THE PREVALENCE AND RISK FACTORS OF SOIL TRANSMITTED HELMINTHS IN PRESCHOOL CHILDREN FROM MARANI SUBCOUNTY, KISII COUNTY, KENYA

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EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

DECLARATION

This thesis is my original work and has not been submitted in part or whole for an award in any institution.

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DEDICATION

I dedicate this work to my most-loved mother Patricia Bosibori.

ABSTRACT

Major obstacles to the survival of children below the age of five in developing world include malnutrition, inaccessibility to safe water and infections due to parasitic worms such as soil transmitted helminths. This cross-sectional study was undertaken in Marani subcounty, Kisii County, to determine the prevalence rate and potential risk factors of soil transmitted helminths (STH) amongst preschool age children. Stool samples were collected from 106 preschool age children. Data regarding the socio demographic and risk factors influencing the prevalence rates was collected using structured questionnaires. The stool specimens were analysed using direct wet mount and MiniParasep technique. Chi square statistics was used for analysis using statistical software SPSS version 16. The overall prevalence rate of STH was 35.8% with single prevalence of 30.2% and co-infection of 5.6%. *Ascaris lumbricoides* recorded the prevalence rate of 19.8% followed by hookworms 7.5% and the least prevalence rate was noted with *Trichuris trichiura* 2.8%. The male gender showed a higher prevalence rate 43.6% than the female gender 27.5 ($\chi^2 = 3.607$, $p = 0.607$). This study reaffirms that there still exists a high prevalence of STH in rural areas especially *Ascaris lumbricoides* which holds a high frequency across all gender in preschool children. Apart from provision of clean and safe water for drinking, education to parents is a fundamental key to control of STH especially to the mothers who play a vital role in the day to day growth of a child.

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LIST OF ACRONYMS AND ABBREVIATIONS

DALY	Disability Adjusted Life Year
GoK	Government of Kenya
MDA	Mass Drug Administration
MDG	Millennium Development Goals
NGO	Non-Governmental Organization
NTDs	Neglected Tropical Diseases
RPM	Revolutions per Minute
STH	Soil Transmitted Helminths
TDS	Trichuris Dysentery Syndrome
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization

CHAPTER ONE
INTRODUCTION

1.1 Background information

In Kenya, a serious problem exists in rural villages where children are at a particularly high risk of illnesses associated with parasitic infections (van Eijk *et al*., 2009). Preschool children account for 10% to 20% of more than two billion people worldwide who are affected with Soil Transmitted Helminths (STH) infections; this has been attributed to low immunity in this age group (Riesel *et al*., 2010). Although the Kenyan government's current strategy in providing mass drug administration to school going children has been very successful in mitigating control against such preschool children have been largely left out, yet they are the most vulnerable age for these infections (Kenya National School-Based Deworming Program, 2013).

Such children harbor STH infections in high intensity as a study done in Elburgon showed that the most prevalent specific parasite species were *T. trichiura* and *A. lumbricoides* as evidenced by high mean egg counts (Mokua, 2015). When STH is not controlled in this population, the entire community is at risk of re-infection because children will defecate in the environment propagating the development of STH eggs that eventually contaminate water and edible vegetation consumed by the community including the already treated school going children hence the need to protect and treat the preschool children against STH (Lynne *et al*., 2007).

Contrary to WHO guidelines on deworming of high risk groups where preschool children fall (WHO; 2013), Kenyan health policy continues to ineffectively manage the issue of STH infection prevention and control. In rural Kenya, deworming is not a habitual practice especially by Parents of preschool children yet such children are considered a high risk group and may harbor the STH infections in high intensity (Crompton *et al*., 2010). These children end up contaminating the environment which makes other members of the community vulnerable to such infections or become reinfected if such children play in places of where defecation or unsanitary disposal of feces is common. Such practice propagates the spread of STH infections (Boschi-Pinto *et al*., 2008) because contaminated feces undergo environmental exposure with soil, which provides a favorable environment and growth thus eggs become infective and may end up contaminating water in rivers, streams or dams that the community regularly use. In this regard therefore, epidemiologic information are needed to justify the prioritization of preschool children for mass treatment programs (Parker *et al*., 2011).

Although direct mortality that may result from helminths infection is low, its morbidity is high. Numerical threshold at which worms cause disease in children has not been established, because its highly dependent on the underlying nutritional status of the host that is, if the host is malnourished, then the worm burden may be high as compared to an individual who does not have nutritional deficiencies (Arora *et al*., 2004). Morbidity from STH infections and the rate of transmission are directly related to the number of worms harbored in the host, it is for this reason the intensity of infection is the main epidemiological index for STH (Lynne, 2007). Systematic studies show that at great risk of morbidity are high risk group which includes preschool, school aged children and pregnant women (Matthys *et al*., 2011). Regardless of the health risks associated with STH infections, sufficient attention has not been given to Marani subcounty (Figure 7) a remote, rural community where health, environmental facilities and infrastructure are poor, inadequate or lacking altogether (MoH, 2000).

To control the morbidity which is associated with STH infections for preschool children living in endemic communities, government of Kenya programs under ministry of public health and sanitation has focused on deworming through school programs. Such efforts have showed a reduction in the transmission of STH in preschool group of children (Obala *et al*., 2013). It is therefore particularly important to cater for preschool children who are untreated portions of the population to ensure control of infections given the impact of STH on early growth and development. This present study is therefore aimed at studying the risk factors in preschool children that are associated with STH in an impoverished indigenous setting in rural Kenya. The results of this study enhanced the growing pool of vital baseline data on the prevalence of STH infection in Kenya.

1.2 Statement of the problem

Mass deworming is not provided to preschool going children (PSC) who are the most vulnerable age/group to STHs, instead, they have to wait until they join school to receive treatment. Marani subcounty is a typical rural area with pre-school going children who are vulnerable to STHs. This study was therefore, undertaken to determine the prevalence rates and socio-economic factors contributing to STHs infection in preschool children. Generally, STH cause malnutrition, intestinal obstruction and lack of appetite, slow growth, weakened general physical fitness, fever, diarrhea, vomiting and impaired cognitive development especially in children whose immunity is still developing (Ahmed *et al*., 2012).

1.3 Objectives

1.3.1 General Objective

Prevalence and risk factors of soil transmitted helminths in preschool children from Marani subcounty, Kisii County, Kenya.

1.3.2 Specific objectives

1. To determine the prevalence and the common soil transmitted helminths in preschool children in households of Marani subcounty.
2. To identify the factors influencing the prevalence of soil transmitted helminths in preschool children of Marani subcounty.
3. To formulate recommendations that advise on policies on public health education strategies in controlling STHs infections

1.4 Justification

The aim of this study was to assess the current prevalence rates of intestinal helminths and the associated risk factors of STH transmission among preschool children in Marani. There is limited information on the prevalence of STH in preschool children in rural areas of Kenya consequently there are no studies in Marani subcounty, yet such information is needed to assist in provision of better healthcare to these children which is in line with the goals of Kenyas ministry of health policy where all children should have a high quality life free of preventable infections. Data generated will assist in implementation of policies such that apart from school going children, preschool children will be included in the ongoing MDA which assists in preventing further reinfections in the already treated population. The health centers and nongovernmental organization were also given this data to help them incorporate deworming programs into their existing programs of post natal care to improve the well being of childhood, additionally this study assisted in the achievement of Kenya’s vision 2030 where it anticipates to lower infant and mortality ratios in addition to improved water and sanitation that will be available and accessible to all. This study added to the growing pool of vital baseline data on the prevalence of STH infection in Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.1 The burden of Soil Transmitted Helminths (STH)

Soil transmitted helminth (STH) infections such as ascariasis caused by *Ascaris lumbricoides*, trichuriasis caused by *Trichuris trichiura* and hookworm infection caused by hookworms are a major health problem of children in rural areas of developing countries (Knopp *et al*., 2008) including Kenya. Such infections impose an enormous public health burden in developing countries and are among the most widespread infectious agents that affect humans particularly in marginalized, low-income and resource constrained regions of the world (Lustigman *et al*., 2012, Wang *et al*., 2012). Globally, millions of people suffer from STH infections such as *Ascaris lumbricoides* 1.2 billion, *Trichuris trichiura* 795 million and hookworms 740 million (Nyarango *et al*., 2008). In preschool children, these STH infections are significantly associated with diarrhea (Stothard *et al*., 2008) and have been categorized under neglected infections of poverty (de Silva *et al*., 2011) whose infection is attributed to inadequate water supply or insufficient access to clean and safe water, poor sanitation (inadequate disposal of human feces and urine), increased population density, urbanization and poor health awareness (Montressor *et al*., 1998). Data from 2010 suggest that 2.6 billion people lacked access to improved sanitation (WHO/UNICEF, 2010). The risk of intestinal parasites is even higher among the inhabitants of urban areas of the developing countries especially in the shanties and slums where there is poor disposal of garbage, poor health systems and overcrowding (Koroma *et al*., 2010). It has been estimated that over one billion people practice open defecation, the vast majority (949 million) living in rural areas (WHO, 2002).

When there is open defecation and low maternal personal hygiene, such as handwashing, the risk of the children getting STH infection is high (Curtis *et al*., 1995). During the 20^{th} century, dramatic reductions in the prevalence of STH were brought about in the developed world following improved living standards and specific control programs (Lone *et al*., 2011).

