County

3.3 Study population

This study targeted children aged between 6 and 12 years from all five public primary schools in Njiru sub county. Four hundred and five pupils were selected from five public primary schools using the probability proportional to size allocation.

Inclusion criteria**:** children aged between 6 and 12 years who had consent from their parents or guardians to participate in the study.

Exclusion criteria**:** children less than 6 years and more than 12 years were excluded from the study. Children who had no written consent from their parents/guardians and children who did not wish to participate in the study were excluded.

3.4 Sample size calculation

The determination of the sample size was grounded on the assumption that the prevalence of intestinal parasites in Kibwezi area near Nairobi was 40% (Nguhiu PN et al., 2009). Based on the data available at 95% confidence interval and a 5% margin of error, the minimum sample size needed is 368 pupils. Sample size formula for number to estimate prevalence in a survey was calculated using Cochran's formula below (Lwanga & Lemeshow, 1991).

$$n = \frac{Z^2 P(1-P)}{e^2}$$

$$n = \frac{(1.96)^2 \times 0.40 \times 0.6}{(0.05)^2} = 368$$

n = 368

where n = minimum sample size required

Z = Z statistic for a level of confidence ($1.96^{2)}$ for 95% confidence

P = prevalence of intestinal parasites in Kibwezi (Nguhiu PN et al., 2009)

e = maximum tolerable error for the prevalence estimate (±0.05)

Anticipated nonresponse rate of 10%. Therefore 10% of 368=36.8

Sample size = 368 +37=405

3.5 Sampling Procedure

The study was conducted in Njiru Sub County. Njiru Sub County had five public primary schools namely, Jehovah Jire, New Njiru, Matopeni, Maua, and Mihango. All the five public primary schools were included in the study. Class registers for grade 1 to grade 6 in each school were used to select both girls and boys aged between 6 and 12 years old using the probability proportional to size allocation (PPS). Simple random sampling (SRS) method was utilized to draw the sample from the population list of each school. STAT TREK's Random Number Generator (2012) statistical tool was used to give each member of the population an equal probability of being selected.

3.6 Fecal sample collection and examination for parasite infections

A unique identification number identified each study child. Because parasitic organisms often pass intermittently and in fluctuating numbers in feces, a minimum of 3 fecal samples from each study child from the 5 schools was collected over a 7-to-10-day period. A good amount (large enough) of morning fecal sample was collected in a container or on a newspaper and transferred into a poly pot with tight fitting lid between 7:30 am and 10:30 am. The stool collection was private. Poly pots with fecal specimen were labeled clearly with child's initials, unique identification number, code of school and the date of sample collection.

Stool samples were processed using the Kato–Katz procedures (Katz et al., 1972) and the formol-ether concentration (Cheesbrough, 2006) methods. The Kato-Katz technique which is quantitative was used for detecting helminthes. A disposable piece of 1. 37 mm-thick cardboard with a hole measuring 6 mm in diameter in the center was filled with stool that was strained using a 105-nylon mesh. After filling the hole, the template was removed, and the remaining sample was covered with a piece of cellophane soaked in glycerin covered with malachite green. The slide was then inverted and pressed down, so that the smear could spread over an area of 20-25 mm in diameter. The preparations were kept at room temperature for 1-2 hours and then examined under the microscope. After counting the eggs in each slide, the number of eggs per gram of feces was obtained by multiplying the figure by 1,000 and dividing by the fecal weight (Katz et al., (1972)**.** Infection intensities for intestinal helminth infections were determined using the WHO criteria (World Health Organization, 1987), and were categorized as low (1-4999 EPG), moderate 5000-49,000 (EPG), and high (>50,000) intensities.

Formal-ether concentration method

The formal-ether concentration technique is qualitative and was used to detect protozoan and helminth parasites. An applicator stick was used to obtain 1.0 g to 1.5 g of feces which was placed in a centrifuge tube containing 10ml formalin. The feces and formalin were mixed and brought into a suspension. The suspension was strained through a mesh sieve into a different centrifuge tube after which 10% formalin was added to bring the total volume to 10ml followed by an addition of 3.0ml of formalin ether. After mixing, centrifuging was performed for 2-3 minutes. The contents after centrifuging consisted of 4 layers. The top three layers were poured off. A drop of the sediment was obtained and placed on to a slide for examination under a cover slip (Cheesbrough 2006). The following criteria provided by Coulibaly et al., (2012) was used to quantitate protozoan infection intensities: (i) negative (no cysts or trophozoites in the entire sediment),; (ii) light infection(1-5 cysts or trophozoites per slide),; (iii) moderate (1 cyst or trophozoite per observation field at a magnification of x 400 or x 500),; and (iv) heavy (more than 1 cyst or trophozoite per observation field at a magnification of x 400 or x 500) (Coulibaly et al., 2012)**.**

3.7. Questionnaire

A structured questionnaire was used to assess potential and existing factors associated with intestinal parasite infections in the children in the study area. Trained field assistants helped in administering the questionnaire to the children.

The questionnaire collected demographic information such as parental/guardian education and economic status. Knowledge or information on personal hygiene, sanitation, water source, exposure to untreated wastewater and agricultural farms, footwear use and deworming was obtained. Of the 446 children who were issued with questionnaires, 384 children returned completed questionnaires for analysis.

3.8. Treatment of infected individuals

All the children who were diagnosed with intestinal helminths infections were treated with Albendazole (400 mg in a single dose tablet), and those infected with intestinal protozoans received Metronidazole (at 5 mg/kg body weight). Praziquantel (40mg/kg body weight) was given to those with schistosomiasis (Gardner & Hill, 2001; World Health Organization, 2002). Drug treatments were supervised by a qualified clinician.

3.9 Data analysis

The statistical analyses were carried out using STATA version 10.1 (StataCorp, College Station, TX). Data on prevalence and infection intensity were compared between groups using Chi-square or (Fisher's exact test). The prevalence of children infected with intestinal protozoa parasites was calculated by obtaining the number of children infected with intestinal protozoa divided by the total number of children in the study. The same was done for those infected with helminths. The overall prevalence of intestinal parasites was calculated by summing the number of children infected by intestinal protozoa, helminths, or both, divided by the total number of children that participated in the study. The factors related to the presence of intestinal parasites in school children were analyzed using generalized estimating equation (GEE) regression model assuming, an autoregressive correlation structure and a logit link (Molenberghs & Verbeke, 2005). GEE was used to analyze the data because there were three stool samples, and therefore three measurements on the presence of intestinal parasites, obtained from each child.

We would expect measurements from the same child to be more related and ignoring the fact that measurements from the same individual are likely to be correlated may result in misleading conclusions.

Unlike the classical logistic regression model, the GEE model takes care of the plausible correlation in the data (Molenberghs & Verbeke, 2005). All variables, which were perceived to be associated with IPs, were included in a full model, and were then dropped from the model in a backward, stepwise fashion. They were then rejected at the $P \geq 0.05$ level on likelihood ratio tests. However, variables considered important for this study were retained even if they were not significant. Before inclusion in the model, the variables which had three responses of 1=Always, 2=Sometimes, 3=Never were first dichotomized (changed into binary) such that the response was 1=yes, if Always; and 0=No, if sometimes=2 or never=3.

