PREVALENCE AND INTENSITY OF SOIL TRANSMITTED HELMINTHS AMONG PRESCHOOL AGE CHILDREN IN ELBURGON MUNICIPALITY, KENYA

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DECLARATION AND RECOMMENDATION

DECLARATION

This thesis is my original work and has not been submitted or presented for examination in any institution.

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RECOMMENDATION

This thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

I dedicate this work to my beloved parents Mokua and Rose and my grandfather Obonyo. You stood with me in every step.

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ABSTRACT

Soil transmitted helminths infections are a major public health challenge in developing countries especially those confined to the tropics. These infections include the three common intestinal parasites namely: *Trichuris trichiura*, *Ascaris lumbricoides*, and hookworm (*Ancylostoma duodenale* and *Necator americanus*). Soil transmitted helminths are among the neglected tropical diseases that infect the less privileged populations whose risk increases with poor hygiene and sanitation. Helminths cause chronic infections. The control soil transmitted helminths include use of cheap drugs but require collective responsibility among parents, health institutions and special programs such as mass deworming campaigns. This study aimed at determining soil transmitted helminths prevalence and intensity, socio-economic factors impacting helminths prevalence and control methods among preschool age children in Elburgon Municipality, Kenya. Two hundred and forty-four participants were registered for the study from households with children below five years of age. Demographic information was collected using a structured questionnaire. Stool sample was collected from subjects for laboratory diagnosis to determine infection. The Kato-Katz technique was used to establish the evidence of eggs and worm burden on sampled stool. The overall STHs prevalence was high, with 86% of preschool age children having infections with one to three of the soil transmitted helminths species. Parasite specific prevalence was reported as 28% mixed infections, 50.84% *T. trichiura*, 25.14% *A. lumbricoides*, and 10.06% hookworm species. Socio-economic factors including level of education of the mother and her occupation, as well as the level of education of the household head showed significant impact on the prevalence of STHs among PSAC in Elburgon Municipality. National school mass deworming campaigns should be extended to include Pre-School Age Children not only in Elburgon but also in other semi-urban centers.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	:	Analysis of Variance
CDC	:	Center for Disease Control
EPG	:	Eggs per gram
K-K	:	Kato Katz
NTD	:	Neglected tropical diseases
PCT	:	Preventive chemotherapy
PSAC	:	Pre-school age children
SAC	:	School age children
STHs	:	Soil transmitted helminths
WHO	:	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background information

Soil transmitted helminths infections are among the neglected tropical diseases (NTD) of the world that infect poor populations although they can easily be treated and eliminated, (CDC, 2010). Over 1.2 billion people are infected with STHs worldwide. *Ascaris lumbricoides* accounts for approximately 800 million infections, *Trichuris trichiura* and hookworm (*Ancylostoma duodenale* and *Necator americanus*) accounts for approximately 740 million infections, (Albonico *et al*., 2008; Burns, 2010). The greater burden of STHs infection is found in the tropical countries including Tropical South America, China, East Asia, and Sub-Sahara Africa (Saboya *et al*., 2013). Kenya has an estimated population of 9.1 million at risk of STHs infection while 2.37 million of this number is children, (GAHI, 2013). The current state prevalence of STHs is directly associated with poor hygiene and sanitation. The prevalence and distribution pattern indicate that children from low-income families living in poor hygiene environments are more at risk of infection, (Gunawardena *et al*., 2008). Clinical symptoms and morbidity from STHs manifests in children between 6-24 months of age. Soil transmitted helminths infection is also common in young mothers, (Vera *et al*., 2005).

Methods used to control STHs include drug treatment, the general improvement of socioeconomic status of the population at risk, improving sanitary conditions, and education. These strategies should be used in combination or singly for effective results, (Pullan *et al*., 2011). Additionally, integrated approach to controlling and preventing NTDs are effective towards programs designed to eliminate these infections, (WHO, 2013). The control strategy of STHs requires direct and collective responsibility from stakeholders, (Vera *et al*., 2005). Soil transmitted helminths control should incorporate diagnostic testing and effective treatment of infected individual at all levels of the health system including community health promotion and education, (Pullan *et al*., 2011).

Available evidence from research data show that, the global strategy to control morbidity due to STHs infection is preventive chemotherapy, (Koroma, 2010). This strategy is effective although it does not entirely prevent reinfection, (Ziegelbauer *et al*., 2012; WHO, 2012). The existing policies lay emphasis on control of intestinal worms in school age children through targeted deworming strategy. There is no effective strategy in place for control of STHs in the pre-school age children. Results from this study documented the current STHs prevalence among preschool age children in Elburgon Municipality, Kenya. The findings seek to assist policy makers extend their control programs to preschool age children not only in Elburgon municipality also in other parts of the country

1.2. Statement of the problem

Preschool age children are not included in mass deworming campaigns aimed at controlling STHs infections in the country. Elburgon Municipality has a high population of preschool age children below five years not covered in the national school deworming program. Quantitative evidence indicates that, infection with STHs usually become established in children at six months of age. Since children living in countries where STHs infection is endemic are at significant risk, younger children may need consideration for inclusion in public health control programs designed for STHs control. Soil transmitted helminth control is effective in school age children through mass deworming, and the same is not available for pre-school age children. Pre-school age are disadvantaged as they have to wait until they are school going to receive treatment. Soil transmitted helminths infection rarely cause mortality in children; they are usually asymptomatic making it difficult to realize the effects of their infection. In Kenya, there is no policy for STHs treatment in preschool age children. Therefore, STHs infection among young children remain a problem especially in Elburgon Municipality with environmental and resource conditions that favor their transmission.

1.3 Objectives

1.3.1 General objective

Improving control strategies for soil transmitted helminths among preschool age children in Elburgon Municipality Kenya, through public health education.

1.3.2 Specific objectives

1. To determine the prevalence and intensity of STHs infection among PSAC living in Elburgon Municipality.
2. To assess the contribution of socio-economic factors to STHs infection among PSAC in Elburgon Municipality.
3. To assess the impact of public health education in Elburgon Municipality associated with STHs control among PSAC.

1.4 Justification

Soil transmitted helminths are among the 13 neglected tropical diseases affecting the most socioeconomically challenged populations. Mass deworming is the only effective and current strategy used for controlling intestinal helminths among children. In Kenya, this strategy is only achievable in school age children therefore locking out pre-school children (children between 1-4 years) who also may need equal attention. Pre-school age children are at great risk of STHs infections because of poor sanitation due to unhygienic raw sewage disposal and their constant contact with the soil when playing. In addition, there is no definite policy in Kenya that provides for STHs treatment and control among this age group. Evidence for STHs infection is important in determining their burden during studies through faecal diagnosis. This study documents the prevalence of STHs among pre-school age children and will be effective to use when planning for controlling the STH among preschool age children in the study area. Successful STHs control on preschool age children may require targeted interventions as those currently used in school age children. These children are at high risk of STHs infection because they actively play in soil that is contaminated with helminth eggs.

CHAPTER TWO
LITERATURE REVIEW

2.1 Epidemiology of soil transmitted helminths

Soil transmitted helminths are a group of common diseases that comprise *Ascaris lumbricoides*, *Trichuris trichiura* and the hookworms *Ancylostoma duodenale* and *Necator americanus*. The total populations at risk for these diseases in the whole world include 1.22 billion for *A. lumbricoides*, 800 million *T. trichiura*, and 740 million for *Ancylostoma* spp., (Albonico, 2008; Burns, 2010). Soil transmitted helminths are considered together because they can be found in a single individual especially children in addition to common mode of transmission and occurrences, (Caumes, 2009). World Health Organization (2013) lists STHs as one disease that falls under the thirteen neglected diseases in the world. Among these infections, ascariasis caused by *Ascaris lumbricoides* is the most common and responsible infection causing 60,000 children deaths each year, (Burns, 2010). Hookworms contribute to the high anaemia morbidity always reported in children, (Burns, 2010). Soil transmitted helminths like other NTDs are grouped as poverty-related diseases that affect people living in third world countries. They are neglected because they receive little attention from healthy policy makers and funding bodies. According to the World Health Organization as shown in Fig. 1, 42 countries in Africa are endemic of STHs infection with 284 million cases and both school age children, and preschool age children are in need of chemotherapy, (WHO, 2009; WHO, 2011).

Soil transmitted helminths are diseases of significant public health importance, (Levecke *et al*., 2011). Today, targeted efforts towards controlling and eliminating NTDs exist. Soil transmitted helminths control is among these NTDs with targeted mass deworming in school age children. In trying to control STHs infections, the World Health Assembly in 2001 passed a resolution urging member states to control the morbidity of STHs infections through large-scale anthelminthic drugs for school-aged children, (Bethony *et al*., 2006). Control of soil transmitted helminths on school age children is foreseeable and is the current recommended used strategy although the same does not exist for PSAC. Sur *et al*., (2004) showed that, periodic deworming work and can be adapted at the community level or as an integral part of helminth programs.

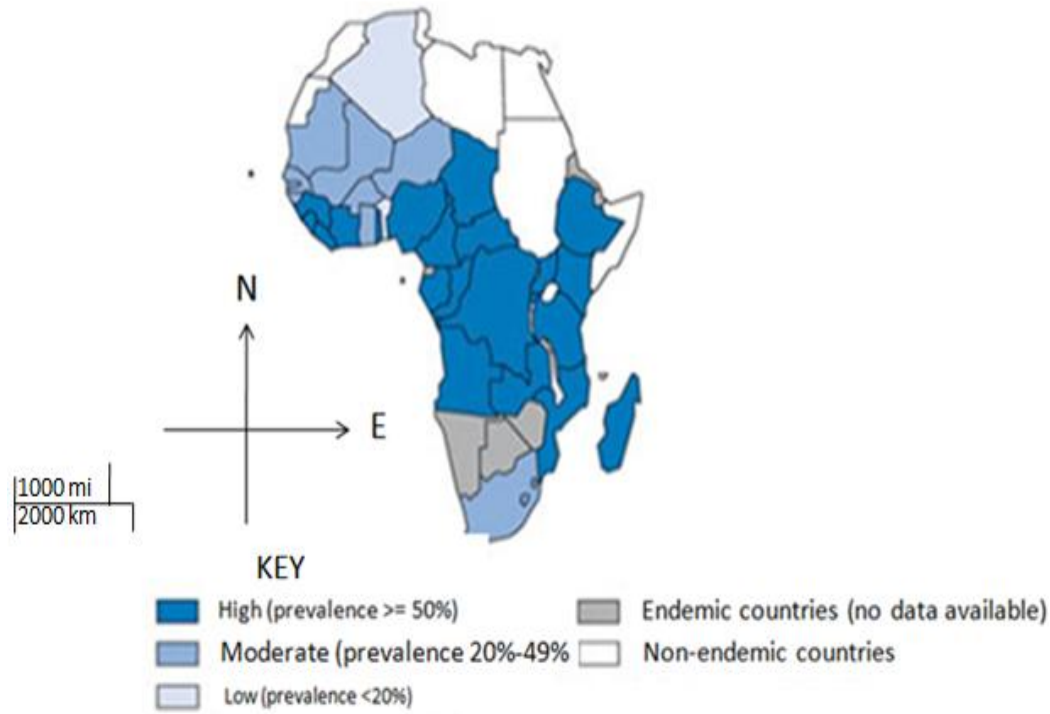


Fig. 1: Prevalence and endemicity of STHs in Africa (Courtesy: WHO, 2011)