These infections are currently sited under Neglected Tropical Diseases (NTDs) by the World Health Organization (WHO, 2002) because they are characterized by their high prevalence, chronic and disabling features (Njenga *et al*., 2011). The NTDs create social and financial burdens to an individual, the family, the community and the nation at large. The disparity between urban and rural populations in terms of access to safe and adequate sanitation is a persistent problem as formally planned urban areas have good infrastructure hence reaching the health centre for treatment is easier compared to rural areas with poor infrastructure which makes health centers inaccessible especially when it rains because the roads become muddy and impassable (GoK/UNICEF, 2009).

2.2 Lifecycle of Soil Transmitted Helminths

2.2.1 *Ascaris lumbricoides*

Man acquires infection through the ingestion of fertilized eggs found in contaminated food, water, or dirty hands. The eggs are digested by digestive juice in the small intestine to liberate the already hatched larvae (Mwinzi *et al*., 2012). This larvae enters the lungs where it matures and passes through the bronchial tree, reach the throat causing an irritation. When man coughs it up due to the irritation, the larvae are swallowed and re-enter the small intestine. Upon maturation, males and females copulate and the female lay fertilized eggs (they are able to lay 200,000 eggs per worm, per day) (Figure 5). When an infected person defecates in an open field; the eggs undergo environmental maturation in moist and warm soil hence becoming infective (Figure 5). When it rains, the infective eggs gain access to rivers, lakes, streams or are splashed to edible herbage or when contaminated soil is used as fertilizer by farmers, eggs stick to the hands of the individual. Poor personal hygiene such as not washing hands before eating, eating raw unwashed fruits and vegetables lead to man acquiring the infection (Arora *et al*., 2004)

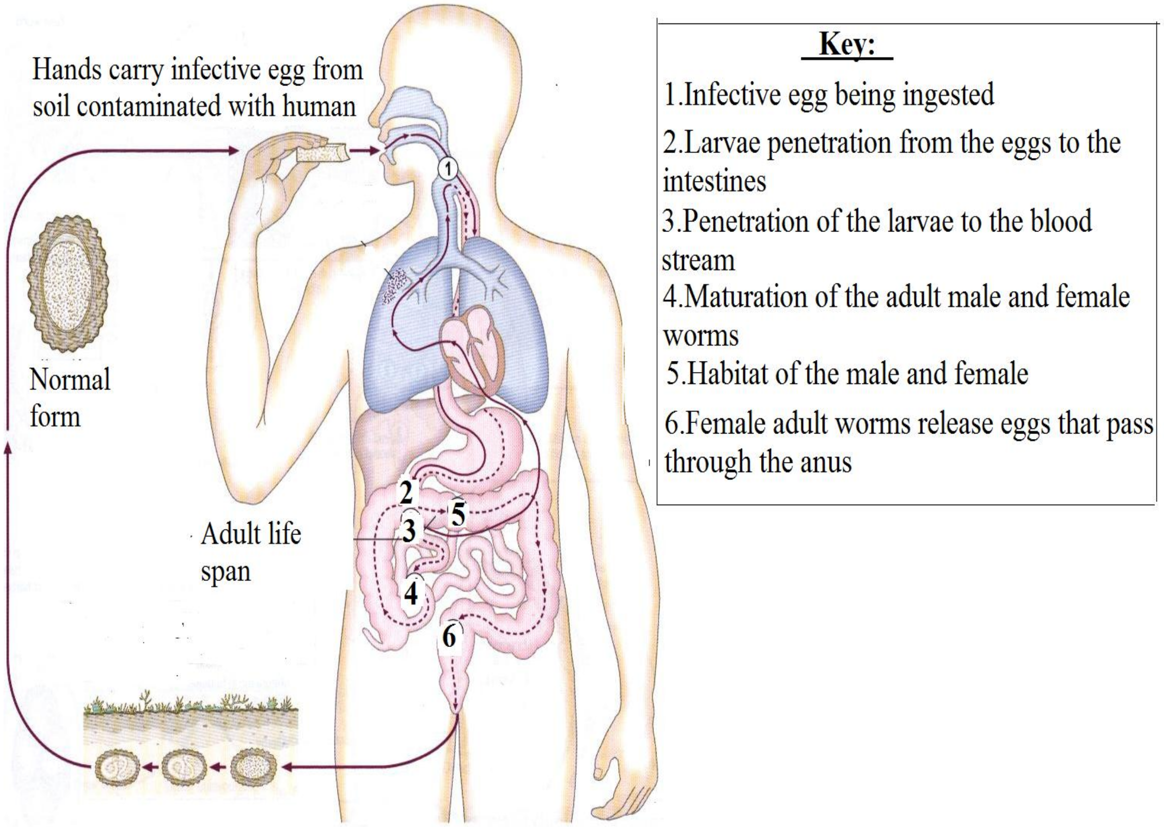

Figure 1: Lifecycle of *Ascaris lumbricoides, (*Source, Chiodini *et al*., 2004)

2.2.2 *Trichuris trichiura*

Man acquires infection through the ingestion of fully embryonated eggs from contaminated soil through contaminated fruits, food, water, vegetable or dirty hands. In the small intestine of man, infective eggs are hatched and then liberate the larvae which moult into adult worm both male and female and attach to mucosa of large intestine. Adults mature in about three months and female worm in about three months, they thus begin to produce 10,000 to 20,000 eggs per worm per day. If man passes out stool in an unsanitary manner, the eggs embryonate in soil, taking a duration of three to five weeks (Figure 6). These eggs require moist soil and shade to grow in order to become infective (Arora *et al*., 2004).

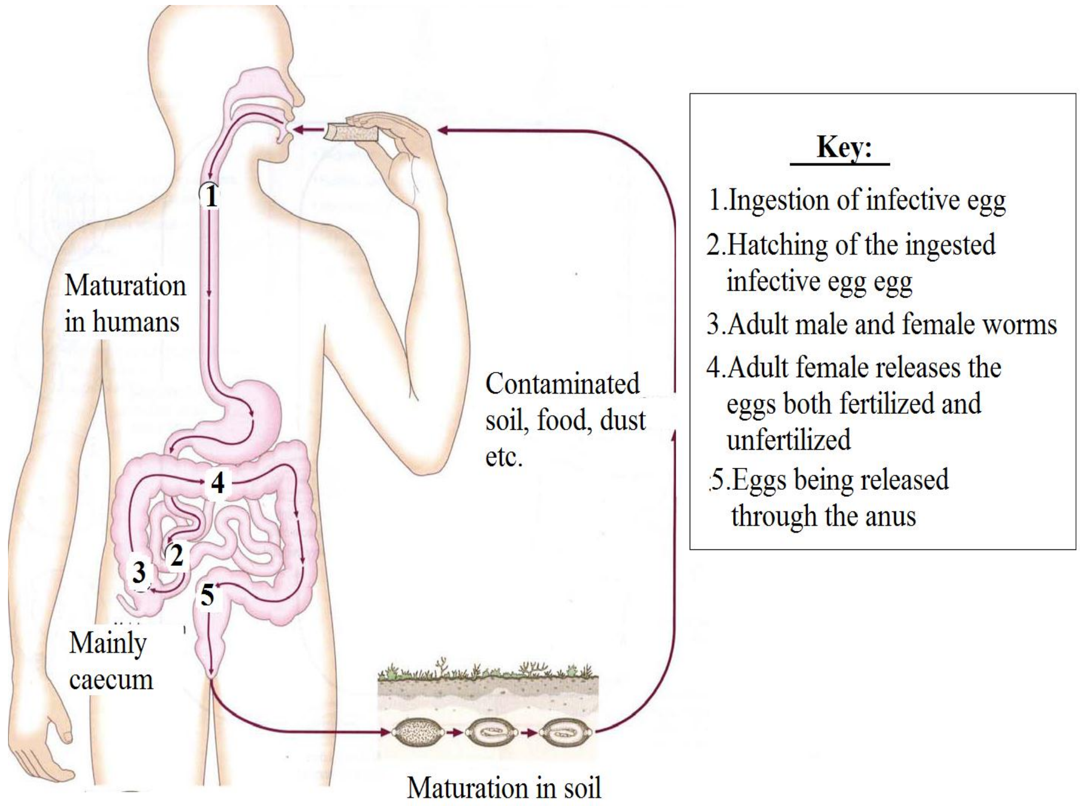

Figure 2: Lifecycle of *Trichuris trichiura* (Source, Chiodini *et al*., 2004)

2.2.3 Hookworms

Man acquires infection through walking barefooted in contaminated water or soil. The infective third-stage filariform larvae (L3) (Figure 7) actively penetrates the soft skin especially between toes, hands and arms, causing a ground itch that maybe pruritic and painful. The larvae then enters the bloodstream undergoes heart-lung migration. In the lungs the larvae moults once and matures growing in size, they then climb the bronchial tree and reach the trachea causing an irritation and are coughed up and swallowed. When they reach the stomach, they penetrate the intestinal wall and reach the small intestine where they mature into adult worms. These adult worms attach themselves onto the mucosal lining and feed on blood. The adult male and female worms then copulate and the female lay eggs that are passed in stool. If the eggs (Figure 7) are deposited onto the soil in the open environment, they develop into infective filariform larvae, which can then be transmitted through the bare feet of a new human host (Arora *et al*., 2004).