3.10 Study approvals

This study was undertaken with the approval of the scientific and ethical review committees of the Kenya Medical Research Institute (KEMRI). Before initiating this study, the area administration, school authorities, head teachers and teachers of each of the 5 (five) participating public primary schools were approached to explain the study and seek their help and support in organizing the study. Parents were also informed about the study through a parents' teacher association (PTA) meeting and provided a signed written consent for their children to participate in the study.

CHAPTER FOUR

RESULTS

4.1 Study population characteristics

Data was collected between March 18th 2013 and April 3rd 2013 from 446 school children randomly selected from all five schools in Njiru sub county. Table 4.1 provides the number of children included in the study and their gender in each participating school in Njiru sub county, Nairobi County.

Table 0.1: Number of children in each school by gender and both genders combined

School	Female	Male	Total
Jehova Jire	49	46	95
Kayole North	41	43	84
New Njiru	45	46	91
Maua	43	47	90
Mihang'o	45	41	86
Total	223	223	446

4.2 Intestinal parasitic infections in children from Njiru Sub County

Both protozoan and helminth parasites were detected in fecal samples of the examined children. A total of 12 parasite species (4 protozoan and 8 helminths) were detected in fecal samples (Listed in Table 4.4 with their prevalence), under a microscope based on their characteristic cysts (for protozoa) or ova (for helminths). *E. histolytica/dispar,* was the most common among the children examined, with a prevalence of 39%. Other intestinal protozoan parasites detected were *G. duodenalis* (8.1%), *E. coli* (2%), and *P. hominis* (0.5%). Among the helminthes detected, *A. lumbricoides* (with a prevalence of 14.8%) and *T. trichiura* (12.8%) were the most common. Other helminth species infecting children from Njiru were hookworm (with a prevalence of 8.5%) *S. mansoni* (5.8%), *E. vermicularis* (4.3*%), H. nana* (3.4%), and a *Taenia* species (1.6%) and *H. diminuta* (0.2%). Overall, the prevalence of intestinal parasites among the study children was 37%, with protozoan infections being the most (at 26.7%). However, in terms of abundance, helminths were the most abundant. Figure 4.1 shows species rank abundance curve based on parasite prevalence data.

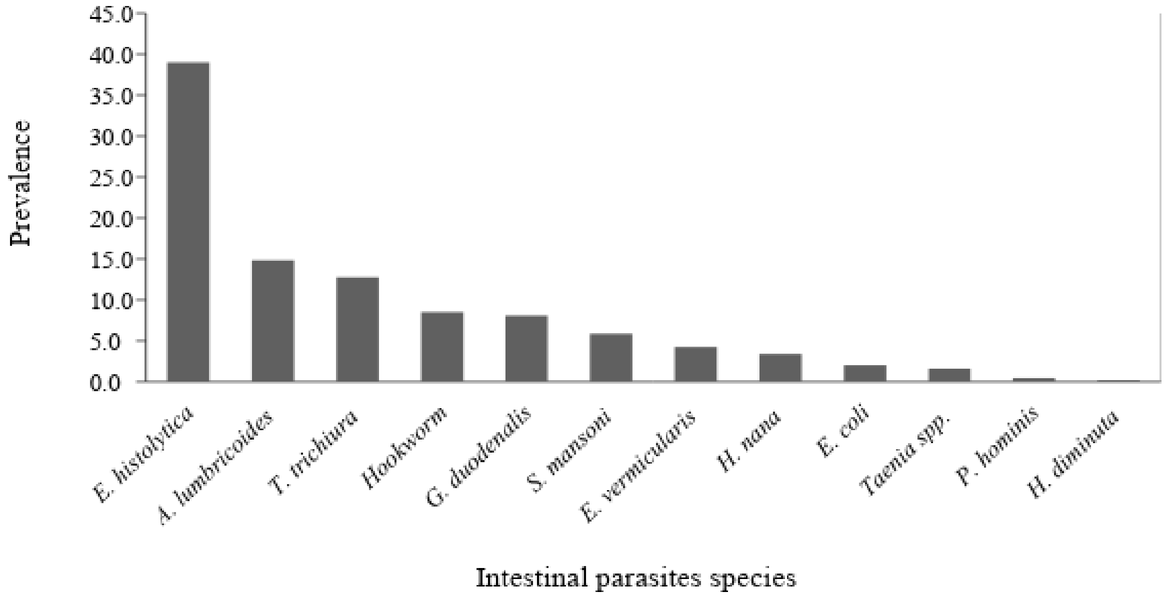

Figure 0.1:Species rank-abundance curve for parasite prevalence data

Overall, among the intestinal protozoan infections, *E. histolytica/dispar* had the highest number of children infected at 174 (39%), whereas, for the helminthes, 66 children (14.8%) were infected with *A. lumbricoides,* 57 (12.8%) with *T. trichiura,* and 38 (8.5%) with hookworm. On the other hand, 9 children (2%) were infected with the non-pathogenic protozoan, *E. coli* and 2 (0.5%) *P. hominis.* Interestingly, a very rare intestinal parasite, *H. diminuta* was also detected in stool samples of one child (0.2%). There were no apparent gender-related differences in the prevalence of parasite infections among the study children (31.8%).

4.3 Prevalence of intestinal parasitic infections among school children in Njiru

On average out of the 446 pupils, 165 (37%: 95%CI 32.5-41.7%) were positive for intestinal parasitic infections which included protozoans, trematodes, cestodes, and nematodes. However, the prevalence of intestinal helminthes and protozoa was 15.1% and 26.7%, respectively. Overall *Entamoeba histolytica/dispar,* a protozoan, was the most predominant intestinal parasite at a prevalence of 39%, followed by *A. lumbricoides*

(14.8%), *T. trichiuria* (12.8%) with *F. hepatica* and *H. dimunita* being the least prevalent at 0.2%.

The prevalence of intestinal helminths and protozoa for three consecutive stool collections are presented in Table 4.2 and Figure 4.2. It can be seen from Table 4.2 and Figure 4.2 that (i) the prevalence of all the IPs combined was higher than that of either helminths or protozoa separately and the prevalence of protozoan infections were higher than helminths during all the three stool collections times; and (ii) the prevalence of the IPs was not identical across the three stool collection times. The latter point emphasizes the fact that an infection can be missed out if a stool collection and examination is performed only once on a given subject/sample and this explains our motivation to take stool samples more than once; 3 times to be precise. In addition, ova and cysts are passed in stool intermittently.

