Prevalence and factors associated with soil transmitted helminth infection among primary school children in Kikumuni sub-location, Machakos County, Kenya

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DECLARATION

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

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DEDICATION

I dedicate this thesis to the entire Kisavi family for their endless love, support, and encouragement during this study.

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LIST OF ABBREVIATIONS/ACRONYMNS

DALY's	Disability Adjusted Life Years
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KEMRI	Kenya Medical Research Institute
KIHBS	Kenya Integrated Household Budget Survey
KNBS	Kenya National Bureau of Statistics
MOH	Ministry of Health
ROK	Republic of Kenya
SPSS	Statistical Package for the Social Science
STHs	Soil Transmitted Helminthes
WHO	World Health Organization

ABSTRACT

Globally, soil transmitted helminthes (STHs) infection has been identified as the main cause of illness and disease where more than two billion people are infected. Specifically, STHs infections during childhood remain a major public health challenge in developing countries, including Kenya where school going children have been reported to be at highest risk. STHs infection burden in Kenya is being addressed mainly through deworming programs, although this strategy reduces illness caused by soil-transmitted helminths, other studies have shown that it does not prevent rapid reinfection. In order to interrupt transmission and to achieve local elimination of helminthiasis, integrated control approaches that include access to sanitation and other complementary interventions of a primary prevention nature are needed. This study sought to establish factors associated with STHs infections among children aged 5 – 10 years from selected schools in Kikumini sub-location in Machakos county, Kenya. This was a cross sectional study that mainly utilized quantitative methods of data collection. It was conducted among 394 school going children from four randomly selected public primary schools in Kikumini sub-location. Data was collected using a structured questionnaire that was administered to caregivers of the school going children, Stool samples were obtained from the children for examination of STHs infection. Overall prevalence of at least one of the STHs infections was 38.6% (152/394). The most frequent STHs were *A. lumbricoides,* hookworms and *T. trichiura* with a prevalence of 25.9 % (102/394), 10.4% (41/394) and 2.3 % (9/394), respectively. A total of 124 children had single or double STHs infections. Majority 77.42% (96/124) of the children had single infection and 22.58 % (28) had double infection. None of the stool samples had triple infection. Bivariate analysis using chi square test and α set at 0.05 threshold for statistical significance, confirmed that availability and kind of toilet facility, household drinking water source, washing of hands before meals, washing of fruits before eating, education level of caregiver and occupation of household head were the risk factors reported to be significantly associated with either of the three STHs infection. On the basis of these results, it can be concluded that STH infection is an important public health problem among school children in Kikumini sub-location. Therefore, the study highlights the need for the government through health sector and other concerned stakeholders to adopt the practice of preventive measures alongside chemotherapy approach to interrupt transmission and to achieve local elimination of helminthiasis in the area.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Soil-transmitted helminths are intestinal worms that infect humans and are transmitted mainly through contaminated soil. They include roundworms (*Ascaris lumbricoides),* whipworm (*Trichuris trichiura*), and hookworm (*Ancylostoma duodenale* and *Necator americanus).* They are considered together because it is common for a single individual, especially children living in less developed countries, to be chronically infected with all three worms. A large part of the world's population is infected with one or more of these soil-transmitted helminthes (WHO, 2012). They are mainly found in regions exhibiting warm and moist climates coupled with poor sanitation and hygiene. Soil transmitted helminthes have a far reaching impact on human health, economics and culture. Although individuals from all societies and regions play host to worms at some time in their lives, the highest rates occur among children in rural areas of the tropics and subtropics (Bethony *et* al., 2006). It is estimated about one third of the world, more than two billion people, are infected with intestinal parasites with an average prevalence of 50% in developed world and almost 95% in developing countries (WHO, 2009). In addition approximately 300 million people are severely ill with these worms and of these, at least 50% are school-age children (WHO, 2009).

School going children have been reported to be at highest risk for STHs due to the fact that as the child grows older the exposure to many of the risk factors for STHs increases.