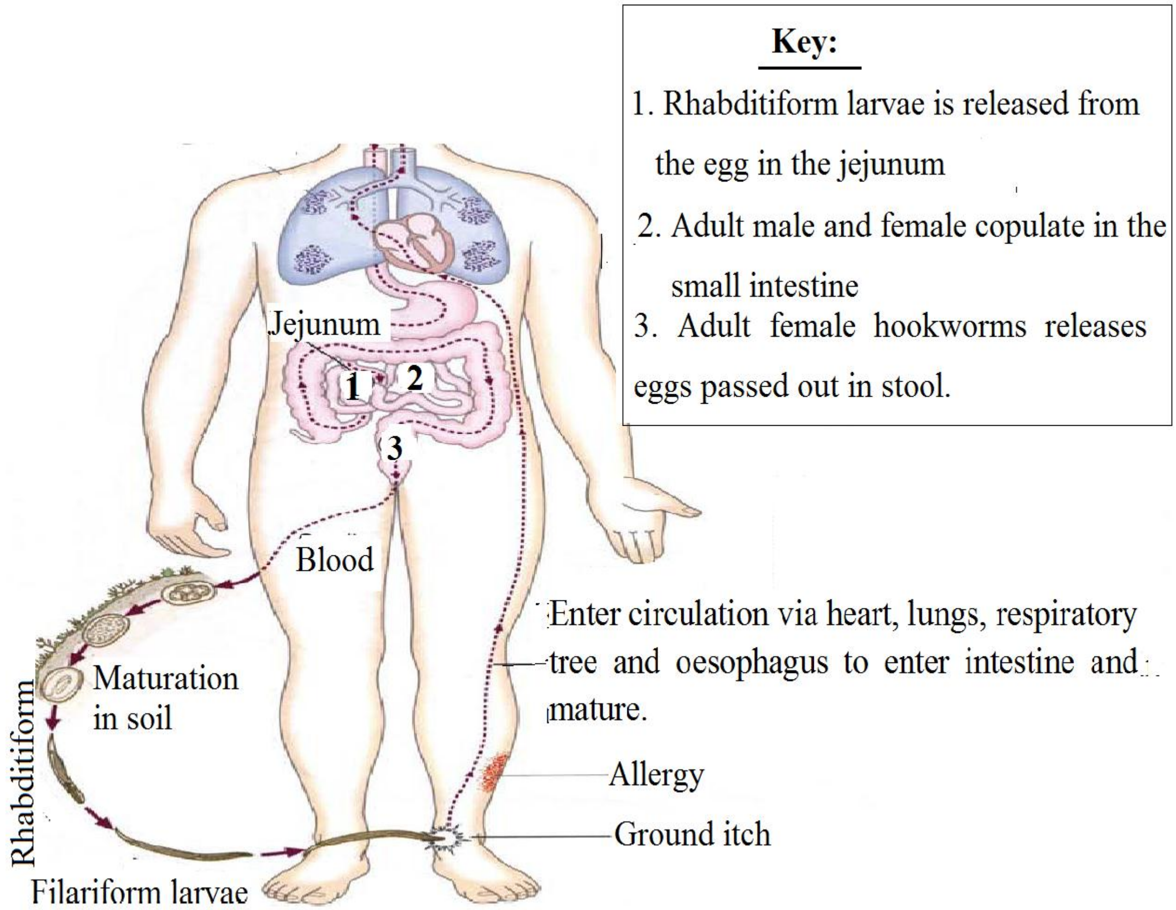

Figure 3: Lifecycle of hookworm, *Hookworm* and *Necator americanus*, (Source, Chiodini *et al*., 2004).

2.3 Transmission of STH

The fecal oral route is significant in the transmission of parasitic infections to humans via poor personal hygiene (Gungoren *et al*., 2007) environmental conditions such as the contamination of soil and water sources with human feces, and poor sewage disposal practices, such as disposal of waste on the home compound and use of night soil as fertilizer. Mothers/caregivers' occupation and places of defecation constitutes risk factors in the transmission of STH. When the soil becomes contaminated, the eggs in soil can be transferred onto vegetables and later either onto the hands or transferred directly into the mouth by ingested raw vegetables. Intestinal parasites have been found to adhere to vegetables, fruits, fingers, utensils, door handles and money (Curtis *et al*., 1995). Additionally, they can be transmitted through flies and contaminated fingernails (Nyarango *et al*., 2008).

2.4 Morbidity associated with soil transmitted helminths in risk children population

In young children, adult worms of *Ascaris lumbricoides* can accumulate in the ileum causing partial obstruction because the lumen is small. High intensity of adult *Ascaris lumbricoides* worms in the small intestine may cause abdominal distension, (Figure 2). The infected children experience pain, lactose intolerance as well as malabsorption of vitamin A. Absorption of other nutrients may also be impaired leading to poor nutritional and growth failure.

When the infective filariform larvae of hookworm penetrates the soft skin between toes, it causes an irritation on the penetrated skin area leading to pruritis that produces a 'ground itch', (Figure 3), an inflammation that leads to local intense itching, where the filariform larvae penetrated (Arora *et al*., 2004).

Hookworm infections cause massive production of eosinophilia. However, the major pathology of hookworm infection results from intestinal blood loss caused by the adult parasite and its invasion and attachment to the mucosa and submucosa of the small intestine and its voracious sucking of blood. In very high intensity, children suffer from severe protein deficiency; with dry skin and hair, oedema and delayed puberty (Wang *et al*., 2012). However, hookworm disease occurs when the blood loss exceeds the nutritional intake by the host, resulting in iron-deficiency anaemia. Infections caused by these helminths may elicit strong immune responses through effects on the immune system (Gerald *et al*., 1996, Curtis *et al*., 1995). Clinical manifestations show in STH infections of moderate and high intensity in the gastrointestinal tract especially in children harboring high intensity of *Ascaris lumbricoides* which cause fatal intestinal or appendix blockage, (Figure 4) (Lynne *et al*., 2007).

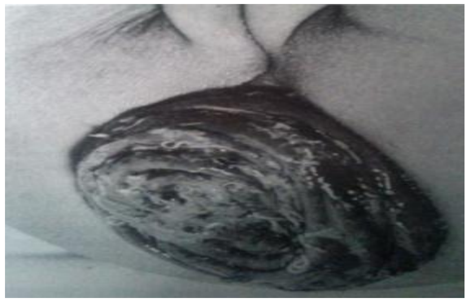

Figure 4: Rectal prolapse caused by *Trichuris trichiura* (Gerald *et al*., 1996).

Figure 5: Childhood abdominal distension caused by high intensity of *Ascaris lumbricoides* (Gerald *et al*., 1996).

Figure 6: 'Ground itch' caused by hookworm larvae during skin penetartion (Gerald *et al*., 1996**).**

Figure 7: Intestinal or appendix blockage caused by high intensity of *Ascaris lumbricoides* adult worms (Gerald *et al*., 1996).

2.5 Effects of STH in preschool children

Chronic and intense STH infections can contribute to malnutrition and iron deficiency anemia; this occurs when the hookworms attach to the intestinal mucosa and use their teeth or plate to prick the blood vessels. Hookworms suck approximately 0.3 mL of blood daily and releases an anti coagulating factor known as coagulase. This anticoagulant ensures there is continuity of blood flow (Arora *et al*., 2004) even when the worms are not sucking. Heavy intensity *Trichuris* and *Ascaris* infections have been known to influence nutritional status with *Ascaris lumbricoides* causing obstruction of bile passage that may cause billiary pancreatis, when the larvae are migrating through the lungs, they may cause a fever, dry cough, and wheezing, making the child and the caregivers health deteriorate (Brooker *et al*., 1999, Hotez *et al*., 2008). Previous studies have revealed that moderate to heavy infection with *Trichuris trichiura* could result in chronic dysentery commonly known as trichuris dysentery syndrome (TDS), inflammatory bowel disease, rectal prolapse, iron deficiency anemia, growth and mental impairment (Cooper *et al*., 1990). The World Health Organization defines health as being “not only the absence of disease and infirmity but also the presence of physical, mental, and social well-being”.

2.6 Infective stages of STH

Adult worms of STH survive for several years in the host (human) and produce large numbers of eggs while eggs can remain viable in the soil for several months. Eggs of *Ascaris lumbricoides Ascaris* eggs are extremely resistant to chemicals and are not killed by the ordinary disinfectants. The shells are impermeable and insoluble in many chemicals. This longetivity contributes to the success of the parasite. Due to this longetivity, it is thus impossible to prevent infections and reinfections when houseyards have been liberally seeded with eggs (Wang *et al*., 2012). Davaine kept human *Ascaris lumbricoides* eggs for five years and at the end of this time two-thirds of the eggs remained intact. The eggs were administered to a rat and 12 hours later living larvae were found in the intestine. He reported that human *Ascaris lumbricoides* eggs may remain alive for two and one-half years in the conducive environment. It is apparent that these eggs remain viable for a long time, from the above observations, it is evident that soil which is continually polluted with feces from man that are infected with *Ascaris lumbricoides* will in the course of time be heavily seeded with living *Ascaris* eggs. It is also apparent that soil will contain viable eggs for a long time without being freshly contaminated (Davaine *et al*., 2009). *Ascaris lumbricoides* and *Trichuris trichiura's* larvae can survive for several weeks depending on the prevailing environmental conditions. Contamination of food, water and hands therefore is the usual means of infection. Hookworm (*A. duodenale* and *N. americanus*) larvae can undergo hypobiosis (arrested development at a specific point in the nematode life cycle) in the human body under certain environmental conditions for several months.