Table 0.2:The number and percent of pupils infected by helminthes, protozoa and all IPs combined at observation (Stool Collection) times 1, 2 and 3 and averaged

Observation	**Helminths**		**Protozoa**		**Combined (Helminth and protozoan infections)**	
Time (stool Collection)	# Infected	% Infected	# Infected	% Infected	# Infected	% Infected
1	71	15.92	86	19.28	142	31.84
2	42	9.42	125	28.03	157	35.20
3	89	19.96	146	32.74	197	44.17
Average	67	15.10	119	26.68	165	37.07

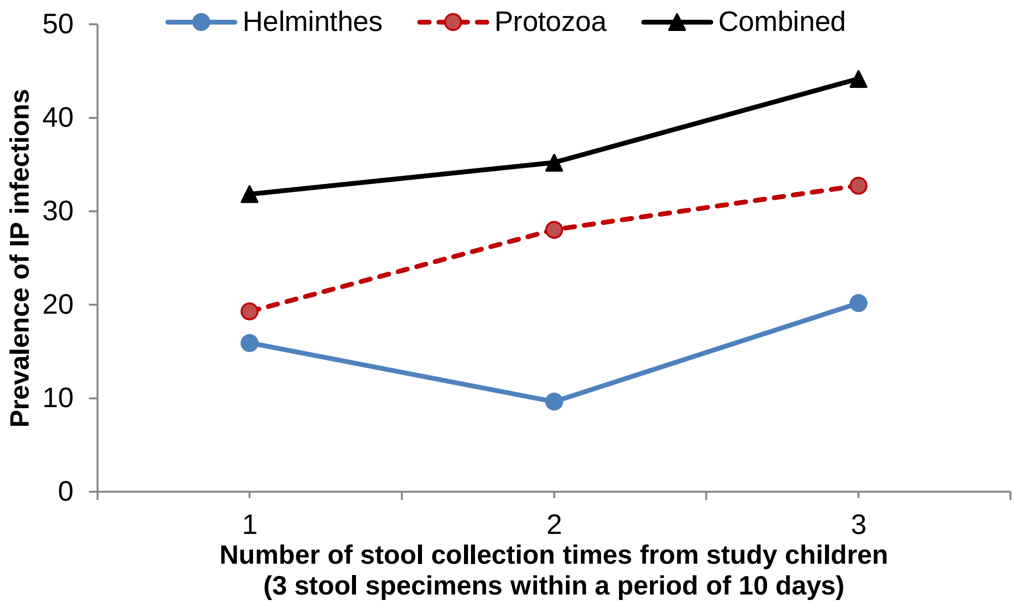

Figure 0.2: Prevalence of helminths (blue), protozoa (red) and both IPs combined (black) at stool collection times 1, 2 and 3.

The results further indicated the prevalence of IPs was 31.84% in both male and female pupils. Although the prevalence in those aged below 10 years (6-9yrs) was slightly lower (36%) than those aged 10-12 years (38%), this difference was not significant (Chi Sq.=0.15, df = 1, p= 0.698). Table 4.3 presents the prevalence of IP infection by class of study. It shows the highest prevalence was observed in class 4 (43.7%) followed by class 5 (42.2%), class 2 (37%), class 3 (35.7%), class1 (35.6%) and class 6 (24.2%). These differences were not significant though (Chi Sq. =7.55, df = 5, p= 0.1827). For the schools; Kayole North had the highest prevalence of 43%, followed by New Njiru (40%), Maua (36%), Jehova Jire (35%) and Mihang'o (31%). The fact that the differences in prevalence among the children in terms of age, gender, class of study and school they attend demonstrates that they are equally exposed to the risk of IPIs with respect to these factors, most probably because they interact in the same environment

Table 0.3: Prevalence of intestinal parasitic infections by class of study

Class	# Pupils in class	% Pupils infected			
		Stool collection Time 1	Stool collection Time 2	Stool collection Time 3	Average
1	58	24.14	34.48	48.28	35.6
2	64	34.38	34.38	42.19	37.0
3	72	29.17	36.11	41.67	35.7
4	93	40.86	40.86	49.46	43.7
5	90	33.33	43.33	50.00	42.2
6	69	24.64	17.39	30.43	24.2

Although our results (see Table 4.2) above have shown that the prevalence of protozoa among the pupils was higher than helminths, Table 4.4 shows that the helminths were more diverse (10 species) than protozoa (4 species). Overall *E. histolytica/dispar*, a protozoan, was the most predominant intestinal parasite at a prevalence of 39%, followed by *Ascaris lumbricoides* (14.8%), *T. trichiuria* (12.8%) with *Fasciola hepatica* and *H. dimunita* being the least prevalent at 0.2% (see Table 4.4)

Table 0.4:Ranked prevalence of individual intestinal parasite species separately for helminthes (left panel) and protozoa (right panel)

	Helminthes			Protozoa		
Rank	Species	# Children infected	Prevalence	Species	# Children infected	Prevalenc
1	*A. lumbricoides*	66	14.8	*E. histolytica/dispar*	174	39.0
2	*T. trichiuria*	57	12.8	*G. duodenalis*	36	8.1
3	*A. duodenale*	38	8.5	*E. coli*	9	2.0
4	*S. mansoni*	26	5.8	*P. hominis*	2	0.5
5	*E. vermicularis*	19	4.3			
6	*H. nana*	15	3.4			
7	*Taenia species*	7	1.6			
8	*D. latum*	1	0.2			
9	*F. hepatica*	1	0.2			
10	*H. dimunita*	1	0.2			

4.4 Parasite infection intensities among the study school children in Njiru

Table 4.5 shows infection intensities for the parasites detected among school children in Njiru . In the case of the intestinal protozoan parasites, both *E. histolytica/dispar* and *G. duodenalis* occurred in moderate to heavy intensities in the fecal samples examined, whereas *E. coli* occurred as a light infection. The samples from 2 children that tested positive for *P. hominis* were categorized as a heavy infection. In the case of helminth infections, many of the infections were light in intensity for all the species detected.

Table 0.5: Intestinal parasitic intensities among the study children from Njiru area, in eastern Nairobi

		Intensity[1]					Intensity[2]		
Protozoa	#Positive	Light	Moderate	Heavy	Helminths	#Positive	Light	Moderate	Heavy
E. histolytica/dispar	174	28.2 (49)[3]	20.7(36)	51.1 (89)	*A. lumbricoides*	66	93.9 (62)	6.1 (4)	0.0 (0)
G. duodenalis	36	27.8 (10)	25.0 (9)	47.2 (17)	*T. trichiura*	57	100 (57)	0.0 (0)	0.0 (0)
E.coli	9	77.8 (7)	11.1 (1)	11.1 (1)	Hookworm	38	92.1 (35)	5.3 (2)	2.6 (1)
P. hominis	2	0.0 (0)	0 .0(0)	100 (2)	*S. mansoni*	26	65.4 (17)	15.4 (4)	19.2 (5)
					E. vermicularis	19	100 (19)	0.0 (0)	0.0 (0)
					H. nana	15	100 (15)	0.0 (0)	0.0 (0)
					Taenia species	7	100 (7)	0.0 (0)	0.0 (0)
					H. diminuta	1	100 (1)	0.0 (0)	0.0 (0)

[1]Protozoan infection intensity determined based on the Coulibaly et al., (2012) criteria; **[2]**Helminth infection intensity based on the WHO criteria (World Health Organization, 1987); **[3]**Figures represent % children in the category (number of children in the category)

Of the children found to be infected, the majority (77%) had single parasite species infections, 18.5% harbored 2 parasite species, 3.6% harbored 3 species and only 1.2% harbored 4 parasite species. In other words, polyparasitism was rare among the study children. Where there were 2 parasite species on an individual, the most common parasite species combinations encountered were: *E. histolytica/dispar* + *G. duodenalis* (in 8 individuals); *A. lumbricoides* + hookworm (in 5 individuals). *E. histolytica/dispar* was common in children that were infected with three parasite species. Interestingly, 2 children had 4 different parasite species per individual. One had *G.duodenalis* + *H. nana* + *Taenia sp* + *H. diminuta,* and the other had *E. histolytica/dispar* + *G. duodenalis* + *T. trichiura* + *H. nana*.