2.2 Biology, ecology and transmission of soil transmitted helminths

Soil transmitted helminths are sometimes referred as geohelminths or intestinal helminths. Their biology, ecology and transmission dynamics are important considerations when grouping these nematodes together. The STHs life cycle follows a general pattern although their mode of infection is slightly different, (Brooker, 2006, Qadri, 2007). Soils transmitted helminths reproduce sexually and produce eggs, which are passed out in the stool. If the infected individual contaminates the environment with infected stool, eggs remain viable in the soil for several months for *A. lumbricoides* and *T. trichiura*. Hookworm infections follow a transcutaneous infection mode through penetrating the bare skin when a victim comes in contact with infectious filariform larvae, (Brooker, 2006). *Ancylostoma duodenale* and *Necator americanus* inhabit the upper part of small intestine. They produce an average of 25,000-30,000 and 9,000-10,000 eggs output per day, respectively. *Trichuris trichiura* produces an average of 3,000-5,000 eggs output per day. The predilection site for this worm is the small intestine and colon, see Table 1.

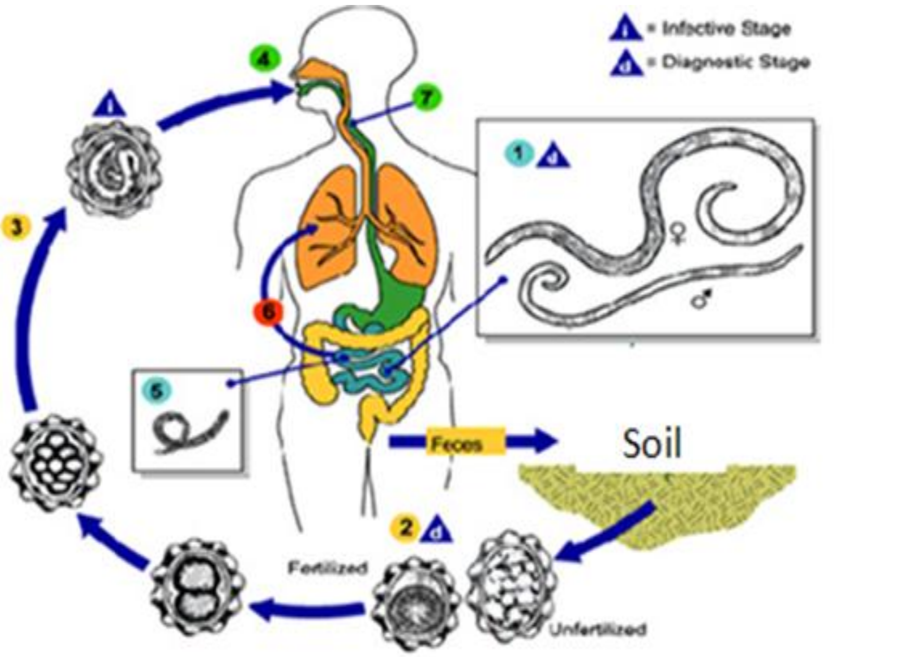
Table 1: Characteristics of adult soil transmitted helminths, (Bethany *et al.,* 2006).

Species	Length (mm)	Daily egg output per Female worm	Predilection site	Lifespan (years)
Ascaris lumbricoides	150-400	200,000	Small intestine	1
Trichuris trichiura	30-50	3,000-5,000	Caecum and colon	1.5-2.0
Necator americanus	7-13	9,000-10,000	Upper small intestine	5-7
Ancylostoma duodenale	8-13	25,000-30,000	Upper small intestine	5-7

Hookworm eggs will hatch immediately they're deposited in the soil, but its larvae will remain viable for several weeks. Studies show that the transmission of STHs follows a basic reproductive number. The basic reproductive number is the average number of female offspring produced by an adult female parasite that attain reproductive maturity in the absence of density dependent factors. *Trichuris trichiura* has the highest reproductive number while *A. duodenale* and *N. americanus* have the lowest, (Brooker, 2006, Qadri, 2007). A high reproductive number results in high infection prevalence and intensity. Physical conditions of the environment affect the dynamic processes of STHs transmission and the development of the free living infective stage. For example, the temperature for maximum survival for hookworm larvae is between 20-300C, soil moisture, and relative atmospheric humidity also affects ova and larvae development. Changing developmental and survival rates affect parasite establishment in humans, which contributes to varied infection rates among hosts. Prolonged fluctuation in environmental factors influences transmission rates and patterns of STHs infection while seasonal changes in a particular area have little effect on the basic reproductive number of helminthes, (Basanez *et al*., 2012).

2.2.1 Life cycle of *Ascaris lumbricoides*

Human beings are the major definitive host for *A. lumbricoides*. Biologically, definitive hosts form an important part of disease transmission cycle, (Caumes, 2009). Adult *A. lumbricoides* has an average of 200,000 eggs on a daily output. This species lays the highest number of eggs among the three STHs considered here as shown in Table 1 for differences in daily egg output, length of the worms, location in the host and an average lifespan. *Ascaris lumbricoides* infections occur through ingesting eggs found in contaminated soil. Infection can also occur through ingesting eggs or larvae in contaminated food, (Brooker, 2006, Qadri, 2007). In ascariasis infection, unfertilized eggs may be ingested but are not infective. Otherwise, when fertilized and embryonated, the larvae hatch and invade the intestinal mucosa to find way via the portal to the systemic circulation and end up in lungs. In the lungs, the larvae mature in approximately 10-14 days, penetrate the alveolar walls, move up to the bronchial trachea, penetrate into the esophagus and are swallowed back to the gastrointestinal canal. The swallowed worms travel to the small intestine to grow and develop into adults, see Fig. 2. The female adult can lay up to 200,000 eggs per day. The large number of eggs this worm produces, the eggs that will survive to hatching and the hatched larvae numbers that will survive leads to a significant infection rate for *A. lumbricoides* as compared to other worms. The prepatent period for this worm is approximately four months, and the adult can live approximately two years.



1. Mature male and female roundworms
2. Fertilized and unfertilized eggs
3. Fertilized egg with infective larvae
4. Fertilized egg ingested
5. Fully hatched larvae in small intestine
6. Larvae penetrates duodenum into alveoli
7. Coughed larvae swallowed back to the intestine

Fig. 2: Life Cycle of *Ascaris lumbricoides* (Courtesy: CDC, 2009).

2.2.2 Life cycle of hookworm (*Ancylostoma duodenale* and *Necator americanus*)

The predilection site of hookworm is upper small intestine. The female hookworm produce fertilized eggs that are passed in faeces. After two days under favorable environmental conditions including moist soil, the hookworm egg hatch to produce larvae. The rhabditiform grows when faeces are deposited in soil. After two molts, the rhabditiform larva becomes third stage lava known as filariform larva, which is infective. This larva is ready to penetrate skin when it comes into contact with the human skin, see Fig 3. Under favorable condition: soil with moisture, shade, and warmth, the filariform stage can survive up to four weeks. During epidemiological analysis, the survival length of the infective stage means that human are at risk of infection the four weeks when the infective filariform stage is active in soil, (McCarthy *et al.*, 2012). The filariform larvae penetrate the human skin on contact. They enter the blood vein and are transported to the heart and end up in lungs. In the lungs, they find their way to the gastrointestinal tract through penetrating the pulmonary alveoli, the bronchial tree and to the pharynx. After penetrating the pharynx they are swallowed and end up in the stomach headed for small intestine. Adult worms reside in the small intestine and attach their buccal to the villi where they suck blood leading to anaemic clinical symptoms of hookworm infection. The prepatent period is important in life cycle of this helminth because it suggest that. The prepatent period of hookworm is 7 weeks from the time the filariforms penetrate the skin to the time when eggs appear in faeces.

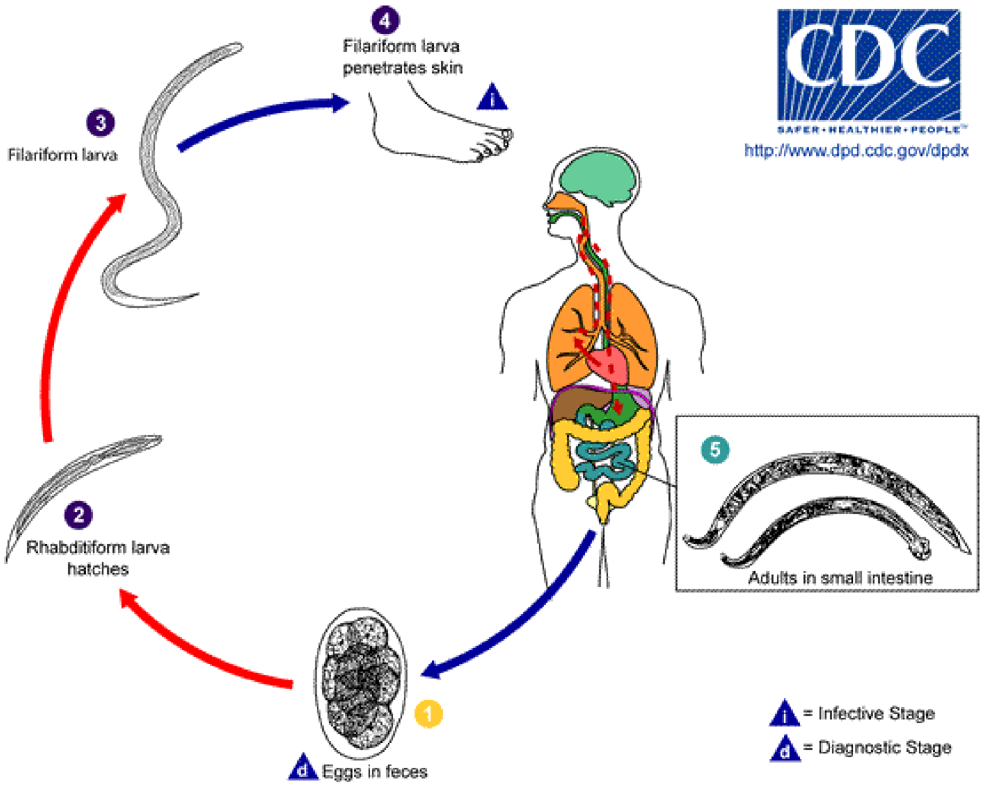


Fig. 3: Life cycle of hookworm parasites, (Courtesy: CDC, 2009). 1: Eggs in fresh faeces as seen in a microscope, 2: First larvae hatched still in faeces, 3: Infective third stage larvae, 4: Infective larvae penetrating the human skin, 5: Male and female adult hookworm in small intestine.