Another factor for increased prevalence in children is their weak immune system and higher nutritional requirements which to many is unaffordable and unmanageable (Bundy *et al.,* 2003). Epidemiological research carried out in different countries has shown that the social and economical status of the individuals is an important cause in the prevalence of STHs. The effect of social economic situation on risk of infectious diseases in general, and STHs infections in particular, is complex in nature and attributed to several factors such as lack of environmental sanitation, low level of education, lack of access to safe water and improper personal hygiene and therefore occur wherever there is poverty (Vikram, *et al*., 2008). Another risk factor for STHs especially in children below 10 years is behavioral habits. This is in relation to geography, hygiene and sanitation. These Children are very active in terms of playing, where most of the games played involve interaction with soil in one way or another. Intestinal parasite eggs hide in fingernails and since most children do not wash their hands, the eggs find their way into the intestines via the mouth (Henry, 1981). Helminths mostly soil transmitted helminths, are associated with an increased risk for nutritional anemias, protein-energy malnutrition and growth deficits in children, low pregnancy weight gain and intrauterine growth retardation followed by low birth weight (Steketee, 2003). STHs rarely cause death but because of the size of the problem, the global number of related deaths is substantial. About 39 million disability adjusted life years (DALYs) are attributed to STHs and these infectious thus represent a substantial economic burden (WHO, 2009).

In 2001, WHO endorsed global strategy to control morbidity due STHs infection through regularly administering anti-helmintic drugs to populations that are at-risk (WHO, 2006). The review to assess the efficacy of chemotherapeutic intervention in line with the World Health Assembly (WHA) resolution since the passage in 2001, noted that since the adoption of the WHO resolution, great progress has been made in a number of sub-Saharan African countries in the control of STH infections and schistosomiasis via mass chemotherapy among school children. However, despite the increased awareness created and concern expressed by the WHO in 2001, 2000 million people are infected by schistosomes and soil-transmitted helminths worldwide, of which 300 million have associated severe morbidity (Uneke, 2010). The conclusion note made on the review was that the prevalence of these helminth infections remains very high even after mass chemotherapeutic intervention. Development of vaccines, environmental control measures and health education alongside regular treatment of school children is needed to ensure realization of the set resolution (Uneke, 2010).

In Kenya, prevalence studies done in various regions on STHs in children have shown high rates of STHs infection and still remain a public health concern. Machakos County in Eastern Province is considered a hardship region due to the vast terrain and hot weather rendering many susceptible to drought, malnutrition and parasitic infection due to water scarcity and the availability of few clean water sources (RoK, 2009). There is no current data on STHs infection in Machakos county thus this study aimed to determine the prevalence of the three STHs of public importance, that are; hookworms, roundworms and whipworms and establish their associated factors among children aged 5-10 years in selected schools in Kikumini sub-location, Machakos county in Eastern province, Kenya.

1.2 Problem Statement

Studies worldwide indicate that the prevalence, intensity and comorbidity of soil-transmitted helminths infections are predominant where poverty prevails, sanitation is inadequate or non-existent and where more health awareness and care is needed (Andrea *et al.,* 2012) with an average prevalence rate of 50% in developed world, and almost 95% in developing countries (WHO, 2009). In consideration of the dynamics, it is estimated that STHs result in 450 million illnesses worldwide (WHO, 2009). All the asserted factors are present and predominant in most developing countries, including Kenya, particularly in rural settings. Soil-transmitted helminths have devastating effects not only to children but also to parents/guardians. It has been confirmed that, STHs affect the nutritional status of the children in terms of appetite depression, food intake, competition for micronutrients, blood loss (anemia) and nutrient mal absorption (Hall, 2008). This eventually affects child growth and development, educational achievement as well as immune system.