4.5 Factors associated with the presence of intestinal parasites among the children in the Njiru area

The results of the generalized estimating equation (GEE) regression final model analysis (Molenberghs & Verbeke, 2005) are presented in Table 4.6. The results show the risk of a child being infected by intestinal parasites in Njiru could be explained by either a parent/guardian's level of education (LR test=10.11, df =4, P=0.0386) or by a family domestic water source (P=0.027). It was also observed children whose parents or guardians had secondary, college and university education levels, were less likely to be infected with intestinal parasites compared with their counterparts whose parents or guardians had only primary level of education or lower (Secondary: OR=0.54, 95%CI: 0.30-0.96; College: OR=0.21, 95%CI: 0.07-0.63; University: OR=0.43, 95%CI: 0.17-1.07). Of the 67 children that said their parents/guardians had a primary level of education, 45 (67.2%) were infected with intestinal parasites, whereas 22 (32.8%) were not. Again, children whose families use the river as the main water source for domestic needs were 5 times more likely to be infected with intestinal parasites, than those who said they did not use river water for domestic needs. Table 4.6 provides the results of this analysis. Of the 7 children who said that they relied on river water for domestic water needs, 6 (85.7%) were positive for at least one intestinal parasite infection.

Table 0:6. Factors associated with the presence of intestinal parasites in school children from Njiru, Nairobi, analyzed using the GEE model described by Molenberghs and Verbeke (2005)

Variable	OR*	95% CI		P value
Eat vegetables (yes/no)	0.59	0.27	1.25	0.169
Parent/guardian education level				
Primary	1.00			
Secondary	0.54	0.30	0.96	0.037
College	0.21	0.07	0.63	0.006*
University	0.43	0.17	1.07	0.069
Don’t know	0.51	0.27	0.98	0.042*
River main family water source (yes/no)	4.88	1.20	19.83	0.027*
Communal tap main family water source(yes/no)	1.17	0.47	2.92	0.731
Family buy water from porters (yes/no)	1.33	0.43	4.14	0.617
Borehole main family water source (yes/no)	1.32	0.53	3.25	0.553
Piped water into house (yes/no)	1.10	0.43	2.81	0.839
Agricultural plots vegetable source (yes/no)	0.68	0.32	1.42	0.300
Market vegetable source (yes/no)	0.58	0.24	1.38	0.216
Toilet type at school				
Pit latrine	1.00			
Flush toilet	0.84	0.40	1.74	0.634
Pupil knows causes of IPs (yes/no)	0.85	0.49	1.48	0.565
Know how people get IPs (yes/no)	1.65	0.95	2.87	0.074

Ever had IPI				
No	1.00			
Yes	0.80	0.44	1.47	0.477
Don't know	1.02	0.42	2.49	0.960
Knows preventive measure (yes/no)	1.39	0.86	2.26	0.179
Play near agricultural plots (yes/no)	0.85	0.39	1.83	0.670
Pass through agricultural plots to collect water	1.16	0.59	2.29	0.674
Help with farm work when not in school (yes/no)	1.24	0.78	1.99	0.365
Spend time in irrigation water/pond				
Swimming	1.00			
Playing	1.30	0.70	2.43	0.401
Other	1.19	0.65	2.18	0.583
Wash hands after visiting toilet (yes/no)	0.81	0.41	1.59	0.533
Wash hands before eating (yes/no)	0.99	0.31	3.17	0.988
Wear shoes outdoors (yes/no)	1.05	0.65	1.69	0.843

*OR= Odds ratio as analyzed using – the GEE model

4.6 Questionnaire data: study population/participant characteristics

Of the 446 pupils from which all three stool samples were collected, a total of 384 questionnaires were collected/returned. 62 pupils did not return their questionnaires (even after follow-up). However, all 446 pupils gave stool samples for the Kato-Katz and formal ether concentration tests. Other than gender, age, and school information, the questionnaire data are therefore only available for the 384 pupils that fully participated in the interview. The subjects were distributed approximately equally across the five schools in Njiru Sub County, Nairobi County.

4.6.1 Child information and household wealth demographics

Of the 384 children, 190 (49.5%) were females and the rest (194) were males. The mean (standard error) age of the children at recruitment was 9.82 (0. 09) years. Most (86.5%) of the children reported that they eat raw vegetables, mainly carrots (83.1%) and half of them (55.4%) reported to eat vegetable salad. 81.51% (i.e., 313/384) of the families buy vegetables from the market, and only 26.3% obtain vegetables from agricultural plots. Raw vegetables are known to be a source of transmitting intestinal parasites if not washed properly.

Almost all the children (96.4%) indicated that their parents went to school and that most of the educated parents had attained the highest level of education of secondary (32.43%), followed by primary (18.11%), University (11.62%) and college (9.46%) (Figure 4.3). It was, however, noted that quite a considerable number (28.4%) did not know the education details of their parents/guardians. The survey indicated that only a small proportion of the parents were unemployed (18.5%). The rest were either self-employed (44.53%), civil servants (10.43%), farmers in agricultural plots (3.39%) or were engaged in other activities (23.18%) in various industries like driving, masonry, hotelier, salon, etc. (Table 4.7).

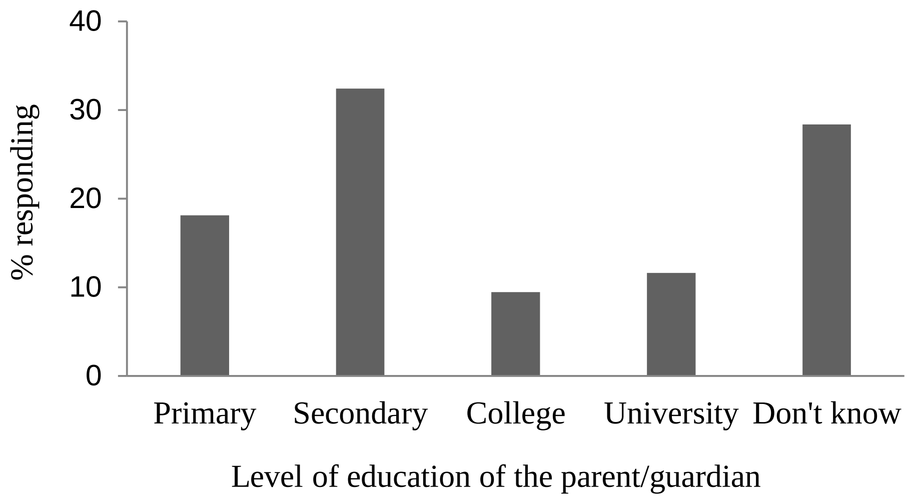

Figure 0.3: Percent distribution of the level of education of parent/guardian

Table 0.7: Occupation of the parent/guardian

Education level	# Respondents	% Respondents
Unemployed	71	18.49
Self-employed	171	44.53
Civil servant	40	10.42
Farmer in agricultural plots	13	3.39
Other (i.e., hotelier, salon)	89	23.18

4.6.2 Household and school demographics

The pupils were also asked questions regarding the main source of water - both for the family and for the school. Their responses are summarized in Table 5. From the upper panel of Table 5, it can be seen that most families use communal tap within housing units (56.8%) as the main water source, followed by water piped into the house, borehole, and water bought from water porters with very few families relying on river, lake or stream as their main water source. For schools, the main water source is water tank (63.8%), but some also boreholes (54.43%) or piped water (41.15%).