2.2.3 Life cycle of *Trichuris trichiura*

The lifecycle of *T. trichiura* begins with passage of undeveloped embryo eggs in stool. In the presence of soil, undeveloped embryo eggs molt into two cell stage and advance to third stage characterized by cleavage that gives rise to embryonated eggs. The developed embryo eggs are infective. The patients get infected by ingesting contaminated soil, fruits and raw vegetables with parasite eggs. After ingestion, the eggs hatch in small intestine, grow as it migrates to establish itself in the colon, see the life cycle of *T. trichura* in Fig. 4. The adult worm can live up to a year with the female shading approximately 3,000-20,000 eggs per day.

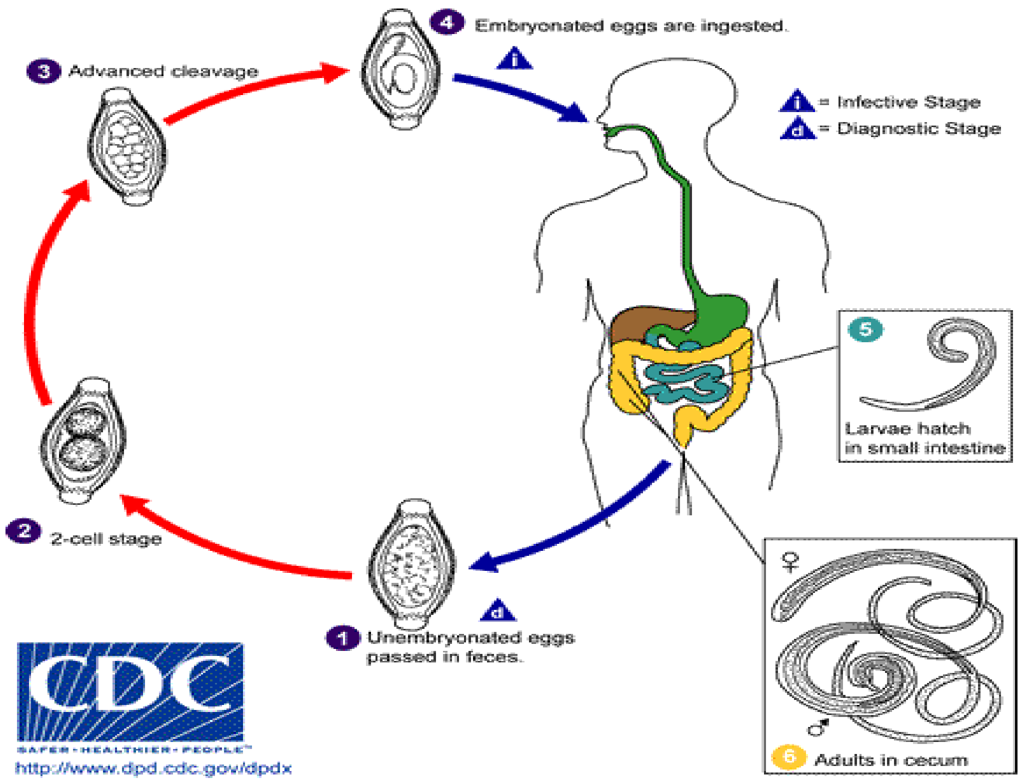


Fig. 4: Life cycle of *Trichuris trichiura* (Courtesy: CDC, 2009).

2.3 Soil transmitted helminthes egg count threshold

Parasite burden is considered light, moderate and heavy using the helminth intensity classification, see Table 2.

Table 2: Numerical egg count threshold of STHs parasite burden

STHs	Light Intensity	Moderate Intensity	Heavy Intensity
T. trichiura	1- 999	1,000-9,999	>10,000
A. Lumbricoides	1- 4,999	5,000-49,999	>50,000
Hookworm *(A. duodenale and N. americanus)*	1-1,999	2,000-3,999	>4,000

2.4 Public health challenge of soil transmitted helminths

In developing countries and especially those confined to the tropics, helminths infection constitutes a major public health challenge, (Hotez *et al.*, 2003). Soil transmitted helminths infections are associated with poverty and are most prevalent in the poorest countries where they afflict the poorest population or populations that are economically disadvantaged, (Brooker, 2006). Although STH burdens have been consistently underestimated in the past, today they are causing concern in the whole world arousing massive efforts of control, (Uneke, 2010). Soil transmitted helminths infections are simple and easy. Hookworms are transmitted through contact with contaminated soil or surfaces where poor raw sewage disposal is common. *Ascaris lumbricoides* and *Trichuris trichiura* are transmitted through ingestion of infective eggs. Children of active playing age who spend most of their time in soil are at great risk of infection. They may have high prevalence and intensity of infection due to high level of exposure, (Peter *et al.*, 2003).

Although STH infections are asymptomatic, morbidity at high prevalence has diverse and severe effect on victims. Soil transmitted helminthes infection in children exacerbates other high mortality infections that are chronic. These chronic infections compromise healthy growth, cognitive development, physical fitness, and iron status and affect the immune response of infected children, (Albonico, 2008; Uneke, 2010).

2.5 Treatment, prevention and control of soil-transmitted helminths

Periodic STH deworming improves growth; improves micronutrient status and cognitive development in PSAC. Such evidence presents strong reasons for considering PSAC in mass deworming campaigns aimed at controlling and eliminating intestinal helminthes, (Albonico *et al*., 2008). In addition, effective STH treatment reduces the danger of distributing eggs in the environment. The goal of STH preventive chemotherapy program is not to cure of the disease, but to control severity by reducing and keeping the worm load below threshold, (Koroma, 2010).

Neglected tropical diseases treatment is cheap and costs less than $1 per capita year, (Burns, 2010). The most effective means of controlling STH is through drug treatment, improved sanitation, and health education. Treatment should be given once or twice per year for pre-school age children and school aged children, (WHO, 2011). In an attempt to control STH infection, WHO launched preventive chemotherapy in 2005 through programs such as Child Without Worms based on mass drug administration. These programs aim at deworming vulnerable high risk groups such as PSAC and SAC and women of child-bearing age, (Friedman, 2012; Knopp *et al*., 2008). Available data from research conducted in Sierra Leone shows that preventive chemotherapy (PCT) is useful in STH treatment and control in PSAC, (Koroma, 2010).

World Health Organization recommends one or a combination of Benzimidazole (albendazole and mebendazole), levamisole, and pyrantel as drugs useful for STH treatment, (Zhang *et al*., 2007). However, Benzimidazoles are the most common drugs in use for large-scale treatment strategies. In addition, they are cheap, effective and available even to the poorest households in developing countries. Two single-dose regimens have made preventive chemotherapy affordable and foreseeable even in resource-poor countries, (Handzal *et al*., 2003, Uneke, 2010). Benzimidazoles are popular with STH endemic communities, (Albonico *et al*., 2008). Paramedical and non-medical personnel can administer antihelminthic drugs. Safety for these large tablets must be carefully administered in children 1-3 years of age due to choking effect. The choking effect is dangerous to young children, but can be avoided by crushing the tablet. World Health Organization recommends a chewable form of mebendazole, which is now available as the drug of choice for the children < 5 years. In addition, the single dose regimen makes this product ideally suited for PCT intervention, (Albonico, 2008, Koroma, 2010).

2.6 Diagnosis of soil transmitted helminths

Soil transmitted helminths are diagnosed by detection of their eggs in fresh stool samples using microscopic and molecular techniques. These techniques are sufficiently sensitive provided that appropriate methodologies are used. According to WHO, STH start to manifest in children aged six months, immediately they start getting contact with soil, (Brooker *et al*., 1999). In endemic areas, any child playing on soil is at significant risk of STH infection. Effective STH treatment on any age group requires adequate evidence, suggesting that finding eggs in the fecal sample through diagnosis justify treatment for these infections. Kato-Katz as a gold standard diagnosing method is a fecal thick smear technique for intestinal helminths examination. This method is also easily adopted for field studies, (Luciano *et al*., 2005). World Health Organization recommends Kato-Katz for quantitative and qualitative diagnosis of intestinal helminthes, (Tarafder *et al*., 2010). This technique is widely used for both field and laboratory investigations. Kato-Katz is ideal for diagnosing geohelminths that lay eggs, and those eggs passed in the stool. During examination, egg count in the fecal sample varies each day because of variation in helminth's egg production and eggs passed out by an individual on a particular day. Kato-Katz technique performs reasonable laboratory diagnosis accuracy for detecting *A. lumbricoides*, *T. trichiura*. However, for hookworm, the general hookworm's low sensitivity is attributed to rapid degeneration of its delicate egg membrane with time, (Machicado *et al*., 2012).