In 2001, the World Health Organization endorsed preventative chemotherapy as the global strategy to control soil-transmitted helminthiasis. The key component of this strategy is regular administration of anti-helmintic drugs to at-risk groups; children, women of childbearing age, and adults in high-risk occupations such as night soil reuse and farming (WHO, 2006). Although this strategy reduces illness caused by soil-transmitted helminthes, studies have shown it does not prevent potent re-infections (Jia *et al*. 2012; Ziegelbauer *et al*. 2012). Despite various chemotherapeutic efforts and policies at the national levels by the government of Kenya and other stakeholders in health sector in Kenya and beyond, soil-transmitted helminth infections continue to be a public health concern. Most studies in Kenya have noted a considerable sustained level of prevalence despite the chemotherapy strategies put in place (Handzel *et al.,* 2003; Obala *et al*., 2013; Rijsptra *et al*, 2000; William, 2007; Akhwale *et al*., 2004). Diminutive attention has been given on surveillance of factors associated with soil transmitted Helminths among children and of particular school going children aged 5-10 years who are the most vulnerable population (WHO, 2009; WHO, 2006) yet in order to interrupt transmission and to achieve local elimination of helminthiasis, integrated control approaches that include access to sanitation and other complementary interventions of a primary prevention nature are needed (Andrea *et al.,* 2012; Ziegelbauer *et al*. 2012; Vikram, *et al*., 2008).

1.3 Justification

In 2001, the World Health Organization endorsed preventative chemotherapy as the global strategy to control soil-transmitted helminthiasis. The key component of this strategy is regular administration of anthelmintic drugs to at-risk groups; children, women of childbearing age, and adults in high-risk occupations such as night soil reuse and farming (WHO, 2006). Although this strategy reduces illness caused by soil-transmitted helminthes, studies have shown it does not prevent rapid reinfection (Jia *et al*. 2012; Ziegelbauer *et al*. 2012). This has been proven by high STHs prevalence studies done in other regions of Kenya (Handzel *et al.,* 2003; Obala *et al*., 2013; Rijsptra *et al*, 2000; William, 2007; Akhwale *et al*., 2004). Reinfection still remains a hindrance to reduction of the worm burden, it is therefore important to understand the effects of various demographic, economic, environmental sanitation and hygiene factors on STH infections hence the study.

Eastern region of Kenya is among the top four STHs prevalent regions in Kenya (Brooker *et al.,* 2009). Machakos county is considered a hardship region due to the vast terrain and hot weather rendering many susceptible to drought, malnutrition and parasitic infection (RoK, 2009). As yet there is no data at county and/or sub county levels on STHs infections exist. This study will provide information on the prevalence and the predisposing factors of STHs infections in Kikumini sub-location in Machakos County. Many studies regarding intestinal parasites in Kenya focus on establishing the prevalence and intensity of these infections in different populations, fewer studies have examined the factors that contribute to intestinal parasites infection. The study findings will therefore provide baseline information on factors associated with STHs infection that may be used by government and other stakeholders in child health care for instance; UNICEF for planning of well driven programs that will operate alongside current school deworming programs to achieve maximum control and prevention of STHs infections in Kenya.

1.4. Research questions

(1) What is the prevalence of Soil Transmitted Helminths infection among aged 5 to 10 years in selected primary schools in kikumuni sub-location, machakos county?

(2) What are the factors associated with Soil Transmitted Helminths infection among children aged 5 to 10 years in selected primary schools in kikumuni sub-location machakos county?

1.5 Objectives

1.5.1 General Objective

To determine Prevalence and factors associated with Soil Transmitted Helminths infection among children aged 5 to 10 years in selected primary schools in Kikumini sub-location, Machakos county.

1.5.2 Specific Objectives

(1) To determine the prevalence of Soil Transmitted Helminths among children aged 5 to 10 years in selected primary schools in Kikumini sub-location, Machakos county.