2.7 Epidemiology of soil transmitted helminths

After pneumonia, diarrhea is the second leading cause of death in children below five years, (Walker *et al*., 2013). The global burden of STH infection has been estimated to as few as 3 million and as many as 50 million Disability Adjusted Life Year (DALY) uncertain but high, (Brooker *et al*., 1999). The WHO estimates that over 270 million preschool children and over 600 million school-age children living in areas where STH are frequently transmitted are in need of treatment and further preventive interventions, (Stothard *et al*., 2008). Kenya is a developing country with prospects of becoming a developed country thus; an important aspect of this vision is improving the quality of life of its people. Such efforts have been successful in most communities in the county but less successful among poorer classes in rural areas, (Ahmed *et al*., 2012).

2.8 Soil transmitted helminths prevalence in preschool children

An infectious disease review on South American indigenous populations found that STH prevalence in many indigenous groups and especially in young children was between 50 percent and 70 percent for *Ascaris lumbricoides* and hookworms (Jia *et al*., 2012). Other published studies record prevalence's above 90 percent in indigenous communities in the same region (Joe *et al*., 2013). Since this study was based on an indigenous setting, this finding maybe assumed possible for Marani community because they share similar setting.

Another study done by Egerton university indicated that the overall prevalence of STHs in preschool children within Elburgon municipality was 86%, while the most prevalent specific parasite species were *T. trichiura* and *A. lumbricoides* as evidenced by the mean egg counts (Mokua, 2015) although this study was done in an urban environment it also revealed that socio-economic factors (level of education, occupation) influenced the prevalence of STHs among preschool children in Elburgon Municipality. Thus from the foregoing, it's important to study the prevalence of STH infections to come up with data that can be used for appropriate action in Kenya for this community. In a study conducted in Rural Southwest China, it shows that 21.2 percent of preschool aged children and 22.9 percent of school aged children were infected with one or more of the three types of STH tested for in the study. In Kenya, a study carried out in Bungoma, Western Kenya estimated a minimum prevalence rate of 68 percent (Riesel *et al*., 2010).

2.9 Poor standards of hygiene that exacerbate soil transmitted helminths

The latrines available in most rural homes have not been designed for use of, and may not be used by, small children because they may be afraid to use them for the risk of falling in, bad odor or the fear of dark spaces (Curtis *et al*., 1995). Because nappies, potties and washing machines unavailable in many poor settings, defecation on the floor is common and potentially seen as the most practical option. From the aforementioned, latrine use by children is thus low, as was shown by a study in Lima, Peru, where less than 25% of under five-year-olds used a toilet (Curtis *et al*., 1995). Systematic reviews have shown a much higher prevalence of diarrhea and higher egg counts for STH in children therefore, child stool often poses a greater health risk than those of adults (Crompton *et al*., 2010). To date, safe disposal of children's stools has received relatively little attention in sanitation programs especially in the rural areas.

2.9.1 Water Safety and its association with soil transmitted helminths

Lack of access to safe water remains a significant risk factor for poor health in developing countries. Over 780 million people now lack access to an 'improved' water source, recent studies have shown that the number of people who rely on microbiologically or chemically unsafe water is overwhelming and majority are found in the rural communities of developing countries (WHO and UNICEF, 2010). Universal access to improved sanitation could reduce diarrhea-related morbidity in preschool children by more than a third; indeed, UNICEF estimates that there will be 124,000 fewer child deaths in sub-Saharan Africa in 2015 if the Millennium Development Goal (MDG) targets on water and sanitation are met. According to WHO, improved water sources include piped water, rainwater, protected springs and protected wells, which are thought to be less likely to be contaminated with pathogens. Provision of safe, reliable, piped-in water to every household is a necessity that may have positive health gain (Halpenny *et al*., 2013) while contributing to the MDG targets for poverty reduction, nutrition, childhood survival and enhanced human dignity.

So as to improve the quality of lives of people in Kenya, efforts such as integration of control strategy consisting of preventive chemotherapy combined with health education and environmental sanitation is needed to interrupt transmission of STH (Jia *et al*., 2012). This intervention is necessary especially to caregivers and children below the ages of five. This is also in accordance with the achievement of Millennium Development Goals (MDG) 4 and 5 of reducing child mortality and improving maternal health respectively (Fenwick *et al*., 2005).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study location

This study was conducted in Marani subcounty in Kisii County, (Figure 8) which is located in former Nyanza province, Kenya, a highland at an altitude of 1660 m above sea level. It receives average rainfall of 1500 mm per annum that is distributed almost throughout the year although there are two rainy seasons (March to May and October to November). The county is densely populated with a population of 37,531 people and a density of 1295 people/km^2. Marani subcounty is located in Kisii county and covers approximately 3873km^2. Temperatures range from 10°C to 30°C with relative humidity of 88% (CBS/GoK, 1999). The Latitude and Longitude of Marani Subcounty is -5766721 and 34.7947915 respectively (CBS/GoK, 1999). The soils around the homes in Kisii are mostly damp and warm, providing ideal conditions for development of helminths.

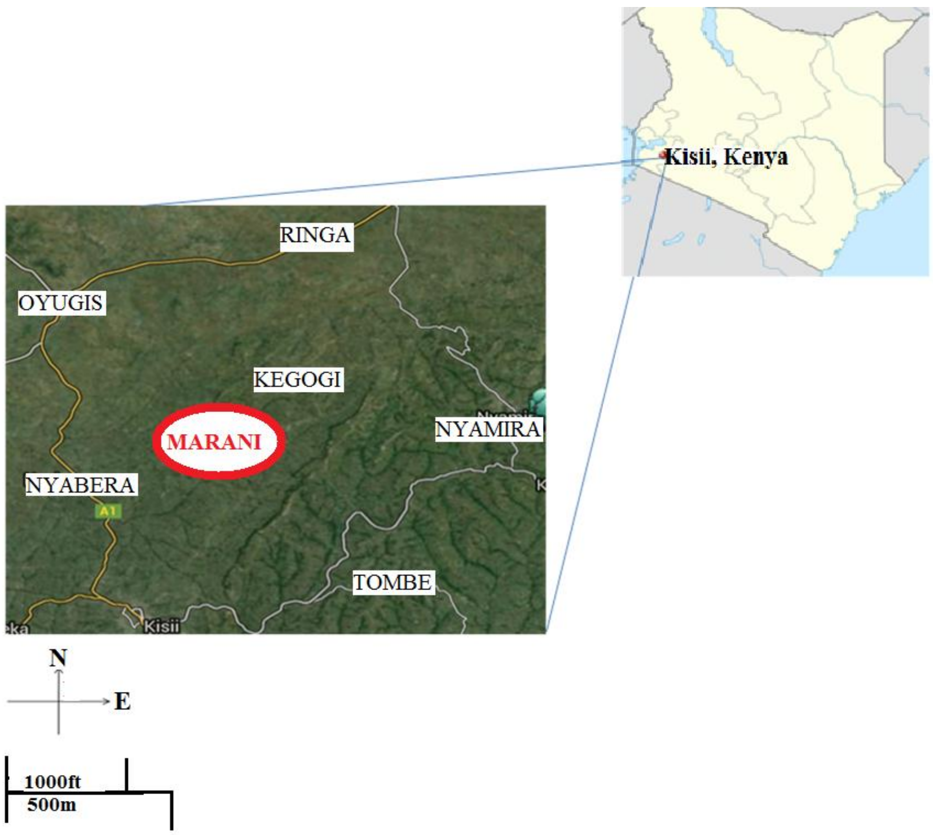

Figure 8: Map of Kenya, inset, Kisii County showing Marani area, (Source, Google maps, 2014)

3.2 Study Design

This study involved administration of structured questionnaire, collection of stool samples and laboratory analysis. To establish the factors influencing the prevalence of soil transmitted helminths amongst preschool children of Marani subcounty a questionnaire were administered to the household parents/caretakers. The questionnaires were formulated into three categories, for parents (Appendix 2), clinicians (Appendix 3) and nongovernmental organizations that targeted treatment of preschool children in their mandate (Appendix 4). Parents were interviewed in their household settings and were required to fill in a pre-tested questionnaire for their family background and socioeconomic information. The questions were designed to generate information about age, sex, parents educational and employment status, source of drinking water, presence of toilet facilities as well knowledge about worms and personal hygiene practices. The questionnaire helped in determining household and individual risk factors that influence soil transmitted helminths infection dynamics in preschool children aged 0-5 years and to establish the effect of water, sanitation and hygiene on soil transmitted helminths infection in rural Marani community.

3.3 Study population

Children who were below the ages of five and had not yet begun attending any public primary school were involved in this study. During recruitment, children born and brought up in the villages of Marani and had lived there for the past one year were eligible. Additionally, those who had not been dewormed for the past three months prior to this study and whose parents gave their consent willingly in writing were recruited.