Microscopy is an essential technique for the examination of fecal specimen, (Arcari *et al*., 2000). Using Kato-Katz technique as the gold standard for the diagnosis of intestinal helminths, it is important not only in intestinal helminths diagnosis but also for quantifying the eggs in a prepared thick smear slide. When examining stool specimen for the presence of parasitological eggs, x10 objective lens is commonly used. Objects suspected to be of parasitological importance are observed to approximate and see if they fall within a given size range and shape of any helminth egg. During slide observation, x40 objective lens is used to focus the subtle details of eggs that are not well distinguished by the x10 objective lens. Helminth egg counting is usually accomplished on positive slides using x10 objective lens, which magnifies a wider field. The slides are examined in a systematic manner so as to avoiding skipping part of the smear. During examination and counting, the helminths eggs can be differentiated using the WHO helminth eggs diagnosis images available in the laboratory, (WHO, 2011). The number of each species eggs are recorded and multiplied by a constant factor of 24 to obtain the actual egg count in units of eggs per gram (EGP) of the faecal sample. Eggs count is done using a definite faecal sample of 41.7 milligrams, (Levecke *et al*., 2011).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study area

This study was done in Elburgon Municipality of Nakuru County, (Fig. 5). Elburgon division has a total human population size of 90,000 with 20,000 households, (Obiria, 2012). Elburgon occupies an area of 436 km^2, and its geographical coordinates are 0^o 18' 0" South, 35^o 49' 0" East. Elburgon has a warm and cool climate with an average annual temperature of 14.3°C and 1126 mm rainfall, (Climate Data, 2013). The economic activities of Elburgon residents include forestry, farming, and livestock keeping. Elburgon town residents live in semi-urban homes with most of the children's playground being hygienically compromised. Such environment favors STH transmission due to the large amount of time children spend on soils, which are contaminated. The major health facility in the study area is Elburgon Nyayo Ward, which is a level four-sub district hospital with a serving doctor, clinical officers and nurses.

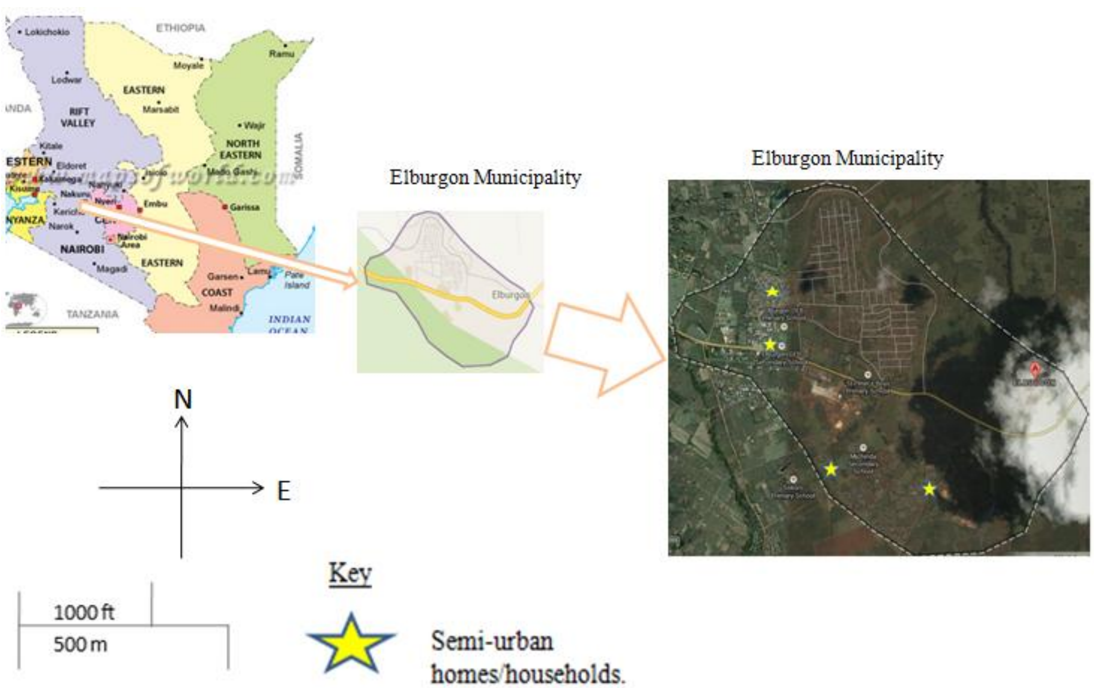


Fig. 5: Map of Kenya, (inset), Elburgon Municipality and the semi-urban household sampling locations. (Courtesy: Google Maps, 2013).

3.2 Study design

A cross sectional survey was undertaken involved a one-time interaction with the study population. Random sampling was done at the study site to select household sampling units. Households with preschool age children below five years old were identified and included in the study.

3.2.1 Target population in the study area

The target population recruited for this study was preschool age children below five years and did not attend public primary schools. During sampling, those who had received STH treatment within three months prior to this study were not eligible for this study. Sample units for this study were homes or households with children below five years living in semi-urban homes within Elburgon Municipality.

3.2.2 Sample size determination

A sample of 255 PSAC from the households with children in Elburgon Municipality was targeted for the study. However, ten household did not participate in initial recruitment due to absence from households selected for the study during the time for recruitment. The sample size for the study was determined using Fisher's *et al.,* (1999) formula illustrated below

$$n = \frac{z^2 p}{d^2}$$

n= sample size for the study

p= prevalence of STH in PSAC

z=statistical constant representing a 95% confidence interval which is 1:96

d= sampling error representing 5%

This sample size was determined using prevalence of STHS on PSAC done in Kibera slums Kenya, which was 21% in 2008 (Albonico *et al.*, 2008).

3. 3.0 Data collection

3.3.1 Methodology: Objective 1, Prevalence and intensity of STH infection among PSAC

3.3.2 Households recruitment

Sampling points (semi-urban homes) in Elburgon were identified for based on random sampling see Fig. 5. At a select sampling point, researchers approached residents, introduced themselves and explained the basic study intentions. Available target residents were asked if they have children below five years and if they were willing to participate in the study. Parents or guardians who agreed to participate in the study had their households assigned with an identifying code beginning from E001. This code was also an identifying code for the questionnaire and the slides as later data collecting instruments. Informed consent was sought from mothers prior to enrolling their children in the study. Informed consent was read to those who were unable to understand it.

3.3.3 Recruitment of preschool age children

In recruited households, parents identified preschool age children. Those who fell under the age of five years as was indicated in the questionnaire were subjects' participants. Identified children were assigned an identifying code, which was the sub code for the main household code. The sub code was used to label the fecal sample.

3.3.4 Faecal sample collection and processing

Mothers of children enrolled in the study were provided with plastic bags and labeled stool sample cups. Mothers/guardians or any adult person in the household was given instructions for faecal sample collection from children. A sufficient demonstration on how to open the stool cup, fetch a sufficient amount of fresh stool and safely seal the stool cup was done. During sample collection day, parents did guide their children to use the plastic bags appropriately so that the faeces do not contaminate the soils. A sufficient amount of stool was collected into relevant stool caps and sealed. The stool caps with samples were transported to the laboratory using a clinical cooler box packed with ice packs. Due to manageable samples (10 samples per day), they were processed immediately.

3.3.5 Kato Katz technique and egg counts

Kato Katz technique (K-K kit) was used for parasitological diagnosis of intestinal helminths eggs. The technique was important for identifying eggs of *A. lumbricoides*, *T. trichiura* and hookworms. The K-K kit used in this study had specific material for stool examination including: a nylon screen mesh size 80µm, plastic templates with a hole of 6mm on a 1.5mm thick templates, which deliver 41.7 mg of faeces, wooden applicator stick, and hydrophilic cellophane of 34 µm thick (WHO, 2000).

Stool examination was carried out to record the physical characteristics of the sample such as solid, semi-solid or watery stool sample. Sample processing for this study were done following the standard operating procedures for Kato-Katz technique (WHO, 2000). Two slides were prepared for each sample. A small amount of fecal material was placed in a newspaper, and a Nylon screen mesh pressed on the top and scrapped so that some of the faeces were sieved through the screen and accumulated on top. The sieved faeces were collected and placed in the template hole placed on top of a microscope slide. Faeces were adequate to fill the 41.7mg template hole. The template was removed carefully to leave a cylindrical fecal sample in the middle of a microscope slide. A presoaked cellophane strip was used to cover the sample in the slide. The cellophane was presoaked in glycerol, water and 1ml of 3% aqueous malachite green. The microscope slide with faeces and cellophane on top were inverted and pressed gently to prevent the cellophane from stripping off. The slides were placed to dry for 10-20 minutes before examination under x10 objective microscope lens. The slides for hookworm egg diagnosis were done before one hour elapsed from the time the slide was ready for microscopy. For *A. lumbricoides* and *T. trichiura* egg examination, the slides were kept in the slide holder until the following day to allow them dry for clarity and easy egg counting.

3.4 Methodology: Objective 2 Assessing the impact of socio-economic factors in STH infection among PSAC

A structured questionnaire was administered in the study area to household respondents to assess the impact of socio-economic factors on the prevalence of STHs infections among PSAC. Questionnaires had identifying codes to ensure that they consistency with stool collected from the same household because stool sample are collected on a different day. Trained field assistants verbally interviewed parents and filled responses in the questionnaire where applicable. The questionnaire captured the socio-demographic and basic household information. Measurable variables in the questionnaire were: level of mother's education, level of household head education, mother's occupation, and head of household occupation, the number of children in the household, and the number of preschool age children in the household see Appendix III. The variable results in the coded questionnaire were compared with matching examined slides of fecal samples to investigate the relationship between STH evidence, egg count and socio-demographic information obtained during the study.

3.5 Methodology: Objective 3 Assessing public health education on the control of STHs among PSAC

A structured questionnaire was administered in the study area to household respondents to assess their knowledge of STHs and STHs control. The second section of the questionnaire captured information regarding parent's understandings on soil-transmitted helminths infection and treatment. The measurable variables were: sources of STH information (Health facility, community health worker, Radio/TV, Talk in the community), whether the household representatives knew soil transmitted helminths, and whether they knew the source of STH transmission. The soil-transmitted helminths treatment status for children subjects was sought indicating whether they have been treated or not and the time when they were treated. Household representatives (respondents) indicated the facility or the source of STH treatment and the type of medication used for treatment such as syrup or tablets. Respondents were also being asked to give their opinion on the institution or institutions they thought should help control soil transmitted helminths in the PSAC. In addition, parents or respondents also gave their opinion on what should be done to eliminate STH.

3.6 Data analysis

Specific parasite egg counts data were analysed using descriptive statistics and the results plotted in graphs. The counts for positive slides for the three helminth infections from the total sampled population were analysed. The percentage for positive slides from the total slides examined were obtained and graphically presented using a pie chart. The percentage of positive slides for each helminth species from the total slides examined was obtained and presented graphical form using appropriate charts. Egg per gram count for each species in each of the positive slides was determined and stratified according to heavy, light and low infection rates and presented in a tabular form.

Scores of the measurable variables were analysed using Microsoft Excel ANOVA to generate significance level. A comparison of information captured in the coded questionnaire and matching examined slides of fecal samples was drawn to analyse the relationship between STH evidence, egg count and each of the variables contained in the first section of the questionnaire. The distribution of STH infection among households and the distribution of helminth species within a household were obtained. Analysis of variance (ANOVA) statistical method in Microsoft Excel program from Microsoft Corporation was used to analyse the differences in distribution of the three STH among and within household to draw conclusions on the contribution of socio-economic status in helminth infection among PSAC. A chosen p-value of <0.05 significance level was used to draw conclusions.