Table 0.8: The main source of water for family (upper panel) and school (lower panel)

Main water source for family	# Respondents	% Respondents
Communal tap within housing units	218	56.77
Piped into the house	97	25.26
Borehole	56	14.58
Buy water from water porters	36	9.38
River, Lake or stream	7	1.82
Main water source for school		
Water tank	245	63.80
Borehole	209	54.43
Piped into the school	158	41.15

Regarding the type of toilets used, most of the children/pupils indicated that at home they either use pit latrine (48.29%) or water closet (flush) toilet (47.51) and almost none (0.52%) of the families use the bush as a toilet. At school, however, a significantly greater proportion of them (82.55%) use pit latrines compared to water flushed toilets (17.45%); Chi square = 322.9, df = 1, p <0.0001)

4.6.3 Knowledge and practices

We also sought to assess the knowledge of the children on IPs. The results indicated 215 (56.28%) children knew what caused intestinal parasites. Of those who knew what caused

IPIs, 72.64% knew what intestinal parasites are. Almost half the pupils (49%) reported that they knew how people get intestinal parasites: Not washing hands before eating, not washing hands with soap after using the toilet, and drinking untreated water. Almost two-thirds of the pupils (64.57%) reported that they consider themselves to be at risk of getting intestinal parasites and indeed, quite a large proportion/number of them (69.63%) reported that they had contracted a parasitic intestinal infection. Of those who ever had IPI, 88.72% reported that they were treated for it. For most (44.92%) of them, however, treatment was given more than one year before the present survey, while others were dewormed approximately 6-12 months or within six months from the time of the survey. Half of the pupils (51.71%) indicated that know preventive measures for intestinal parasites. Some of the preventive measures mentioned include (i) washing hands with soap and water after using the toilet; (ii) washing hands with soap and water before eating; and (iii) Washing hands with soap and water after changing the baby's diaper.

4.6.4 Practices

We also set to assess the practices that increase the chances of the pupils getting IPIs. Out of the 384 pupils, 10.42% affirmed that they always played near agricultural plots while 48.70% affirmed that they sometimes played near agricultural plots. 64.06% of pupils said they never passed through the agricultural plots on their way to and from school. However, 21.09% affirmed that they sometimes passed near agricultural plots on their way to and from school. To assess whether pupils came into contact with contaminated soil, a significant number of pupils (48.18%) stated that they helped with farm work at the agricultural plots. 52.08% of the pupils also said that they spend time in the irrigation waters/ponds during their free time whereby 33.17% spend their time swimming in the irrigation water/pond, 32.66% spend their time playing in the irrigation water/pond while another 34.17% spend their time in other water related activities. A significant number of pupils (61.98%) confirmed that they washed their hands without soap after using the toilet while 8.85% did not wash their hands at all after using the toilet. In addition, 59.38% washed their hands without soap before eating while 3.65% did not wash their hands at all before eating. In terms of unhealthy practices roughly half (49.74%) said they at times did not wear shoes outdoors, while 4.43% said they never wore shoes outdoors.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

Intestinal parasitic infections of humans are common in Kenya (Nyarango et al., 2008). However, very few studies have determined the prevalence of IPI's in an environment where raw sewage is routinely used for irrigation farming in the peri-urban area of Njiru, in Nairobi County. The presence of parasite infections in school children from Njiru was, therefore, not surprising. The presence of 12 parasite species with an overall prevalence of 37% among children in the Njiru area in eastern Nairobi was, nevertheless, interesting, and the results suggest that intestinal parasites may be very common in the area, and these may be of major public health concern. A study conducted by Kamande et al., (2015) in school children in Murang'a had a higher overall prevalence of 53.8%. A similar study conducted by Fuhrimann et al., (2016) in Hanoi, Vietnam in an area where peri urban dwellers are exposed to wastewater had lower prevalence of 30%. This difference could be attributed to improvements due to education and socioeconomic developments arising from urbanization (Fuhrimann et al., 2016).

Eight helminths (15.1%) and 4 protozoans (26.7%) were recovered from the infected children. A study conducted by Ngonjo in school children in Thika revealed 6 helminths with a prevalence of 42% and 3 protozoa infections with a prevalence of 46.3%. Ngonjo's study was comparable to my study with similar species of helminths and protozoans being found in school children. Ngonjo's study however had higher prevalence of helminth and protozoan infections which could be attributed to variations in geography, socio-economic conditions, and cultural practices of the population in Thika (Ngonjo et al., 2012). A study conducted in Nakuru in school going children from informal settlements revealed a lower IP prevalence of 17.3%. This lower prevalence is attributed to improvements in sanitation, hygiene, deworming programs, and general good health practices (Chege et al., 2020).

Both protozoan and helminth infections occurred among the children, and even though most of the parasites occurred in low prevalence, these infections threaten public health. Of significance was the high prevalence of *E. histolytica/dispar* (39%) in the area, a parasite often associated with contaminated water, including areas where wastewater is used for irrigation farming (Ayed et al., 2009). *E. histolytica* is a major cause of diarrhea in children. Transmission of *E. histolytica* is via the fecal oral route.

The consumption of contaminated water or food is usually the route of human infections with *E. histolytica/dispar. C*ontaminated hands may play a major role in the transmission of intestinal protozoan and some helminth infections, in particular, those associated with poor hygiene and transmitted through the fecal oral route (Suresh & Chandrashekara, 2012). Even though more than half of the responding children in the present study indicated that they washed hands with soap and water before eating and after using the toilet, among those who said they washed their hands, 219 (62.4%) were positive for at least one of the parasitic infections detected in the children from this area.

Similarly, 20 (60.6%) of those who said they never washed their hands were positive for at least one of the parasitic infections. During our visits to the study schools in the Njiru area, there was no evidence that soap was provided for use by the children in or near the school toilets areas, suggesting that children who said they washed their hands after using the toilets or before eating, probably, washed their hands with water only. It is also possible that they did not consistently wash their hands with water and soap. It has been observed that people who do not wash their hands with soap and water were at a significantly greater risk of infection with *E. histolytica/dispar* and other intestinal parasitic infections than those who did (Cheesebrough, 2006**)**. This explains why the children, who said they washed their hands with soap and water after visiting the toilets or before eating in the present study, were still infected with *E.histolytica/dispar* and other

IPs. Even though hand washing after using the toilet(P=0.533) and before eating (P=0.988) was deemed to not be a factor associated with IPI's in this study, other studies such as Kamande's study established the use of plain water only for hand washing as a factor associated with the presence of IP in school children (Kamande et al., 2015). Research conducted in North India by Singh et al., (2021) in patients shows those who did not have a habit of washing hands before meals were significantly associated with *Entamoeba* species infection.

E. histolytica/dispar and other Ips is a common infection in children, especially in localities where hygiene is poor (Katz et al., 1972**)**. Interestingly, most of the children (85.7%), who said they used river water as their main source of water for domestic purposes were infected with *E. histolytica/dispar*. The majority of the study children in Njiru live and/or go to school within an area where wastewater is frequently used for irrigation farming. It is very likely that untreated sewage and/or contaminated river water were the sources of these infections among the children in the area. Although Kamande et al., (2015) study done in Murang'a county was not in an area where sewage water is used for irrigation, the source of water may have been contaminated by infected humans defecating in bushes and fields. Kamande's study reported that children of Murang'a who used the river as their source of water had a sixfold odds risk ratio of being infected with an IPI (Kamande et al., 2015). This risk factor was comparable to my study which had an almost 5 fold odds risk of being infected with an intestinal parasite.