3.4 Determination of the sample population

The sample population size was calculated using Fisher's sample size (Fisher *et al*., 1993) p = (68%) (Obala *et al*., 2013) as shown below.

$$n = \frac{Z^2 \text{ x } P\,(1-P)}{d^2}$$

Where:

n: required sample size = from population.

P: estimated prevalence of soil transmitted helminths on preschool children

z : 95% confidence interval, standard value

d^2: Level of Precision at 5%, standard value =0.05

$$n = \frac{(1.96)^2 \times 0.68\,(1-0.68)}{(0.05)^2} = 333$$

Calculated sample size n = 333

To account for refusals/inability to produce stool specimen when required, the sample size was decreased by 50% and arrived at a minimum sample of size 167.

3.5 Objective 1: Determination of the prevalence rates of soil transmitted helminths

3.5.1 Fecal sample collection

Consent was sought from the parents who were required to accept through signing, thereafter; a polypot container for stool collection was given to them. Instructions of stool collection were given to the parents. Only one stool sample was submitted per participant. A total of 106 stool samples were collected from the preschool children. The stools were stored in the Miniparasep kit and placed in a cool box at 4ºC then transported to the Microbiology –Hub, Kericho for analysis.

3.5.2 Direct method of fecal analysis

This is a diagnostic test that is able to detect the adult worm and eggs of hookworms. The fixed stool held in the MiniParasep kit was centrifuged at 1500rpm for 2mins and the supernatant poured off. The sediment was resuspended using an applicator stick, using a drop pipette, a drop of sediment was transferred to clean glass slide containing a drop of saline or 1% lugols iodine. This sample was briefly mixed then cover slipped and examined under both power ×10 and ×40 objective lenses microscopically. For quality control, every lot of the MiniParasep was examined for any breakage or contamination before use.

3.5.3 MiniParasep technique of fecal analysis

This is a concentration technique that uses 3ml formain and trixton X as preservatives in a kit. This technique allows for the quantification and identification of helminths eggs. A pea size stool sample was put in the kit and mixed to form a homogeneous solution. After 24hours, this kit was then centrifuged at 1500 r.p.m for two minutes, supernatant poured off and sediment resuspended (MHK-PAR 2012). A drop of the sediment was put in a glass slide; cover slipped and examined under both ×10 and ×40 objective lenses microscopically for quantification of helminths egg. All slides were read independently by different laboratory technologists at the Walter Reed Microbiology Hub-Kericho. When any inconsistent detection occurred, the discordant slides were re-examined and the results discussed until an agreement was reached.

3.6 Objective 2: Predisposing risk factors influencing the prevalence rates of STH

3.6.1 Questionnaire

Questionnaires were used to collect measurable variables such as parents education level, type of water treatment, availability of deworming programmes, sources of water and type of toilet from the parents/caregivers before any child was enrolled into the study.

3.7 Objective 3: Formulation of recommendations and policies

This was done after data analysis of results by extensive literature review of government policies.

3.8 Data analysis and presentation

Data for this study was initially entered in Microsoft excel spreadsheet (2007) and later imported to SPSS software (SPSS version 16.0) chi-square for statistical analysis. Data generated for objective one included variables such as age, co-infection and prevalence were presented in tables and a bar graph. Variables for objective two based on the questionnaire data that included sex of the children, sources of water and parent’s level of education were analyzed and presented in tables. When significant values were found of p-value that was less than 0.05 using chi square on SPSS, it was considered statistically significant while a p-value of greater than 0.05 was considered statistically insignificant.

CHAPTER FOUR
RESULTS

4.1 Objective 1. Prevalence of helminth infection among Marani preschool children (Aged 0-5years)

4.1.1 Overall prevalence of STHs among children in the study area

This study was undertaken to determine the prevalence of intestinal helminth infection among the preschool children (below the ages of five) in Marani subcounty. Out of a total of 106 preschool children enrolled for this study, 35.80% were positive for either *Ascaris lumbricoides*, *Trichuris trichiura* or hookworm mono infections see (Figure 9).

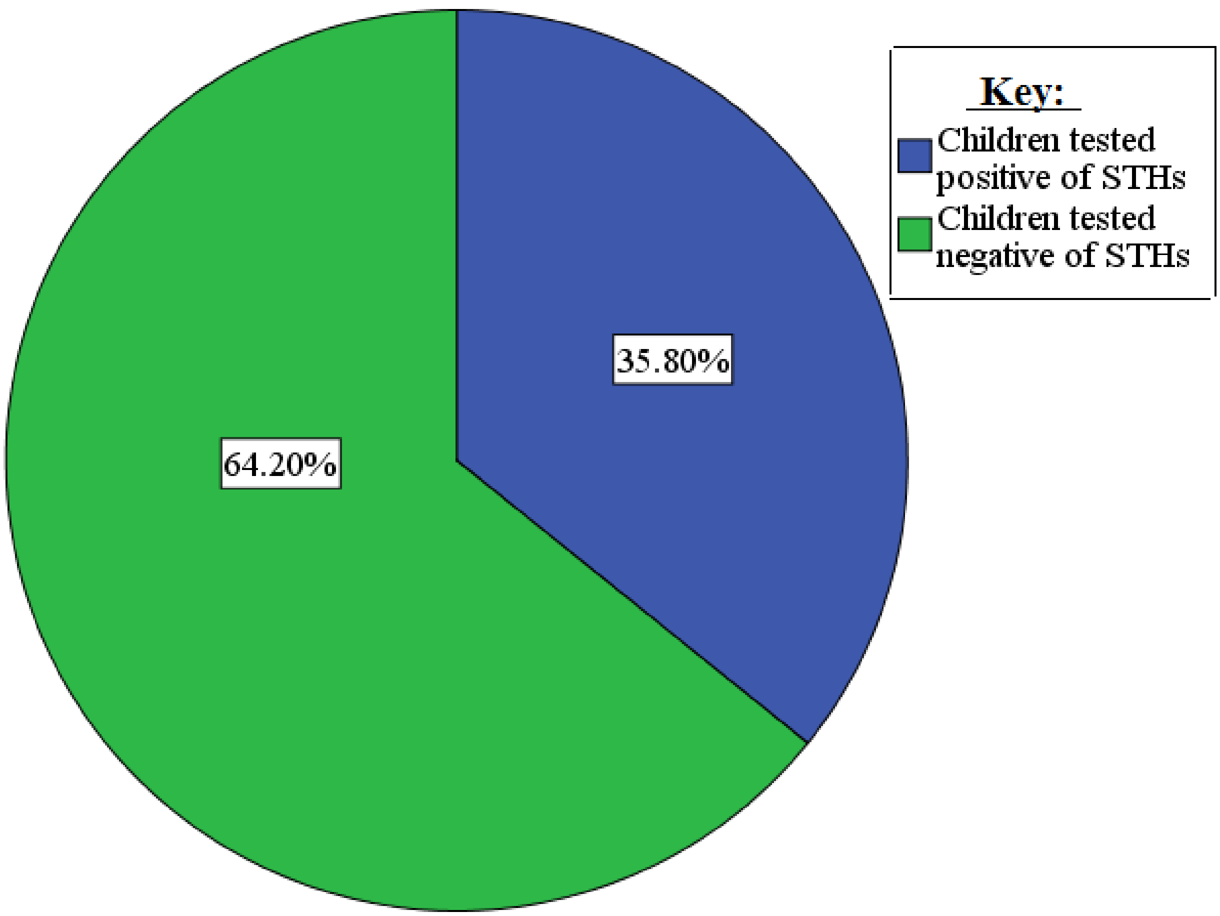

Figure 9: Overall prevalence of STHs among preschool children in Marani subcounty

4.1.2 Parasite species specific prevalence rates

Infection with *Ascaris lumbricoides* had a predominant prevalence of 19.8% among preschool age children in Marani subcounty followed by hookworm infection with a prevalence rate of 7.8% and the least prevalent worm species was *Trichuris trichiura* (2.8%), (Figure 10).