Data of the scores from the measurable variables of the impact of public health education in the questionnaire were tabulated and analysed using Microsoft Excel program from Microsoft Corporation to generate by charts.

3.5 Ethical approval

The permission to conduct this research was granted by Egerton University Ethics Research Committee through the Division of Research & Extension. Ethical approval was given for this study subject to the following must fulfill conditions: ensuring confidentiality for the participants and ensuring professionalism in collection and disposal of faecal sample and reporting to the committee the progress of the research on a quarterly basis. A written informed consent was sought from parents prior to recruiting them and their children to the study.

CHAPTER FOUR

RESULTS

4.1 Objective 1: Prevalence and intensity of soil transmitted helminths

4.1.1 Enrollment rate of preschool age children

A total of 244 children below five years from 154 households were registered for the study. Stool examination was undertaken in 179 preschool age children whose data was analysed to the end. The turnout rate was 73% while those who registered for the study but did not provide stool sample for laboratory examination were 27% (65 children who registered for the study did not provide samples for stool examination due to absence from their home during stool sample collection days), see Fig. 6**.**

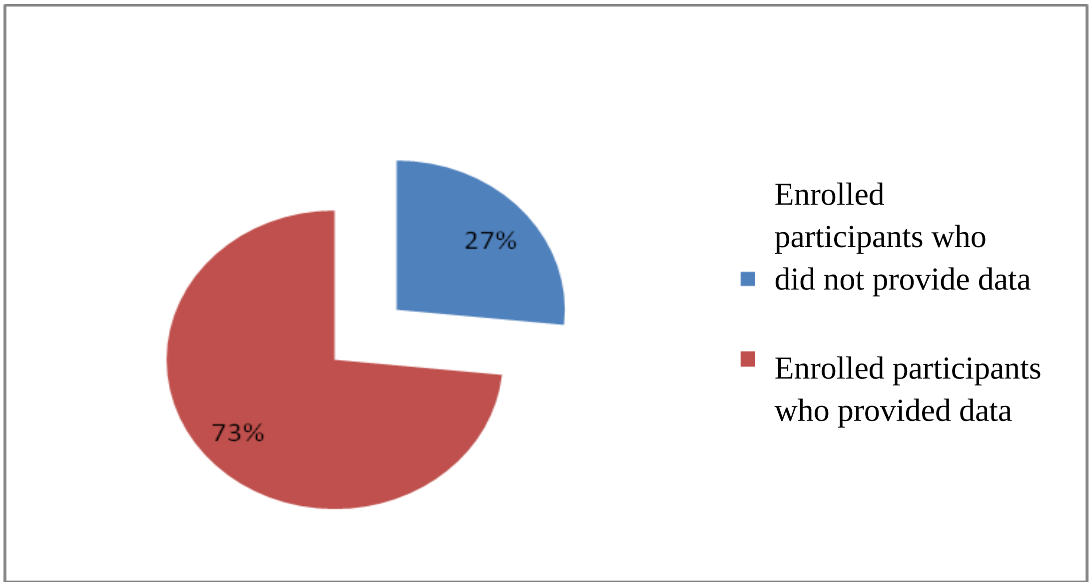


Fig. 6: Enrollment rate of preschool age children in Elburgon Municipality

4.1.2 Overall prevalence of soil transmitted helminths

Overall prevalence of STH in Elburgon Municipality was 86% of 179 PSAC sampled. Fourteen percent of 179 PSAC sampled were negative as per the fecal samples analyzed, see Fig. 7.

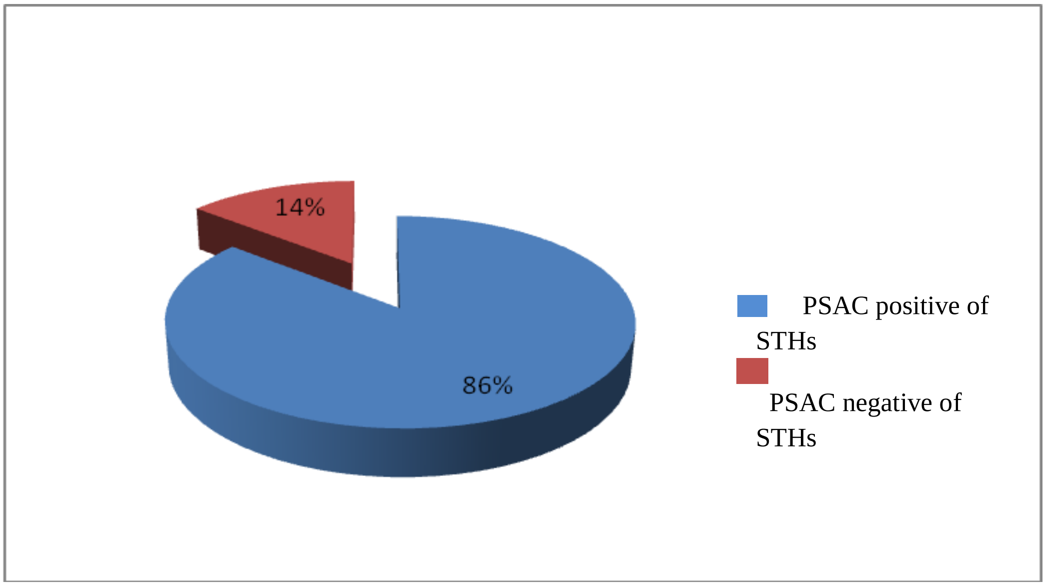


Fig. 7: Overall prevalence of STH in Elburgon Municipality

4.1.3 Mixed STH parasite infection of PSAC participants

Mixed parasite infection was evident in 28% of 179 PSAC participants based on the stool samples analyzed in Elburgon Municipality. A combination of *T. trichura* and *A. lumbricoides* recorded the highest parasite prevalence, see Fig 8**.**

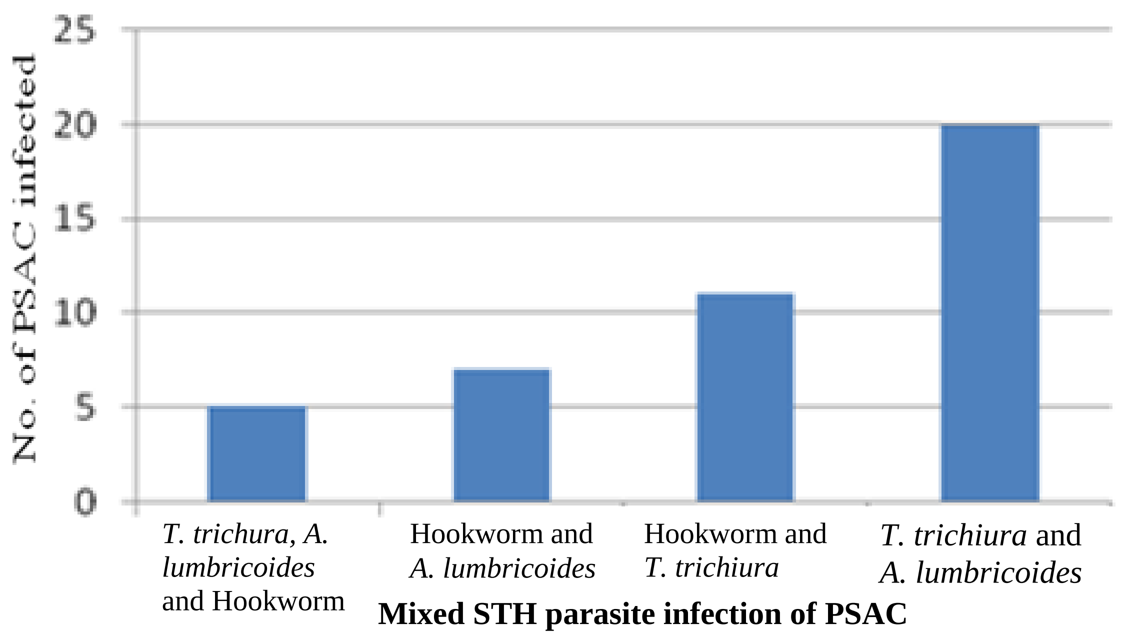


Fig. 8: Mixed STH parasite infection of PSAC participants

4.1.4 Specific STHs parasite prevalence in Elburgon Municipality

Specific STH parasite prevalence in Elburgon municipality indicated that *T. trichiura* was the most prevalent with 91 cases (50.84%), followed by *A. lumbricoides* with 45 cases (25.14%) and hookworm with 18 cases (10.06%) based on fecal samples examined. Hookworm prevalence of 10.97% was the lowest as compared to other helminthes in the study, see Fig. 9.

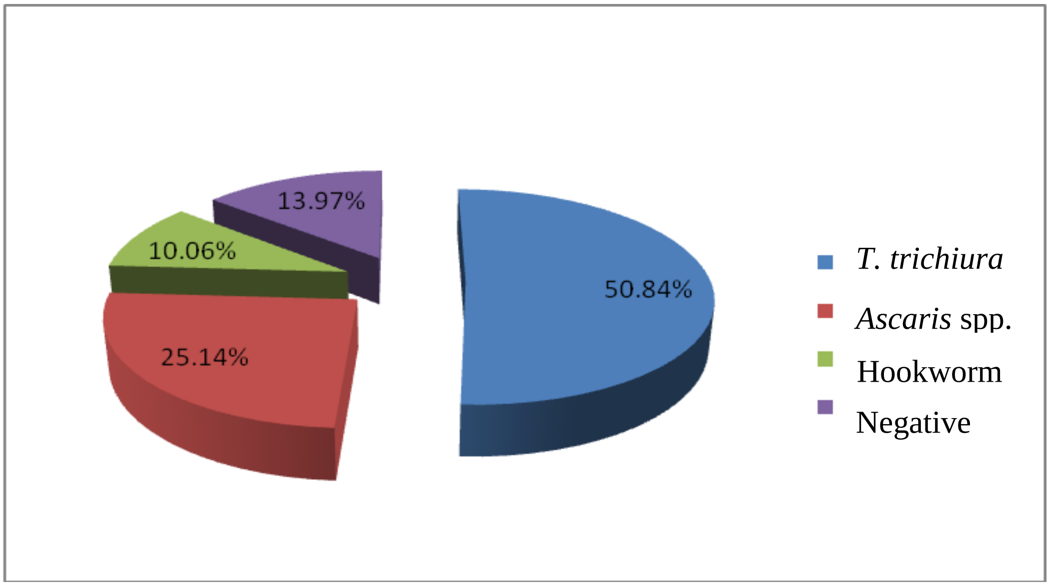


Fig. 9: Specific STHs parasite prevalence in Elburgon Municipality

4.1.5 Mean Egg Per Gram (EPG) counts for STHs in Elburgon Municipality

Mean EPG counts indicated that *A. lumbricoides* had the highest mean EPG Parasitic burden describe the intensity of STH infection among the PSAC children living in Elburgon Municipality. *A. lumbricoides* recorded the highest number of parasite burden in children with heavy infection and had a mean of 34,851.7 EPG of faeces samples. *T. trichiura* and hookworm recorded a mean of 48.8 and 45.3 EPG of faeces respectively as shown in Table 2**.** A significant number of subjects (21.8%) had *A. lumbricoides* with reportedly heavy worm burden. *T. trichiura* and hookworm infections had light worm burden with none of them recording heavy parasitic infections. None of the three parasites recorded a moderate worm burden. *T. trichiura* and hookworm did not have high infection intensity.