G. duodenalis, another intestinal protozoan parasite of public health significance was also present among the study children in Njiru, albeit in low prevalence (8.1%). Although the true prevalence of *Giardia* infection in Kenya is not properly documented, studies have shown *Giardia* cysts are commonly isolated from children in Kenya (Thiong'o et al., 2011). Like in the case with *E. histolytica/dispar*, the infected children may have acquired G*iardia* from sewage-contaminated water or food or through the direct fecal-oral route. Results of a study conducted in Pakistan have suggested that farming households and households living in close vicinity of wastewater-irrigated fields had an increased risk of

G. duodenalis infection (Ensink et al., 2006). Although the commensal, *E. coli* was present, it is not considered of public health significance. However, it is often found together with the other pathogenic protozoan parasites, often associated with poor hygiene. Similarly, the flagellate, *P. hominis* (formerly known *as Trichomonas hominis* (Compaoré et al., 2013) another non-pathogenic intestinal protozoan, without a cyst form, was also, detected in fecal samples of a few children, and acquired via the fecal-oral transmission route, is usually more common in children than in adults (Chomicz et al., 2004).

It was also observed that besides the protozoan parasites, other intestinal parasites were also common infections among the study children in the Njiru area. Several studies conducted in different parts of the world also show that parasite species like those seen in the Njiru area commonly infect populations that live within localities where wastewater is used for irrigation farming (Al-Shamiri et al., 2010). Similarly, such parasites have been found in areas without clean drinking water or sewage elimination systems (Diaz et al., 2006). Among the parasites most commonly found under such conditions include *G. duodenalis*, *E. histolytica/E. dispar*,*A. lumbricoides*, *T. trichiura*, *E. vermicularis*, and *H. nana* (Khouja et al., 2010). In the present study, these parasites were also present in the Njiru area, suggesting that these parasites characteristically occur in environments where hygiene conditions are generally poor.

The presence of *S. mansoni* in the peri-urban area of Njiru was interesting, but not surprising. *S. mansoni* is transmitted in freshwater habitats through *Biomphalaria* (Gastropoda: Pulmonata) snails and is a parasite of public health significance, and responsible for causing human schistosomiasis (Phuc et al., 2011). Although schistosomiasis is generally considered a rural disease, it is increasingly becoming a common infection in peri-urban and urban areas in the endemic areas, especially, in informal settlements (Dabo et al., 2015**).** *S. mansoni* is endemic in Kenya, and in fact occurs in localities in the nearby Tala-Kangundo area of Machakos county, (approximately 50kms from the Njiru area), where it is transmitted in seasonal streams by

Biomphalaria pfeifferi, and has also, previously been reported from the Nairobi area (Thiong'o et al., 2002). While we do not rule out the possibility that the cases of *S. mansoni* infection reported from the Njiru area, were imported from the nearby endemic area of Tala-Kangundo, there is a possibility that active transmission of *S. mansoni* does probably occur in the Njiru area.

In the present study, one child was found to be infected with the rat tapeworm *Hymenolepis diminuta* a rare infection in humans, with distribution, generally limited to rural and degraded areas, and which utilizes fleas (Arthropoda: Lepidoptera) as intermediate hosts. *H. diminuta* is not generally associated with farming areas where wastewater is used for irrigation farming, or with untreated wastewater and sediments. However, it has been reported to be transmitted to humans through ingesting arthropods carrying cystercercoid larvae as intermediate host, thereby providing a source of additional infections and a mechanism for egg dispersal (Kılınçel et al., 2015). *H. diminuta* eggs released from the rodent in feces are ingested by the arthropods and develop into the cysticercoid tapeworm larvae, and humans, primarily, children become infected when they ingest arthropods (Kılınçel et al., 2015). In the human, the tapeworm larvae develop into an adult worm in the intestine, and when mature, produce eggs, which are passed out in feces. We do not know how the child in Njiru may have acquired *H. diminuta* infection.

This study also revealed the presence of *E. vermicularis* in children in the area. *E. vermicularis* is rarely reported in parasite prevalence reports, possibly because it is rarely investigated, given the procedure for its diagnosis that is rather cumbersome and complicated to be used for the routine purpose (Salim et al., 2014). Enterobiasis is estimated to infect 4-28% children globally however recent and profound prevalence, and burden estimates are missing, particularly in Sub-Saharan Africa (Salim et al., 2014). Although we are not sure how the children may have become infested with *E. vermicularis* in the Njiru area, it is possible that they may have been infected by ingesting eggs contained in dust, water or sticking on hands and food (Salim et al., 2014).

The present study revealed that school children in peri urban Njiru had light to heavy infection intensities of protozoan and helminthes. While this study showed many school children had light helminthes intensities, a few children had moderate to heavy infection intensities of *A. lumbricoides*, Hookworm, and *S. mansoni*. A similar study conducted across six regions in Kenya by Okoyo et al., (2020) showed significant light intensity of infections in primary school children. The reduction in intensities was attributed to rigorous rounds of mass drug administration over a five year period. A study conducted by Njenga et al., (2022) in young children in Kibera, Nairobi showed a light intensity of STH infection in all children in the study. Njenga et al., (2022) attributed the low intensities to deworming efforts of school children in the area. The present study revealed many of the children in peri urban Njiru had low single species infection, and while the occurrence of polyparasitism was present, the proportion of those multiple parasite species infections (23%) was generally, low compared with those observed in other studies in other parts of Kenya. A study conducted in Murang'a by Kamande et al., (2015) had a lower poly-parasitism of 9.3% among the study children. Kamande's study had four cases of co-infections with helminths (Kamande et al., 2015). While this study revealed that only 1.2% of children harbored 4 parasites species, a study performed by Thiong'o et al., (2001) in Bondo western Kenya revealed that poly parasitism in rural children is common and some children may harbor as many as nine parasites per individual in a given time. Polyparasitism is known to negatively affect the health and well-being of children (Thiong'o et al., 2001).

Our observations suggest that parents/guardians with a low level of education were associated with increased likelihood of their child becoming infected with intestinal parasites. This observation agrees with the observation made by Quihui et al., (2006) among children in a Mexican rural school. It was interesting to note, however, that irrespective of the educational status of parents/guardians, the proportion of children infected with at least one intestinal parasite species was unexpectedly high. The prevalence of infections among children of parents with above high school level of education can be explained in part by the fact that many of the families with working parents, employ house helps with generally lower educational levels to look after their children as they go to work. Many of these house help may have limited information or awareness of how intestinal parasites are transmitted or even how they can be prevented. An alternative explanation is that it is possible that either parents/guardians across all educational levels do not generally have time to enforce good hygiene habits in their children or they do not feel motivated to enforce proper hygiene habits in their children. A study conducted in Ethiopia associated primary school children who had illiterate mothers and fathers with the presence of IPIs (Aschale et al., 2021). In addition, a study conducted in North India by Singh et al., (2021) identified patients who were uneducated were significantly associated with having parasitic infection.

The environmental conditions at Njiru included contaminated soil, the presence of sewage, poor sewage disposal, and use of wastewater for irrigation farming as ideal conditions for intestinal parasites to thrive and become a public health problem (Ensink et al., 2006; Haque, 2007). Thus, people who live in such an environment are not only under the risk of becoming infected with parasitic infections that are transmitted via the fecal-oral route, but also, those that enter the human body by penetration of intact skin such as soil-transmitted hookworm infection (Salim et al., 2014).