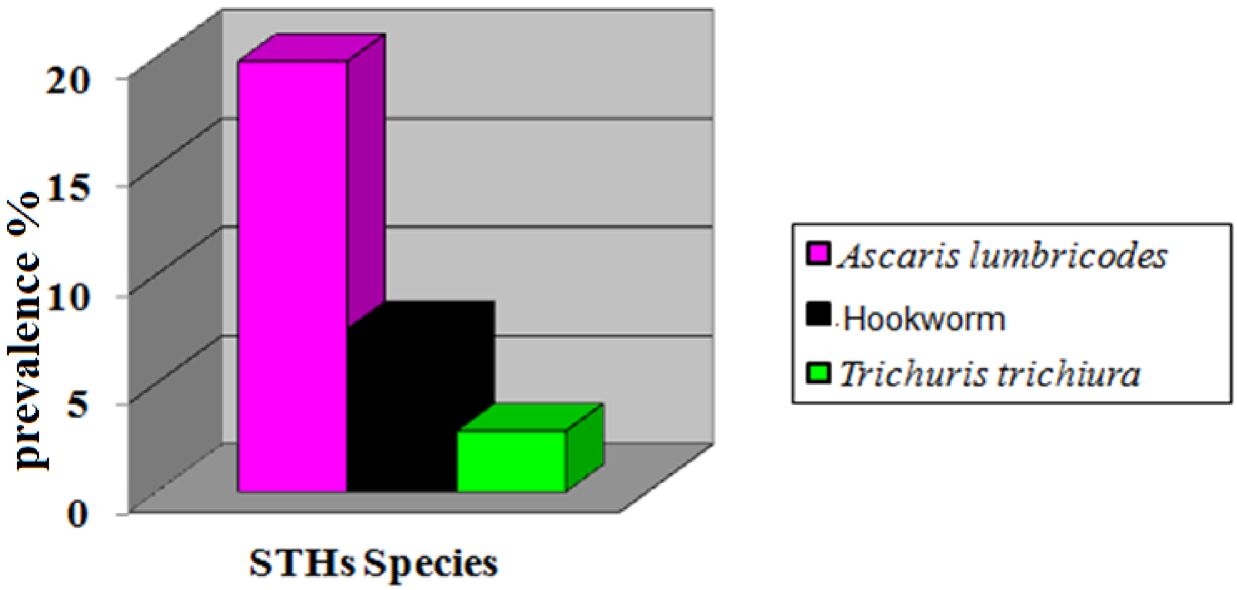

Figure 10: Prevalence of mono parasite infection in 106 preschool children

4.2 Objective 2. Predisposing risk factor influencing the prevalence rates of STH

4.2.1 Soil transmitted helminths distribution as categorized by sex

There was a higher mono species and co-infection prevalence in males than in females (Table 1). Out of 106 preschool children there were 51 females and 55 males. Even though the variation between male and female was statistically insignificant p = 0.607, more male 24 (43.6%) preschool children were infected than the female 14 (27.5%) (Table 1).

Table 1: Prevalence (%) of soil transmitted helminths as categorized by the sex of preschool children from Marani (N=106, Females=51, Males=55).

	Sex	
	Female	**Male**
Children with no infection	72.5	56.4
Ascaris lumbricodes	15.7	23.6
Trichuris trichiura	2.0	3.6
Hookworm	5.9	9.1
Ascaris lumbricoides/ Trichuris trichiura	3.9	5.5
Ascaris lumbricoides/ hookworm	0.0	1.8

4.2.2 STH distribution in preschool children according to parents levels of education

Prevalence of soil transmitted helminths in Marani subcounty had varied results with level of education of parents. Table 2 shows the prevalence of helminth infection tended to decrease with increasing education standards amongst parents, from none educated parents to parents who had post secondary education giving a statistical significance of $p = 0.002$. *Ascaris lumbricoides* had a high prevalence in preschool children fron none educated parents 6(33.3%) while in preschool children from parents who had post secondary education the prevalence was 1(5.3%).

Table 2: Prevalence (%) as categorized by the level of education of the preschool children's parents (N=106: No education n=18, primary n=33, secondary n=36, post secondary n=19)

		Levels of education			
		None	Primary	Secondary	Post secondary
Helminth	Children with no infection	27.8	57.6	72.2	94.7
	Ascaris lumbricodes	33.3	18.2	22.2	5.3
	Trichuris trichiura	0.0	9.1	0.0	0.0
	Hookworm	27.8	6.1	2.8	0.0
	Ascaris lumbricoides/ Trichuris trichiura	11.1	6.1	2.8	0.0
	Ascaris lumbricoides/ hookworm	0.0	3.0	0.0	0.0

4.2.3 Relationship between prevalence of soil transmitted helminths and source of domestic water

Most families in Marani used river and rain water concurrently 37(34.9%). Few children depended on rain water as a single source of water 13(12.2%) (Table 3). Table 3 indicates that statistically, the sources of water did not impact significantly p = 0.965 on the prevalence of STH. However, those who used water from well alone and combination of well/rain had the highest prevalence rate of 25% followed by users of river water 22%. Only (7.7%) preschool children using rain water as single source water were affected. *Ascaris lumbricoides* had a high prevalence rate among well users as compared to hookworm which was not isolated among any well user. Co-infection of *Ascaris lumbricoides* and *Trichuris trichiura* soil transmitted helminths was the most prevalent among the well users (6.3%).

Table 3: STH distribution in various sources of water. (Prevalence % Rain users n=13, River users n=36, Well users n=16, River/Rain users n=37 and Rain/Well users n=4)

		Source of water				
		Rain	**River**	**Well**	**River /rain**	**Rain /well**
Helminth isolated	Children with no infection	84.6	58.3	68.8	62.2	50.0
	Ascaris lumbricodes	7.7	22.2	25.0	18.9	25.0
	Trichuris trichiura	0.0	2.8	0.0	5.4	0.0
	Hookworm	7.7	8.3	0.0	8.1	25.0
	Ascaris lumbricoides/Trichuris trichiura	0.0	5.6	6.3	5.4	0.0
	Ascaris lumbricoides/ hookworm	0.0	2.8	0.0	0.0	0.0

4.2.4 Relationship between water treatment and prevalence of soil transmitted helminths

In the study area, domestic water treatment had varied effects on STHs prevalence among preschool children. Table 4 indicates that water treatment method did not significantly (p = 0.278) influence helminth isolation. Although *Ascaris lumbricoides* was highly prevalent in preschool children who used untreated water (23.8%), it was also prevalent in preschool children who boiled their water (22.2%).

Table 4: Relationship between helminth prevalence (%) and water treatment method (N=106: No treatment n=63, chemical users n=25, boiled water users n=18)

		Water treatment		
		None	**Chemicals**	**Boil**
Helminth isolated	Children with no infection	60.3	80.0	55.6
	Ascaris lumbricodes	23.8	8.0	22.2
	Trichuris trichiura	4.8	0.0	0.0
	Hookworm	6.3	8.0	11.1
	Ascaris lumbricoides/Trichuris trichiura	4.8	0.0	11.1
	Ascaris lumbricoides/ hookworm	0.0	4.0	0.0

4.2.5 The relationship between use of toilet and prevalence of soil transmitted helminths

Toilet and prevalence of soil transmitted helminths is shown in Table 5, indicating that the type of toilet does not significantly (p = 0.896) influence helminth prevalence. However, hookworm had a higher prevalence when the preschool children used the environment (28.6%) compared to with pit latrine users with a prevalence of *Ascaris lumbricoides* (22.7%), the highest amongst mono species infection. Out of the 66(36.4%) preschool children who used pit latrine 36.4% were infected with soil transmitted helminthes.

Table 5: Relationship between the type of toilet and prevalence of soil transmitted helminthes (N=106: pit latrine users n=66, environment users n=5, pit latrine/ environment users n=22, flush toilet users n=5, pit latrine/flush toilet users n=8)

		Type of toilet				
		Pit latrine	Enviro nment	Pit latrine/ environment	Flush toilet	Pit latrine/flush toilet
Helminth isolated	Children with no infection	63.6	80.0	68.1	80.0	75.0
	Ascaris lumbricodes	22.7	20.0	18.1	20.0	12.5
	Trichuris trichiura	3.0	0.0	0.0	0.0	0.0
	Hookworm	6.1	0.0	4.5	0.0	12.5
	Ascaris lumbricoides/Trichuris trichiura	3.0	0.0	9.0	0.0	0.0
	Ascaris lumbricoides/ hookworm	1.5	0.0	0.0	0.0	0.0

4.2.6 Effects of previous deworming on soil transmitted helminthes

Previously dewormed preschool children did not significantly (p = 0.341) influence helminth isolation (Table 6). Out of the 106 sampled preschool children 76(71.6%) did not have a history of being dewormed. In this group, *Ascaris lumbricodes* showed a prevalence of (14.5%) as compared to those who had been dewormed the past three months. Preschool children dewormed in less than three months had no helminth infection but after six months of deworming, the prevalence increased to 22.2% and the children who had been dewormed one year ago had the highest prevalence rate of 42.1%.

Table 6: Relationship between helminth prevalence and previous dewormed status (N=106, never dewormed n=76, dewormed past 3months n=2, dewormed past 6months n=9, dewormed past 12 months n=19)

		Previous dewormed status			
		Never	**3months**	**6months**	**12months**
Helminth isolated	Children with no infection	69.7	100.0	77.8	31.6
	Ascaris lumbricodes	14.5	0.0	22.2	42.1
	Trichuris trichiura	3.9	0.0	0.0	0.0
	Hookworm	6.6	0.0	0.0	15.8
	Ascaris lumbricoides/Trichuris trichiura	3.9	0.0	0.0	10.5
	Ascaris lumbricoides/ hookworm	1.3	0.0	0.0	0.0

CHAPTER FIVE
DISCUSSION

5.1 Discussion

This study was undertaken to determine the prevalence of soil transmitted helminths among preschool children from Marani subcounty, Kisii County, Kenya. The prevalence of STHs in Marani subcounty area among preschool children below the ages of five was moderate with (35.8%) children having an infection with one or more helminths. Three species of soil transmitted helminths were identified from the stool samples of the preschool children that were included in this study namely, *Ascaris lumbricoides, Trichuris trichiura* and hookworm. Of these, *Ascaris lumbricoides* had dominance in frequency (19.8%) followed by hookworm (7.5%) and *Trichuris trichiura* which was detected with least frequency (2.8%). This trend agrees with the results of (Smith *et al.*, 2001) who found the same trend in soil contaminated with fecal sample as compared to stool sample. This infection pattern suggests that the spread of infection of these worms is entirely through fecal pollution in soil. Studies elsewhere have documented varied prevalence of STHs infection in the same age group. A recent study done in Nairobi, Kibera slums, Kenya, reported a slightly higher prevalence of 40.7% infection with any of the three common STHs (Davis *et al*., 2014). These results suggest that STHs in the study area pose significant public health challenge.