Table 2: Mean EPGs and STHs intensity in PSAC in Elburgon Municipality

			Helminths infection intensity		
Parasite species	**Mean EPG**	**Maximum EPG**	**Light**	**Moderate**	**Heavy**
T. trichiura	48.8	144	91 (50.84%)	0 (0%)	0 (0%)
A. lumbricoides	34851.7	64824	6 (3.4%)	0 (0%)	39 (21.8%)
Hookworm *(A. duodenale and N. americanus)*	45.3	120	18 (10%)	0 (0%)	0 (0%)

NB: EPG denotes eggs per gram, % denotes parasite specific prevalence

4.2 Objective 2: Socio-economic factors and STHs prevalence among PSAC

Socio-economic factors (level of education, occupation) among households in Elburgon Municipality showed significance of STH prevalence among PSAC in Elburgon Municipality. Socio-economic information related to STH transmission was captured using a structured questionnaire. Socio-economic independent variables analysed for this study were level of mothers education (informal education, primary, secondary and tertiary), mother's occupation (formal employment, self employment, casual laborer or farmer), head of household, level of household head education, head of household employment and size of the household. The dependent variable was the presence or absence of any of the three STH infections (*T. trichiura*, *A. lumbricoides* and hookworm) for children who provided samples from the household. Prevalence of STH infection varied with socio-economic factors. Mother's education, father's education and father's occupation showed significant differences ($p<0.05$) in PSAC STH infection. Mother's occupation and head of household did not show significant difference ($p>0.05$) in PSAC STH infection in Elburgon Municipality, see Table 4.

Table 3: Socio-economic factors impacting STHs infection among PSAC

Socio-economic factors	N	n (%)	P. value
Mothers education			
No education	34	26 (14.5)	
Primary	64	112 (62.6)	0.00091
Secondary	22	16 (8.9)	
Tertiary	-	-	
Mothers Occupation			
Formal employment	14	28 (15.6)	
Self employed	29	42 (23.4)	0.033393
Casual laborers	46	49 (27.4)	
Farmer	31	35 (19.6)	
Head of household			
Father	110	144 (80.4)	0.91529
Mother	10	10 (5.6)	
Level of education of head of the house			
No education	-	-	
Primary	77	100 (55.9)	0.0035
Secondary	38	52 (29)	
Tertiary	5	2 (1.3)	
Occupation for head of the family			
Formal employment	62	61(34.1)	
Self Employed	32	40 (22.3)	0.001562
Casual Laborer	15	40 (22.3)	
Farmer	11	3 (1.7)	

N = Number of household respondents, n = number of infection cases, (%) = prevalence

Significance level (P = 0.05)

The number of children in the households were divided into five categories namely; 1 child, 2 children, 3 children, 4 children and 5 children, see Table 4 below. The specific STH prevalence within these groups was evenly distributed with no significant difference, ($p > 0.05$). Households with one child had the highest STH infection cases followed by households with four children. The lowest prevalence of STH infection with regard to the number of children in the household was recorded from household with five children**.**

Table 4: Prevalence of STHs and children in the households

No. of children in the households	No. of households sampled	No of STHs infection	Prevalence of STHs infection
1	31	24	13.4%
2	51	60	33.5%
3	24	35	20%
4	12	32	17.9%
5	2	3	1.7%
Total	**120**	**154**	

4.3 Objective 3: Impact of public health education on STH control

The result revealed that 60% of parents interviewed identified the hospital as the main source of intestinal helminths information. Talk in the community including chamas (self help groups), and other small meetings in situations like discussing about kids health with neighbors who have been to the hospital represented 21% while community workers contributed to 19% of source of information about STH. No respondent admitted the role or radio or TV as a source of intestinal helminths infection, see Fig. 10.

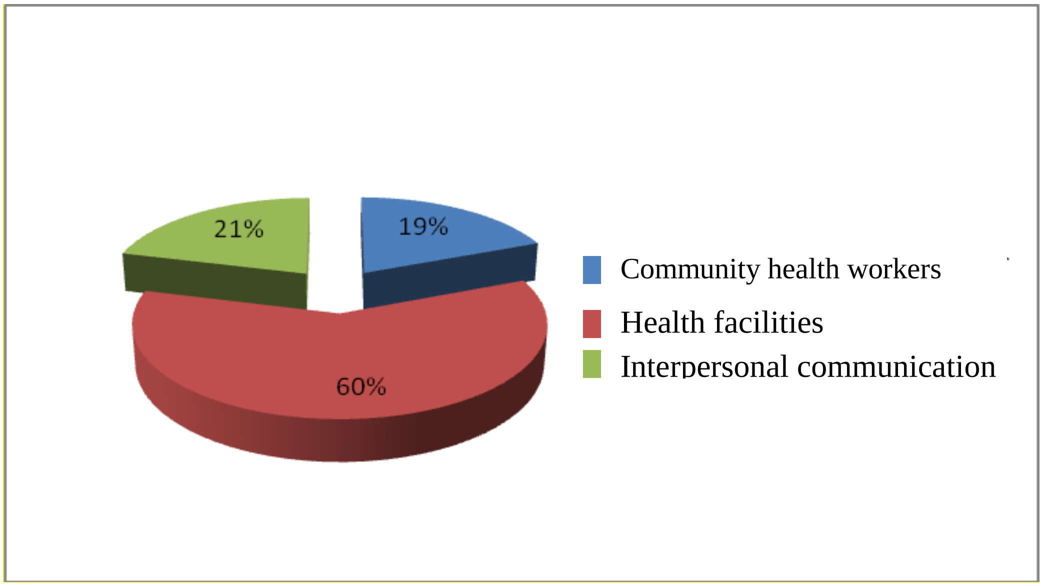


Fig. 10: Impact of various sources of public health education on the control of STHs

Data generated from the questionnaire showed that respondents had varied knowledge on who got infected with intestinal helminths. Forty two percentage of respondents admitted that adults got intestinal helminths infection while 3% pointed out to children, see Fig 11.

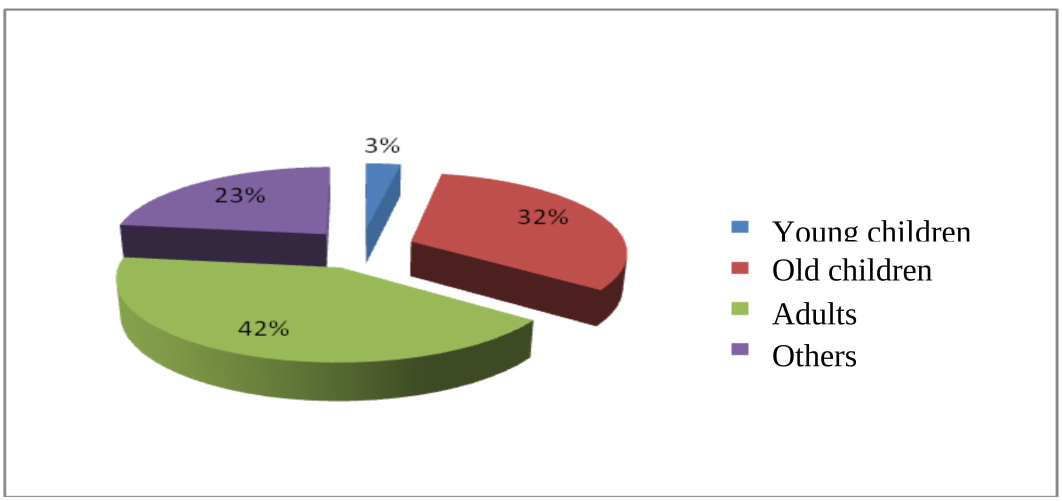


Fig. 11: Information on STHs infection in Elburgon Municipality

The results of this study indicated that 71 (59%) of parents who were interviewed would not know if their children were infected with intestinal helminthes, while 49 (41%) said that they can recognize if their children are infect with intestinal helminths, see Fig. 12. Those who would know when children have helminths large stomach, rumbling stomach, too much eating and rough face skin as symptoms caused by intestinal helminths infection.

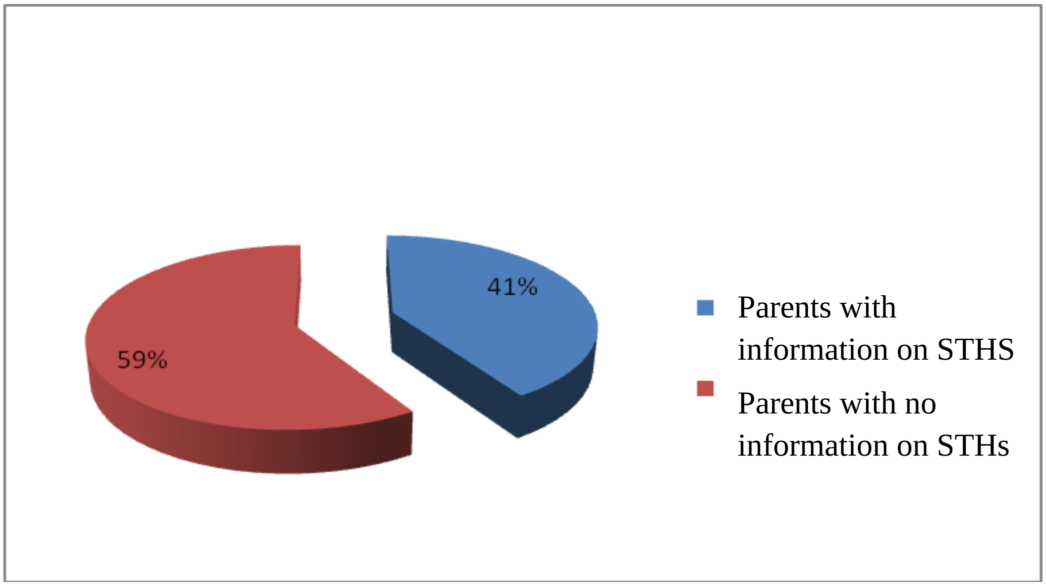


Fig. 12: Parents with knowledge on STHs control, Elburgon Municipality

According to this study, 31% of parents had treated their children in the previous three months prior to this study. Out of those who treated their children, 69% had not treated their children and did not know whether their children have had anthelminthic medication. When comparing these results with the general prevalence of the STH infection among PSAC children in Elburgon, there was a significant relationship ($p < 0.05$) between children who had been treated as opposed to those had no STH infection.