5.2 CONCLUSION

The presence of 12 parasite species suggests that IPs are common in the Njiru area. The high prevalence of *E. histolytica/dispar* at 39%, followed by *A.lumbricoides* at 14.8%, *T. trichiura* at 12.8% just to mention these few are in agreement with a study done in Tunisia that showed similar intestinal parasites in raw wastewater samples (Sabbahi et al., 2022). Therefore, the presence of a variety of intestinal parasites known to be found in wastewater explains why the same intestinal parasites were found in children in the Njiru area. Generally, both protozoan and helminth infections occurred among the children in light intensity. Despite there being a low prevalence and intensity of IPI's in school children, these infections threaten public health. Of significance was the high prevalence and heavy intensity of *E. histolytica/dispar* in the school children, a parasite often associated with contaminated water, including where wastewater is used for irrigation farming (Ayed et al., 2009). Results of this study showed that children whose parents or guardians had primary education only and those who used the river as their main water source were more likely to be infected with an intestinal parasite. Awareness of factors that are significant is key in decreasing the risk of having an IP.

5.3 RECOMMENDATION

The presence of a diversity of intestinal parasitic infections of public health significance in Njiru is a major cause of concern, Comprehensive measures to mitigate their impact on human health, particularly among children, is urgently needed. In particular, the study recommends to the Ministry of Health to fund deworming programs routinely and consistently in schools, routinely perform parasite testing in school children and improve public health education awareness on intestinal parasitic infections. Given intestinal parasitic infections may have severe consequences for children (World Health Organization, 1987), further action is required to analyze the effects of IPI's on the growth and cognitive behavior of children in Njiru sub county. In addition, further studies are needed to investigate the morbidity and mortality of the IPI's in school children.

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APPENDICES

Appendix 1: Interview questionnaire (Administered to the children with the aid of trained research assistants)

DEMOGRAPHIC INFORMATION

A1). Child information

CHILD INFORMATION	
Primary school code………………………….	Primary school Name…………………………
SUB COUNTY code……………………………………….	District Name………………………………..
Pupil's ID…………………………………..	Date of visit…………………………………..

Pupil's last name……………………………	Pupil's first name…………………………….
Pupil's initials…………………………………	Date of birth………………………………….
Age in years…………………………………...	Gender: Male……… Female…………
Parent/Guardian's last name………………....	Parent/Guardian's first name………………….
HEALTH INFORMATION	
Weight…………….kgs	Stool sample taken: Yes……… No…….

Personal demographics

A2). Do you eat raw vegetables? 1. Yes □ 2. No□

A3). If yes, specify the type of vegetable eaten raw? 1. Carrots □ 2. Vegetable salad □ 3. Other □

Household wealth demographics

A4). Did your parent/guardian go to school? 1. Yes □ 2. No□

A5). If yes, what is their level of education?

1. Primary □ 2. Secondary □ 3. College □ 4. University □ 5. I don't know □

A6). What is your parent/Guardian's occupation?

1. Unemployed □
2. Self-employed (specify) □ -----------------
3. Civil servant □
4. Farmer in nearby agricultural plots
5. Other(specify)□----------------------------

Household demographics

A8). What is the main source of water for the family?

1. River, Lake, or stream □ 4. Borehole □

2. Communal tap within housing units □ 5. Piped into the house □

3. Buy water from water porters □

A9). What is the source of vegetables for the family?

1. Agricultural plots □ 2. Market □

3. I don't know □

A10). What kind of toilet do you use at home?

1. Bush □
2. Pit latrine □
3. Water closet(flush)toilet □
4. Other □

School demographics

A11). What is the main source of water for the school?

1. Water tank □ 4. Borehole □
2. Piped into the school □ 5. Other □
3. Buy water from water porters □

A12). What kind of toilet do you use at school?

1. Pit latrine □2. Flush toilet □ 3. Other □

KNOWLEDGE

B1). Do you know what causes intestinal parasites? 1. Yes □ 2. No □

B2). If yes, do you know what intestinal parasites are? 1. Yes □ 2. No □

B3). If yes, please specify

1. Worms and related parasites □ 2. Insects' □ 3. Other □ 4. I don't know □

B4). Do you know how people get intestinal parasites? 1. Yes □ 2. No □

B5). If yes, please specify

1. Not washing hands with soap after using the toilet □

2. Not washing hands before eating □

3. Drinking untreated water □

4. None of the above □

B6). Do you think you are at risk of getting intestinal parasites? 1. Yes □ 2. No □

B7). Have you ever had an intestinal parasitic infection? 1. Yes □ 2. No □ 3. Don't know □

B8). If yes, were you given deworming medication? 1. Yes □ 2. No □ 3. Don't know □

B9). If yes, how long ago?

1. Less than 6 months □ 2. 6 months to one year □ 3. Above one year □

B10). Do you know any preventive measures? 1. Yes □ 2. No □

B11). If yes, please specify

1. Washing hands with soap and water after using the toilet □
2. Washing hands with soap and water before eating□
3. Washing hands with soap and water after changing the baby's diaper □
4. None of the above □

PRACTICES

C1). Do you play in or near agricultural plots?

1. Always □ 2. Sometimes □ 3.Never □

C2). Do you pass through the agricultural plots on your way to or from school?

1. Always □ 2. Sometimes □ 3. Never □

C3). Do you pass through agricultural plots on your way to or from collecting water for household use?

1. Always □ 2. Sometimes □ 3.Never □

C4). When not in school do you help with the farm work in the agricultural plots?

1. Yes □ 2. No □

C5). Do you spend time in the irrigation water/pond? 1. Yes □ 2. No□

C6). If yes, what do you do in the water?

1. Swimming □ 2. Playing □ 3. Other

C7). Do you wash your hands after using the toilet?

1. Without soap □ 2. With soap □ 3. Do not wash hands□

C8). Do you wash your hands before eating?

1. Without soap □ 2. With soap □ 3. Do not wash hands□

C9). Do you wear shoes outdoors? 1. Always □ 2. Sometimes □ 3. Never

KIAMBATISHO CHA PILI

Nakala ya maswali kwa mujibu wa mtafiti kwa watoto

DEMOGRAFIA

A1). Habari kumhusu mtoto

HABARI KUMHUSU MTOTO

Kodi ya shule…………………………………	Jina la shule……………………………………
Kodi ya taarafa………………………………..	Jina la wilaya…………………………………..
Nambari ya kusajiliwa………………………...	Tarehe ya kuzuru………………………………

Jina la mwisho…………………………………	Jina la kwanza la mtoto……………………….
Ufupisho wa jina lake kwa kutumia alfabeti…………………………………	Tarehe ya kuzaliwa…………………………………… …
Miaka	Jinsia :Mume………….Mke………………..
Jina la mwisho la mzazi/mlezi……………………………… … ….	Jina la kwanza la mzazi……………………………………… ….

MAELEZO KAMILI KUHUSIANA NA AFYA

Uzito wa mizani………………….kilo	Sampuli ya kinyesi kilichochukuliwa:

	Ndio…….La……………

Demografia ya kibinafsi

A2). Unakula mboga zisizopikwa?

1.Ndio □ 2. La □

A3). Kama ndio, eleza ni aina gani ya mboga ambayo mwala bila kupikwa?