Infective stages of these STHs can remain viable in the soil for several months. Eggs of *Ascaris lumbricoides* are extremely resistant to chemicals and are not killed by the ordinary disinfectants. The shells are impermeable and insoluble in many chemicals. This longetivity contributes to the success of the parasite and because of this longetivity, it is thus impossible to prevent infections and reinfections when houseyards have been liberally seeded with eggs (Wang *et al*., 2012). This longetivity and survival of these eggs contribute to its high prevalence. The World Health Organization recommends treatment of STHs when the prevalence is above 10% in a given target population (WHO 2012).

Findings from this study showed that there was varied prevalence across parasite species. Among the three helminths, *Ascaris lumbricoides* was the most dominant followed by *Trichuris trichiura* and hookworms respectively. These findings are consistent with different studies undertaken in Nigerian in the same age group in different years (Bethony *et al*., 2006; Nmorsi *et al*., 2009 and

Chijioke, 2011). These studies documented that *Ascaris lumbricoides* was the most prevalent among common STHs infecting preschool children. In addition, studies elsewhere and STHs prevalence reports from endemic countries indicate that ascariasis is more prevalent as compared to other helminths (Hotez *et al*., 2008, de Silva *et al*., 2011). Studies conducted by (Albonico *et al*., 2008) for the same age group across endemic countries reveals that, *Ascaris lumbricoides* is undisputedly the most dominant infection with the highest prevalence ranging from as low as 3% (in Phillipines rural area) to as high as 88% in Madagascar. *Ascaris lumbricoides* prevalence among preschool school children was 20% in Kenya (Albonico *et al*., 2008). The high prevalence of *Ascaris lumbricoides* among preschool children and its dominant trend across endemic countries suggests that it is the most common helminthiases infecting humans of all age groups. The health implication includes malnutrition and iron deficiency anemia; this occurs when the hookworms attach to the intestinal mucosa and use their teeth or plate to suck blood. Hookworms suck approximately 0.3mL daily and release anti coagulating factor; coagulase, which guarantees continuous blood flow (Arora *et al*., 2004). Heavy intensity *Trichuris trichiura* and *Ascaris lumbricoides* infections have been known to influence nutritional status with *Ascaris lumbricoides* causing obstruction of bile passage that may cause billiary pancreatis, Previous studies have revealed that moderate to heavy infection with *Trichuris trichiura* could result in chronic dysentery commonly known as trichuris dysentery syndrome (TDS), inflammatory bowel disease and rectal prolapse (Brooker *et al*., 1999, Hotez *et al*., 2008).

A study from a Southern Ethiopia village by (Nyantekyi *et al*., 2010) found that *Trichuris trichiura* was the most prevalent (82.9%) helminth among children below five years of age. In the same country but in a different state called Wondo Genet found out a slightly different result where hookworms were more prevalent followed by *Ascaris lumbricoides* and *Trichuris trichiura* (Houmsou *et al*., 2003). A study in Brazil in a rural community reported as high as 68.2% of Hookworm infection as compared to *Ascaris lumbricoides* (Fleming *et al*., 2006). In addition, the published studies by (Albonico *et al*., 2008) established that hookworm infection in Thika, Kenya has an average prevalence of 29% as compared to *Ascaris lumbricoides* (20%) and *Trichuris trichiura* (15%). From these studies, the noted comparative differences from many STHs specific parasite prevalence suggest that the surveys were done under different environmental conditions. From Ethiopia, STHs prevalence surveys among preschool children suggest that data was collected during the wet season and most of the sampled children walked barefoot thus had increased risk of the infection with hookworm. Results from Kenyan studies quoted above suggest that majority of preschool children live in rural farming areas where children accompany their parents to the farm (Riesel *et al*., 2010; Fleming *et al*., 2006). Most of the activities in farms involve interaction with soil, in addition there is a likelihood of open defecation, which increases the helminths ova in the environment hence increasing the risk for children who accompany their parents to the farm. Soil transmitted helminths occur in many tropical countries and the infection has most often been considered occupational (Giles 1997). Although Marani subcounty as the study area of this research is a purely rural area, hookworm was not a dominant parasite suggesting that there exist variations of STHs parasite specific prevalence in endemic areas justifying why the prevalence of STH is used to make treatment decisions as compared to the prevalence of one of the parasites. All the STH will be common in rural areas where the risk factors are common. The prevalence of one over the other might not be clear (Fleming *et al*., 2006).

Mixed infections of *Ascaris lumbricoides* and *Trichuris trichiura* and had a higher prevalence than mixed infections with *Ascaris lumbricoides* and hookworm. Although with a lower prevalence rate of double infection (4.7%), these results show the same trend with several studies elsewhere that have reported combination prevalence of intestinal helminths infection in school going and non school going children. A cross-sectional survey study documenting specifically *Ascaris lumbricoides* and *Trichuris trichiura* prevalence among children aged 2-12 years in Honduras community, Central America, reported a mixed infection of 25.8% of stool sampled, (Smith *et al*., 2001). Similar results to Honduras community done in Malaysia indicate that mixed infection by two helminths *Ascaris lumbricoides* and *Trichuris trichiuria* was also high 25.43% among urban and (22.18%) among rural children, (Ahmed *et al*., 2011).These two helminths have a similar mode of infection and slightly the same ova survival in soil, (Chiodini *et al*., 2004). Therefore, double infection in one individual is expected especially in areas where their prevalence dominates. The common double STHs prevalence suggests that this occurrence is a norm, especially in endemic areas where Kenya is a representative, (Mwandawiro *et al*., 2011).

The result from this study showed that male preschool children had slightly higher infection rate with either single or combined helminths infection than female children. These results concur with a study by (Obala *et al*., 2013), which found a similar trend in Webuye, Kenya. In addition, a study in Sudan also found that gender did not influence the likelihood of infection with helminths but found a higher infection rate with *Trichuris trichiura* among male children. Another study done in Nigeria reported male children had higher infection especially with *Ascaris lumbricoides* than the female children during an epidemiological study of gastrointestinal helminths among pupils in urban and sub-urban communities (Kirwan *et al*., 2009). A study in Babile town, Eastern Ethiopia documented an overall higher prevalence of 9 species of intestinal helminths among males (28.8%) as compared to females (24.4%), (Davis, 2014). The observation of high prevalence of STHs among male as compared to females suggest that they are more often engaged in predisposing activities such as football, barefoot playing and also playing in streams or ponds as compared to female (Shrestha, 2001). Male children have more outdoor activities than girls hence the reasons for having a higher risk of helminths infections. Rural villages have high division of labor and gender roles separate between boys and girls and this trend has always been a significant reason for high helminths prevalence in the male gender (Knopp *et al*., 2008). Merhraj and colleagues have proposed that the general morbidity impact of intestinal helminths has significant devastating impact on male children than female children (Mehraj, *et al*., 2008).

In the current study, higher prevalence of combined *Ascaris lumbricoides* and hookworm infection was reported from children who frequently used open defecation. The results concur with studies elsewhere that have documented positive association between open defecation and preventable diseases such as diarrhea and intestinal helminths (Smith *et al*., 2001; Fleming *et al*., 2006). A study conducted in sub-Sahara Africa comparing 31 cities on the variable of improved sanitation indicated that, open defection is the worst form of sanitation and its reduction has a significant impact on the general health of the population (Hopewell and Graham, 2014). Although there are limited data about direct association of open defecation and soil transmitted helminths prevalence, creating separate MDG for reducing open defecation across United Nations member countries reveals the challenge with this form of raw sewage disposal (WRC K5/2379, 2014). Demonstrating the challenge of open defecation is received a significant attention when the United Nations office launched new campaign on 28 May, 2014 to end the practice this practice (UN, 2014). This campaign, which will involve worldwide improved access to toilets and latrines, is expected to eliminate environmental faecal contamination for the period 2015-2030 with approximately 2.5 billion people targeted (UN, 2014). Soil transmitted helminths have been associated with resources poor countries explaining poor sanitation in living environment. Furthermore, persistence with open defection in resource poor countries is associated with the high cost of maintaining an efficient sewage system (Hopewell and Graham, 2014). Hypotheses that relate sanitation with local financial resources that support infrastructure development to improve resident's living standards have been proposed. Therefore, the poor infrastructure in living areas such as poor sewerage system and effective use to toilets have been associated with soil transmitted helminths infections (Olsen, 2003).

Poor sanitary disposal of human feces and indiscriminate defecation are the principal factors in the aetiology of soil transmitted helminths especially hookworm infections. It has been reported places of defecation can increase risk factors in the transmission of soil transmitted helminths (Nguyen *et al.,* 2006). In Marani subcounty, STH infection was highest among preschool children who used pit latrine and environment as their place of defecation, as compared to those who used flush toilets. These results agree with the reports of (Anosike *et al.,* 2006) who noted in Nigerian rural homes that children preferred bushes because the pit latrines were far from their homesteads. In the same country, studies associating intestinal helminths with open defecation report hookworm as the dominant parasite. Additionally, hookworm has been highly associated with farming occupation suggesting that prevalence with hookworm has a defined trend and risk factors (Hopewell and Graham, 2014). A defined infection trend with regard to predisposing factors suggests that open defecation was popular because either the toilets were far or not available in the compound. Use of flush toilets has been reported as an improved means of fecal disposal and environmental hygiene as compared to pit latrines and open defecation because it has a controlled sewerage system but these sanitary strategies are not available in rural villages. Nevertheless, the concept of controlled sewage system is costly and is not always considered in resources poor settings such as Marani.