CHAPTER FIVE

DISCUSSION

This study was undertaken to determine the prevalence and intensity of STH infection among preschool age children in Elburgon Municipality. Overall prevalence of STH infection was 86% among PSAC. These results indicate the prevalence of soil transmitted helminths among preschool age children in Elburgon Municipality is high. Based on stool sample examination, majority of children had an infection with *T. trichiura*, *A. lumbricoides* or hookworm (*Ancylostoma duodenale* and *Necator americanus*). Among the three common intestinal helminths in the study, *T. trichiura* had the highest prevalence as compared to *A. lumbricoides* and hookworm (*Ancylostoma duodenale* and *Necator americanus*), respectively. *Ascaris lumbricoides* had a higher intensity representing parasitic burden among patients. The overall high prevalence of STH in Elburgon Municipality among PSAC agrees with results of recent studies in a similar environment on children below five years in Webuye, Western, Kenya, which recorded an overall prevalence of 74.4%, (Obala *et al.*, 2013). A similar study conducted in a similar location in Nyanza, Kenya but with older children of age between five years and nine years reported a minimum estimated prevalence of 68%, (Riesel *et al.*, 2010; Odiere *et al.*, 2011; Ng'etich *et al.*, 2013). These results suggest that there is a general trend in soil transmitted helminths prevalence among preschool age children in semi urban households in similar towns in endemic areas. The common trend on STH infection in similar households is a result of common environmental conditions and similar socio-demographic statuses of patients, (Ezeagwuna *et al.*, 2009).

Results from this study showed that *T. trichiura* was the most prevalent parasite, (50.84%) as compared to other STHs. These findings concur with national survey conducted in Philippines that compared STH prevalence in urban and rural villages, (Belizario *et al.*, 2013; Scolari *et al.*, 2000). This results and reviewed data from various researches on comparison of STH infection between rural and urban dwellings suggest that *T. trichiura* is more prevalent in urban dwellings that rural villages, (Scolari *et al*., 2000). High prevalence of STH infections in endemic areas are usually associated with poor sanitation, indiscriminate raw sewage disposal and low household living standards, (Mwinzi *et al.*, 2012). Furthermore, lack of control strategies such as deworming programs targeted towards young children and the assumption that young children are not a risk factor in geohelminths infections are some of the factors that could result in such a high prevalence in an endemic area. The high prevalence in a rural-urban area indicates that children are hardly dewormed thus contributing to high infection rates, (Uneke *et al.*, 2006; PAHO, 2011; Albonico *et al.*, 2008). The poor sanitary environment of this area, the socio-demographic statuses of the parents in the households and lack of deworming campaigns could be responsible for the high prevalence of STH among pre-school age in Elburgon Municipality. Additionally, due to the age of young children and unsupervised defecation, infected children could defecate indiscriminately hence exacerbating infections because of contaminating soil with helminths eggs, (WHO, 2011).

This study showed that mixed parasite infection was common among PSAC as compared to single parasite infection based on faecal sample examination. Hookworm and *A. lumbricoides* mixed infection was not common. Mixed parasite infection distribution pattern was observed because *T. trichiura* was frequent and had a higher infection rate than the other two helminths. Therefore, a combination of *T. trichiura* with either hookworm or *A. lumbricoides* is expected. Similar studies in other parts of the country have reported that preschool age children and school age children harbor more than one infection in those found positive, (Ng'etich *et al.,* 2013). These results suggests that mixed soil transmitted helminths infection is common. Research on STHs often report results of mixed infection of these three helminths as compared to one parasite in a given patient. Therefore, researchers admit that mixed parasite infection is a global public health problem generally accepted in parasite endemic areas, (Belyhun *et al.,* 2010; Ng'etich *et al.,* 2013; Uneke *et al.,* 2008).

Findings from this study showed that *A. lumbricoides* had the higher parasite intensity, >50,000, based on STHs egg per gram count. The findings concur with those of Chan *et al*., (1994), who reported that *Ascaris* spp. has a high egg laying fecundity, (Chan *et al*., 1994. High number of eggs per gram of sampled stool indicates high intensity of soil transmitted helminthes. These results suggest that approximately 15% of human population with these intestinal helminths harbor heavy infection, (PAHO, 2011). In any given endemic area, observation in the proportion of individuals with heavy infection as compared to light and moderate infection create an over dispersed parasite burden trend, (Chan *et al*., 1994). The few individuals who harbor heavy infections suggest that, they are the population noted with develop morbidity associated with intestinal helminths. Morbidity is pronounced in young children. Morbidity and clinical conditions in children with high worm load is a subject of intensive study. The consequences of parasitic burden in patients and especially in children are clear. Interpretations of low hookworm burden, moderate and heavy infection include losing approximately 2mg and 5mg of haemoglobin in one gram of the patient's faeces respectively, (Albonico *et al.,* 2008). In Elburgon Municipality, low hookworm infection among PSAC was reported and no moderate or heavy infection reported. Therefore, results from this study suggest that hookworm infection was related to losing 2mg of haemoglobin per gram of faeces per day, (Albonico *et al.*, 2008). Anaemia and iron deficiency are associated with high hookworm infection while a combination of geohelminths cause synergistic effects such as stunted growth, negative effects on cognitive development and malnutrition among others, (Albonico *et al.,* 2008; Wang *et al.,* 2012; Katona and Kotana-Apte, 2008).

Results from this study showed that, the level of education of the mother and her occupation as well as the level of education of the household head showed significant impact on the prevalence of STHs among PSAC in Elburgon Municipality. The results of this study are similar to other findings, which found that socio-economic factors influence the prevalence of STHs among preschool aged children in a given locality, (Ostan *et al.,* 2007). Most research on soil transmitted helminths often reports a significant positive correlation of prevalence and socio-economic status, (Raso *et al.,* 2005). This results suggests that lower socio-economic statuses such as unemployment, low education, poor living environment, living in overcrowded space and the general low family social statuses have been associated with high STH prevalence in both PSAC and SAC in intestinal parasite endemic areas, (Ostan *et al.*, 2007; Rosa *et al.*, 2005). This study showed that there was significant impact between parents education level STHs prevalence among PSAC in Elburgon Municipality. Other researchers have made similar observations relating STH prevalence and parental education. These results suggest that there is a common trend in relationship between level of education of parent and prevalence of STH and transmission in endemic areas. Higher level of education of the mother is generally associated with lower parasite prevalence, (Ostan *et al.*, 2007). Children from parents with low educational level are expected to have higher prevalence of STH infection than children from parent with high educational level due to health information and knowledge gap. Higher education of the mother is associated with having health knowledge and low negligence of health and hygiene in their families hence the expected difference in PSAC STHs prevalence. On the contrary, the level of education of the household head in similar studies has reported no relationship between father's education and children's STH infection, (Ostan *et al.*, 2007). In this study, the high STH prevalence in PSAC seems to utilize the impacts of living in the same poor sanitation environment where children from different household play together. These results suggest that, similar living conditions, and living in common environment eliminate STH infection stratification among maternal education levels. Therefore, STH infection and transmission in non hygiene environment does not favor low transmission for highly educated parents. Exposure risk to children of educated parents and non educated parents is the same. Although educated parents are associated with parasite deworming awareness and can treat their children appropriately, living in compromised environment and among a high number of STH victims will tend to increase chances of reinfection after deworming. The ever presence of STH cases in endemic areas cause a constant supply of helminth eggs in the soil hence high risk of infection, (Nash *et al.*, 2004). Maternal occupation is associated with potential risk of STH infection. Reviewed researches have reported that parental occupation has a significant effect in children's intestinal worm infection. Mothers with formal employment are reported to have children with lower worm infection even though they have little time spared for the children, (Nash *et al.*, 2004; Ostan, 2007; Quihui, 2006). Parents who are farmers almost often are reported to have high, close to 100% prevalence of children infected with soil transmitted helminth with hookworm being the most prevalent in this occupation. This study reported a significant difference in maternal employment and child's worm infection. Mothers who were formally employed and casual laborers showed a lower prevalence rate in the overall STHs infection in their children than mothers who were self employed and those who were farmers. Similar research studies have reported the influence of father's occupation in helminth transmission in children. Children whose fathers are farmers have reported high STH prevalence followed by casual laborers with formally employed fathers reported to have a significant lower STH infection rate in their children, (Nash *et al.*, 2004; Ostan, 2007).

The prevalence of STHs in relation to parent occupation within Elburgon Municipality was found to be high. There was also a high infection rate of the parasites across all occupation levels (farmers, casual laborers and formal employment in the timber industry). These findings are similar to studies carried out similar environmental conditions that favor worm eggs survival provide significant reason for high worm prevalence among different parental occupation in Elburgon Municipality. Although there were different occupation levels among parents of PSAC in the study area, it is important to note that they all households sampled live in the same poor sanitation environment. Most of the parents employed in Elburgon Municipality work in the timber lumbering industry, (Obiria, 2012). Although parents working in lumbering factories are either casuals or permanently employed, they all lived in slum like households in the same environment. This suggests that their employment status do not have any influence in reduced STH infection in their children hence the generally high prevalence of STH infection among PSAC in this area. Olsen *et al.*, (2001) have shown from different surveys that even if parents have different education levels and living in similar environment, helminth transmission will still remain high regardless of the education level and occupation statuses of parents. The environment and living conditions determines to a great extent the presences of parasitoses in high risk communities. Even if other factors are held constant, higher helminths prevalence will be seen across all level of parental education category and occupation if poor sanitary conditions, overcrowded residential homes and lack of universal deworming strategies still exist.