1. Karoti □ 2. Kachumbari □ 3. Nyinginezo □

Demographia ya uwezo wa kupata fedha

A4). Je, mzazi/mlezi wako ameshawahi kuenda shule ili kupata elimu? 1. Ndio □ 2. La □

A5). Kama jibu lako kwa swali A4 ni ndio, je mzazi wako alifika kiwango gani cha masomo?

1. Shule ya msingi □ 2. Shule ya upili □ 3.Chuo □ 4. Chuo kikuu □ 5. Sijui □

A6). Je, mzazi wako anafanya kazi gani?

1. Hafanyikazi □ 2. 3.
2. Amejiandika(eleza) □---------------------
3. Ameandikwa na serikali(eleza)---------------- □

4. Mkulima katika mashamba yalio karibu na shule □ 5. Nyiginezo (eleza) □-------

Demografia ya nyumbani

A8) Ni wapi familia yako hupata maji ya matumizi

1. Mto,kisiwa □

2. Mfereji unaotumiwa na jumuia ya watu □

3. Kununua kutoka kwa wauza maji □ 4. Bwawa la maji □

5.Kutoka mifereji ya nyumbani □

A9. Ni mahali papi ambapo mnapata mboga zenu za kutayarishia familia?

1. Kutoka kwa shamba □ 2. Kutoka kwa soko □ 3. Sijui □

A10. Ni choo cha ania gani mnachokitumia nyumbani kwenu?

1. Kichaka □ 2. Choo cha kuchimba □ 3. Choo cha jamii cha kupiga maji □ 4. Vinginevyo □

Demografia ya shule

A7). Je, asili ya maji ya shule ni ipi?

1. Tanki ya kuhifadhi maji □ 2. Kutoka mifereji ya maji □

3. Kununuakutokakwawauzamaji□ 4. Bwawa la maji□ 5.vinginevyo□

A8). Ni choo cha aina gani mnachotumia shuleni ?

1. Choo cha kuchimbwa □ 2.Choo cha kupiga maji □ 3. Kingine □

UMAARIFA

B1)**.**Unajua ni mambo yapi usababisha vimelea vya tumbo? 1. Ndio□

2. La □

B2). Kama jibu lako ni ndio, wajua vimelea vya tumbo ni vipi? 1. Ndio □

2. La □

B3). Kama ndio; eleza

1. Minyoo na vimelea vingine□ 2. Wadudu□ 3. Vinginevyo □ 4. Sijui □

B4). Unajua jinsi watu hupata vimelea vya tumbo?

1. Ndio □ 2. La □

B5). Kama ndio; eleza

1. Kutoosha mikono na sabuni baada ya kutembelea choo □

2. Kuto osha mikono na sabuni kabla ya kula □

3. Kuto kunywa maji safi yaliyo chemshwa □

4. Jibu lolote lisilo ambatana na majibu yaliyotajwa

B6). Je, uko hatarini ya kuambukizwa vimelea vya tumbo? 1. Ndio □ 2. La □

B7). Je, umeshawahi kupatikana na vimelea vya tumbo? 1. Ndio □ 2. La □ 3. Sijui

B8). Kama ndio, ulipewa tembe za kuangamiza vimelea? 1. Ndio □ 2. La □ 3. Sijui

B9). Kama ndio, ulipewa tembe baada ya muda gani ?

1. Muda usiopungua miezi sita □ 2. Miezi sita hadi mwaka moja □ 3. Kuzidi mwaka moja □

B10). Unajua jinsi ya kuepuka kupata vimelea vya tumbo?1. Ndio □ 2. La□

B11). Kama ndio eleza

1. Kuosha mikono na sabuni kabla ya kutembelea choo □
2. Kuosha mikono na sabuni kabla ya kula □
3. Kuosha mikono na sabuni baada ya kubadilisha napi ya mtoto □
4. Jibu lolote lisilo ambatana na majibu yaliyotajwa □

VITENDO

C1). Unacheza ndani au karibu na Ploti za kilimo?

1. Kila wakati □ 2. Wakati mwingine □ 3. Sijawahi

C2). Unapitia kati ya shamba za kilimo unapoenda shuleni?

1. Kila wakati □ 2. Wakati mwingine □ 3. Sijawahi □

C3). Unapitia shamba za kilimo unapoenda kuchota maji ya matumizi ya nyumbani au kivingine?

1. Kila wakati □ 2. Wakati mwingine □ Sijawahi □

C4). Wakati haumo shuleni wewe husaidia kulima au kazi nyingine shambani?

1. Ndio□ 2. La □

C5). Je, wewe uzuru maeneo ya maji ya kidimbwi?

1. Ndio □ 2. La □

C6). Kama ndio,wewe hufanya nini majini ?

1. Huogelea □ 2. Huchezea □3. Vinginevyo □

C7). Je,wewe huosha mikono yako baada ya kutembelea choo?

1. Bila sabuni □ 2. kwa sabuni □ 3. Sioshi □

C8). Je,wewe huosha mikono yako kabla ya kula?

1. Bila sabuni □ 2. kwa sabuni □ 3. Sioshi □

C9). Je, wewe huvalia viatu nje ya nyumba?

1. Kila wakati □ 2.Wakati mwingine □ 3. Sivai kabisa □

Appendix 2: Study approval

RECEIVED
19 DEC 2012
CENTRE FOR BIOTECHNOLOGY RESEARCH AND DEVELOPMENT
P.O. Box 54840
NAIROBI

KENYA MEDICAL RESEARCH INSTITUTE

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KEMRI/RES/7/3/1 **December 14, 2012**

TO: **Ms CHRISTINE KARIMI NDOKO (PRINCIPAL INVESTIGATOR)**
STUDENT No. TM304-1108/2011

THROUGH: **DR. KIMANI GICHUHI,**
THE DIRECTOR, CBRD,
NAIROBI

19/12/12

Dear Madam,

RE: SSC PROTOCOL No. 2367 – REVISED (INITIAL SUBMISSION): A SURVEY OF INTESTINAL PARASITIC INFECTIONS IN SCHOOL CHILDREN IN THE PERI-URBAN DIVISION OF NJIRU, NJIRU DISTRICT IN NAIROBI COUNTY AND THE ASSOCIATED FACTORS

This is to inform you that at the 210th meeting of the KEMRI Ethics Review Committee held on 26th November 2012, the review of the above referenced application was initiated and is now concluded.

The Committee noted that:

(a) The objective of the proposed cross-sectional study is to determine the prevalence, intensity and factors associated with intestinal parasites among school going children in Njiru Nairobi.
(b) A physical exam will be performed and stool specimen obtained for laboratory investigations.
(c) A total of 405 pupils aged 6-12 years of age will be enrolled into the study.

After careful consideration, the Committee concluded that more information is necessary before a final decision on the study can be reached:

1. **Document Version Control**: Please ensure that the document has a version number and date e.g. Version 1.1 dated 14 December 2012 if the document is finalized on 14 December. This facilitates tracking of the document of record.
2. **Endorsement of Application**: Please ensure that each of your supervisors review and sign off the revised version of the proposal to register their endorsement of the proposed research and their supervisory role.
3. **Conceptual Framework**: Please add information on parental/guardian education and economic status.
4. **Ethical Considerations in the Body of the Study Protocol and Informed Consent Documents:**
    a. This section should be restructured under key subheadings to ensure comprehensive address of key elements