In this study children who were never dewormed had a higher infection rate of STH than those who had been dewormed but had stayed for twelve months or more without deworming also had a high infection rate. Similar studies that try to investigate the prevalence of post STHs prevalence in a given location report significant improvement and reduction of overall STHs prevalence with treatment (Abera *et al*., 2004; Ngonjo *et al*., 2012). (Gelaw *et al*., 2013) reported a significant decrease to the infection rate these helminths after being treated with anthelminthic drugs. According to a survey done by (Ngonjo *et al*., 2012) there was a reduction rate of most STH infection especially *Trichuris trichiura* after administration of anthelminthic therapy. This result suggests that anthelminthic treatment with STHs is effective in a period below one year. The World Health Organization (WHO) recommends that effective control of STHs should include periodic deworming and recommends treatment after every six months in high transmission areas (WHO, 2012). Control of STHs is generally associated with low prevalence although these infections are never eliminated in endemic areas. During treatment, a few population who harbor these helminths, who miss treatment and who in a way introduce the helminth ova in soil are the main source of reintroducing STHs infection in an otherwise treated community.

In the rural Marani subcounty, most families have no access to clean and safe water for drinking. This study sought to find out the type of water used in relation to infection rates with STH in a questionnaire where most families used river and rain water followed by well.

Preschool children who drank water from the river had a high infection rate (41.7%) followed by river/rain water (37.8%). The least infected preschool children used rain water (15.4%). Prevalence was high with *Ascaris lumbricoides* which was detected regardless of the type of water being used. While other families treated their water by chemical to make it safe for drinking, others boiled. Even with water treatment strategies, *Ascaris lumbricoides* was detected (22.2%) from sampled preschool children who used boiled water as opposed to those who used water treated with chemicals (8.0%). Many observations have been made upon *Ascaris* eggs with various chemicals that are highly destructive to protoplasm. Galli-Vallerio was successful in developing *Ascaris* eggs to the embyonated stage in solutions of hydrochloric, sulphuric, nitric, and acetic acids which were 2 to 50 per cent in strength. He also noted that eggs placed in saturated solutions of copper sulphate, iron sulphate, acetate of copper, and from 2 to **5** per cent of formalin will develop embryos to a embryonated stage (Galli-Vallerio; 2010). This great resistance perhaps attributes to the findings of regardless of the water treatment; *Ascaris lumbricoides* was present in the sampled preschool children. However, in general, water treatment did not show statistically significance associations with soil transmitted infections in Marani subcounty.

This study revealed that as parents' level of education increased the prevalence of the STH among preschool children also reduced. Even though the number of educated parents involved in this study were few compared to the less educated there was a significant association between level of education and low prevalence of helminths. In this regard, the more educated a parent is may improve the level of hygiene and hence the reason for low prevalence rate of STH among educated parents. In contrast, a study in northwest Ethiopia (Abate *et al*., 2013) showed that even though there were slightly higher prevalence rates of STH among the illiterates there was no significant association between education status and parasitic infections. Nevertheless, this study concurred with two other studies conducted in Karachi, Pakistan (Wagar *et al*., 2003) and Upper Egypt (Curtale *et al*., 1998) revealing that when parents are given consistent health education especially maternal, it has a positive influence in reduction of the prevalence rates of helminths based on the STHs isolation. These results suggest that health education has a significant impact in reducing morbidity and infections associated with soil transmitted helminths not only among preschool age children but also in the community.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

There is a high prevalence (35.8%) of STH in Marani subcounty which is a predominantly rural area. In the preschool children, *Ascaris lumbricoides* had a high prevalence as a mono-parasite. In all the mixed infections, *Ascaris lumbricoides* was present. Use of toilet was not important to most families since they did not associate toilet with infections with soil transmitted helminthes. Most parents were not aware of the importance of deworming their PSC. Socio-economic factors including sources of water and type of toilet being used in by the preschool children influenced the prevalence of STH. There was no data from the NGO since there exists none for STH control in Marani subcounty. Most families had no access to clean and safe water for drinking with most using river water which contributed to spread of STH which has a significant difference.

6.2 Recommendations

A lot has been documented about soil transmitted helminths in school going children but less has been explored about preschool children especially in Marani area where this is the first study. Provision of public health education through the ministry of health and sanitation would help in reducing STH especially to parents of preschool children. This maybe done through radio programmes, local health centers by the ministry of sanitation and hygiene. The government should extend community based mass deworming to preschool children down to rural level as well as encourage NGOs to go to Marani to assist in soil transmitted helminths eradication programmes since only recommended drugs should be used in this age group. This will help achieve vision 2030 of lowering infant mortality and investing in their future through better health. Deworming the preschool going children would be very effective in controlling soil transmitted helminths. Water treatment should be encouraged by making chemicals available, accessible and cheaper to parents of preschool children. More future studies are recommended in Marani to determine the high prevalence of *Ascaris lumbricoides*.

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APPENDICES

Appendix 1: Participant Consent Form

Project title: Study of point prevalence of soil transmitted helminths in preschool children in Marani Subcounty, Kisii County, Kenya 2013

Scientists at Walter Reed Project-Kericho in collaboration with your local health office are conducting the above study. Worms can cause adverse health effects on children such as intestinal obstruction, poor cognitive and physical activity, deprivation of nutritional uptake and slowed growth. You are requested to willingly participate in this study by agreeing to give your child's stool for examination. This stool will be examined for the presence of disease causing worms. Provision of stool is a harmless procedure and will not cause any effect to you. Participation in this study will be used to collect data that can help improve public health measures that control these infections, including treatment and prevention methods.

Site : Marani rural villages

Principal investigator : Nyakang'o N. Louise and WRP- Kericho

Phone number : 0723 380014

Voluntary participation: Participation in this study is completely voluntary. If you decide to participate kindly note that the results may either be directly or indirectly made available to you and that you will not be compensated in any form for your participation. If you decide not to participate in this study, no adverse consequences will be imposed upon you.

By signing this form I am attesting that I have read and understood the above information and I freely give my assent to participate in the project. If I have any questions regarding the project I will contact Louise Nyaboke Nyakang'o or WRP-Kericho.

Parent/guardians Name: …………………… Signature……………………………………..

Ref Study ID no……………………………… Childs Name: ……………………………….

Appendix 2: Questionnaire for the parents/guardian

Please tick √ in the box against the appropriate choice.

Ref study ID No. (child)…………………

Demographic and socio-economic

1. Do you have preschool child or children ? Yes [ ] No [ ]

   Age…………………………………………

Socio-economic

2. How many people do you live with in your house?

   ………………………………………………………………

3. What is your highest level of education ?

   None [ ] Primary [ ] Secondary [ ] College/University [ ]

4. What is the source of income for the household?

   Farming [ ] Casual laborer [ ] Business [ ] Public Servant [ ]

5. Where do you source for water for domestic use?

Piped water [ ] River [ ] Tank [ ] Well [ ] Rain water [ ]

Other Specify please………………………………………………………………

6. (a) Do you treat your water?

Yes [ ] No [ ]

(b) If yes, how?

Boil [ ] Chemicals [ ]

Other, please specify …………………………………………………………..

7. (a) Do you use

Pit latrine [ ] Flush toilet [ ] other, please specify……………………………….

10. When did you deworm your child or yourself last?

3months ago [ ] 6 months ago [ ] 1 year ago [ ] Never

Appendix 3: Questionnaire for Health Centers

Please tick √ in the box against the appropriate choice.

1. (a) Do you have a deworming programme for preschool children?

Yes [ ] No [ ]

(b) If yes, how do you conduct it?

Home visits [ ] Hospital visits [ ] Visit to nursery schools [ ] other, please specify…………………………………

2. If no, why……………………………………………………………………………
3. Do you carry out a laboratory diagnosis for the identification of the helminths?

Yes [ ] No [ ]

If yes, what is the common species of helminths in this area?

……………………………………………………………………………..

4. What drugs do you use for the treatment of the Soil Transmitted Helminths for the infected preschool children? ……………………………………………………….
5. Are these drugs always available in the health centers?

Yes [ ] No [ ]

6. Are they for sale to the community or free

……………………………………………………………………………………….

7. What geographical area does your deworming exercise cover?

....

Appendix 4: Questionnaire for Non Governmental Organisation

Please tick √ in the box against the appropriate choice.

1. Do you have a deworming program for preschool children?

   Yes [ ]   No [ ]

2. If no, why…………………………………………………………………………

3. If yes, how do you conduct it?

Home visits [ ] Hospital visits [ ] Visit to nursery schools [ ] Other, please specify…………………………………

4. What age group do you include in your deworming program?

………………………………………………………………………………………..

5. What is the frequency of the deworming program?

   Monthly [ ] After 3 Months [ ] After 6 Months [ ] Yearly [ ]

6. What anthelminthic drugs do you commonly use for deworming?

………………………………………………………………………………………..

7. Does your deworming exercise cover the whole of Marani area?

   ....