The findings from this study indicated that households with more than one child had high STHs prevalence as compare to households with one child. These results are similar to reached conducted by Ostan *et al*., (2007), who found that overcrowded households always have high prevalence of STHs infection. The results suggest that the high prevalence for household with any number of children may be attributed to the general high prevalence of STH infection in Elburgon Municipality. Crowded households tend to have high infection rate because of close contact with a victim who harbors intestinal helminthes, (Ostan *et al.*, 2007). Therefore, children living in households with one member having worms will tend to increase infections risk to other children hence the general observed trend in crowded families having a high prevalence rate than smaller families especially for *T. trichiura,* (Belizario *et al*., 2013).

Information received form health facilities had the highest impact on the control of STH within Elburgon Municipality. These finding concur with health education research conducted in Peruvian Amazon, (Gyorkos *et al.*, 2007). These results suggest that health education from health facilities and chemotherapy is used in controlling STH among PSAC in Elburgon Municipality. According to WHO, (2000), the umbrella of primary healthcare system in controlling and preventing diseases include health education, drug treatment and sanitation. Therefore, one of these three approaches partially assist is controlling and preventing diseases. Otherwise combined diseases control strategies remain effective, (Asaolu and Ofoezie, 2003).

Health education probably is a primary beginning in trying to control diseases, especially preventable diseases. Therefore, health facilities and related resources such as health care professionals play a key role in disease control, (Coulibaly, 2012). Majority of mothers in Elburgon take their children to hospitals and post natal clinics, they are expected to have heard about helminthes control in health facilities for the first time. In this study, majority of parents who reported to have heard about helminths from a community health worker and talk from neighbors respectively could be fathers who filled the questionnaire or mothers who have their first child and the child is probably below nine months. Children below nine months might have little exposure to soil because they have not reached the stage of being left on their own, (WHO, 2000). In addition, mothers with infants are more likely to be careful with their child below one year and who are rarely prescribed with antihelminthic drugs.

Mass media did not provide public health education to the residents of Elburgon Municipality. This observation differs from findings elsewhere in which the role of media exposure was found to enhance STH control, (Schmidt *et al*., 2009). The results suggest that most of the programs aired on radio regarding communicable diseases are usually those that campaign on key diseases of public health importance such as malaria, tuberculosis, measles, sexual transmitted diseases and diarrhea. Intestinal helminths are neglected tropical diseases, which do not receive attention from the government bodies in charge of public health administration, (Schmidt *et al.*, 2009. Aunger *et al.*, 2010). Although numerous evidence data exists about intestinal helminths infection in children in Kenya, most of these data are from research on SAC population. Even though this population is receiving mass deworming intervention, this program is still not aired or campaigned on radio. Hand washing campaign is also a massive program campaign aired in popular TV and radio stations but this program and campaign tend to be an initiative of soap companies that advertise the superiority of their soap, (Aunger, 2010; Strunz *et al.*, 2014). Regardless of the soap advertisement, the message is relevant to health campaign aimed at preventing communicable diseases in children include helminths although interviewed guardians seem to would have more likely to hear about intestinal worms in these numerous campaigns on radio.

There was low parental knowledge on STHs control in the study area. It is expected that people living in STH endemic areas are at risk of infection, although the intensity of risk may be different. While children of 12 months to adults of approximately 50 years are generally infected with soil transmitted helminths, the infection characteristics is structured according to age, which often shows variation, (Hotez *et al.*, 2006). The population age that gets infected with STH has been studied and characterized. Most STH studies try to investigate a specific element in one of these groups. The most STH age group structures commonly used in studies include the pre-school age children (children below 5 years), school age children (5-17 years) and adults, especially pregnant mothers living in endemic areas, (Saboya, 2013). Therefore, it is expected that everybody and not only the parents be aware of risk age group for STH if at all eradication campaigns are required to be successful, (Hotez *et al.*, 2006). Gyorkos *et al.*, 2013 show that STH-related knowledge is a key tool in trying to control these infections in endemic areas. Additionally, STH infection cycle will continue if some individuals in the community harbor this infection. For example, *T. trichiura* is evidently a round worm that can infect everybody in the household if one member is infected with it regardless of their age, (Huang *et al.*, 2003). This means that treating children who are obvious risk population does not guarantee absence of this worm infection in the household if there is an adult who has the infection. The general knowledge that any age group is at risk of getting STH is justifiable to help in controlling the worms in endemic areas and not only in target age group while leaving certain age groups with the worms.

This study showed that significant number of parents had not treated their children with any antihelmintic drug. Consequently, majority of parents who reported that they did not treat their children in three months prior to this study influenced the overall high prevalence reported in this study. Soil transmitted helminths treatment is associated with low prevalence while the low prevalence is often associated with either frequent treatment or non-endemicity. The WHO recommends chemotherapy using Benzimidazoles (Albendazoles and Mebendazoles) for STHs control when prevalence is, (> 20%) classified as low infection in a given area. However, high prevalence (< 20%) shows absence of helminth controlling measures in a community that reveals infection evidence, (Hotez *et al.*, 2006; Belyhun *et al.*, 2010).

CHAPTER SIX
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

- The overall prevalence of STHs in PSAC 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.
- Socio-economic factors (level of education, occupation) influenced the prevalence of STHs among PSAC in Elburgon Municipality
- Health facilities provided significant public health education on the control of STHs in Elburgon Municipality

6.2 Recommendations

- National school mass deworming campaigns should be extended to include Pre-School Age Children not only in Elburgon but also in other semi-urban centers.
- Outreach public health education should focus at the household levels in the country

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APPENDICES

APPENDIX 1

HELMINTHS EGG COUNT FORM

Collection Date________ Time______ Examination Date_____________ Time________

Sample No. / Slide No.	Stool Characteristics	*T. trichiura*	*A. lumbricoides*	Hookworm (*Ancylostoma duodenale* and *Necator americanus*

APPENDIX II:

INFORMED CONSENT FORM

RESEARCH TITLE: PREVALENCE AND INTENSITY STUDIES OF SOIL TRANSMITTED HELMINTHS AMONG PRE-SCHOOL AGE CHILDREN IN ELBURGON, KENYA

Introduction

You are kindly being asked to participate in Soil-transmitted helminths study for Pre-School Age children in Elburgon town. The purpose of this consent form is to give you information that will help you decide whether you and your child will participate in the study or not. You are allowed to ask questions related to the study and researchers. Remember this is a voluntary exercise on your part.

Purpose of the study

The main objective of the study is to assess the prevalence of STH among PSAC and determine the treatment strategy used by Elburgon health facilities in controlling STH among PSAC. This study will provide important information that will help in determining the best strategies to use for controlling STH among PSAC.

Study procedure

This study requires you to contribute in two parts. First, you will be interviewed about the child, what you know about STH in home and how you treat your child of STH. The first part is a questionnaire part. Second, you will provide your child stool sample for STH laboratory examination. You will be given a stool cup and an old news paper and taught how to collect child's stool very early in the morning.

Discomfort

You might feel uncomfortable collecting stool into the stool cup. We will provide safety hand gloves for you to use.

Benefits

You will directly benefit as mother for free diagnosis and treatment of your child. Your child will receive free treatment with antihelminthic if stool sample will be positive of STH. In addition the information you give will benefit the society because it will be part of evidence to come up with a strategy to use in controlling STH among PSAC.

Assurance of confidentiality

Your identity and other records about you and your child remain confidential. The information we collect about you and your child will not appear when we present this study result for publishing.

Right to refuse or withdraw from the study

This study will be explained to you and you will have to ask any questions you have. Rememebr, participation in the study is voluntary. You may also withdraw from the study at any time during data collection.

Costs

There is no cost to participate in this research. Participation is entirely free.

I acknowledge that this consent form has been fully explained to me in a language that I understand and had the opportunity to ask questions which have been answered to my satisfaction. I agree voluntarily to participate in this study and I know I have the right to withdraw at any time.

Participants name__________________Signature________________ Date________________

Interviewer name__________________Signature________________ Date________________

Investigator name_________________ Signature________________ Date_________________

Contact: If you may have any questions in future, please contact Mr. Dennis Mokua. Mobile Phone No. 0712598054. Email: mokua2007@yahoo.co.uk Or Egerton University, Department of Biological Sciences. P.O. BOX 536 Njoro.

APPENDIX III

QUESTIONNAIRE

Questionnaire No. _______ Interviewer's Name____________________________________

Household No.______ Parent's/Mothers Name_____________________________________

Date of the Interview______________________ Time ______________________

SECTION 1

Socio-demographic and household information

Tick or indicate where appropriate.

Level of education of parent/mother.

No formal education ☐

Class 8 ☐

Form four ☐

Tertiary ☐

Are you employed? Yes ☐ No ☐

Formal employment

Self employed ☐

Casual Laborer ☐

Farmer ☐

Who is the head of the household? Father ☐ Mother ☐ Other (Specify)__________

Level of education of the head of the household

No formal education ☐

Class 8 ☐

Form four ☐

Tertiary ☐

What does the head of the home do for a living?

Formal employment ☐

Self employed ☐

Casual Laborer ☐

Farmer ☐

How many children are in the household? ___________

How many children are below 5 years? ___________

Do those below 5 years go to school? Yes ☐ No ☐

If yes which school?

Private/Academy ☐

Public ☐

Daycare ☐

Name of school ________________________________

When did they start going to school/daycare? Date_________________________

SECTION 2:

Parent/mother's understanding of soil-transmitted helminths, infection, and treatment.

Do you know what STH are/is?

Yes ☐

No ☐

How do you call them in your mother tongue? _______________________________

Kiswahili____

From which source did you first get information on STH?

Health worker ☐

TV or Radio ☐

Clinic/Dispensary/Hospital ☐

Community groups ☐

Other ____

Where does STH come from?

Eating soil ☐

Dirty drinking water ☐

Playing in dirty water ☐

Eating dirty food ☐

Don't know ☐

Other source explain____

Who get infected with STH?

Non-school going children ☐

School going children ☐

Adults ☐

Everybody ☐

Don't know ☐

Are you able to know if any one mentioned above has STH?

Yes ☐

No ☐

If yes how Explain____

Has your child been treated of STH?

Yes ☐

No ☐

If yes when?

Recent indicate date/month or year

Long time indicate date/month or year

If yes where?

Health facility ☐ Name____

Other (specify) ____

If yes what was the drug?

Syrup ☐

Tablets ☐

Do you know the cost of STH medication?

Yes ☐ how much KShs____________ or it is free ☐

No ☐

Who do you think should help you control STH? __________________________________

What do you think can be done to eliminate STH?

____

____