(2) To determine factors associated with Soil Transmitted Helminths among children aged 5 to 10 years in selected primary schools in Kikumini sub-location Machakos county.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction of Soil transmitted Helminthes

Soil-transmitted helminths are a group of parasitic nematode worms causing human infection through contact with parasite eggs or larvae that thrive in the warm and moist soil of the world's tropical and subtropical countries. Of particular worldwide importance STHs are roundworm (*Ascaris lumbricoides*), whipworm(*Trichuris trichiura*), and the anthropophilic hookworms (*Necator americanus* and *Ancylostoma duodenale*). *Strongyloides stercoralis* is also a common STH in some of these regions, although detailed information on the prevalence of strongyloidiasis is lacking because of the difficulties in diagnosing human infection (WHO, 2006). The life cycles of *Ascaris, Trichuris,* and hookworm follow a general pattern. The adult parasite stages inhabit the gastrointestinal tract (*Ascaris* and hookworm in the small intestine; *Trichuris* in the colon), reproduce sexually, and produce eggs, which are passed in human feces and deposited in the external environment. STH is categorized among neglected tropical diseases because it inflicts tremendous disability and suffering, which can be clinically treated, yet negligible attention has been given for many years (WHO, 2012).

2.2 Epidemiology of Soil transmitted Helminthes

The most striking epidemiological features of human helminth infections are aggregated distributions in human communities, predisposition of individuals to heavy (or light) infection, rapid reinfection following chemotherapy, and age-intensity profiles that are typically convex (with the exception of hookworm) (Hotez *et al*., 2005). For all the major human STH infections studied to date, worm burdens exhibit a highly aggregated (overdispersed) distribution so that most individuals harbor just a few worms in their intestines, although a few hosts harbor disproportionately large worm burdens (Anderson and May 1991). One feature that may help explain overdispersion is that individuals tend to be predisposed to heavy (or light) infections. Predisposition has been demonstrated for all four major STHs and the schistosomes. The underlying cause of such predisposition remains poorly understood. However, a combination of heterogeneity in exposure to infection or differences in susceptibility to infection and the ability to mount effective immunity (genetic and nutritional factors) is likely to be important.

Climate is an important determinant of transmission of these infections, with adequate moisture and warm temperature essential for larval development in the soil. Equally important determinants are poverty and inadequate water supplies and sanitation (Brooker *et al.,* 2006). In such conditions, soil-transmitted helminth species are commonly co-oendemic. There is evidence that individuals of all ages with many helminth infections have even heavier infections with soil-transmitted helminthes and the major source of environmental contamination. Because morbidity from these infections and the rate of transmission are directly related to the number of worms harboured in the host **(**Raso *et al*., 2004), intensity of infection is the main epidemiological index used to describe soil-transmitted helminth infection. The age-dependent patterns of infection prevalence are generally similar among the major helminth species, exhibiting a rise in childhood to a relatively stable asymptote in adulthood. Maximum prevalence of *A. lumbricoides* and *T. trichiura* is usually attained before five years of age, and the maximum prevalence of hookworm and schistosome infections is usually attained in adolescence or in early adulthood (WHO, 2012).

2.3 Transmission of Soil transmitted Helminthes

2.3.1 Roundworms *(Ascaris lumbricoides)* and whipworms *(Trichuris trichiura)*

When an infected person defecates, eggs from the worms are passed in the stool. If he or she does not use a latrine but defecates outside (near bushes, in banana grove, in the garden or in a rice field), the soil becomes contaminated with worm eggs. *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms are also spread when faeces are used as fertilizer. The vegetables may grow well but their leaves will be covered with worm eggs. Other people in the village and especially children playing on the ground become infected with the eggs. Their hands are covered with eggs so small they cannot see them. Somebody else will swallow the eggs without realizing it as they eat their food. When the eggs reach the intestine, they develop into adult worms (Crompton and Nesheim, 2002).

2.3.1a Life Cycle of roundworms *(Ascaris lumbricoides)*

Adult round worms 1 live in the lumen of the small intestine. A female may produce up to 240,000 eggs per day, which are passed with the feces 2. Fertile eggs embryonate and become infective after 18 days to several weeks 3, depending on the environmental conditions (optimum: moist, warm, shaded soil). After infective eggs are swallowed 4, the larvae hatch 5, invade the intestinal mucosa, and are carried via the portal, then systemic circulation to the lungs 6. The larvae mature further in the lungs (10 to 14 days), penetrate the alveolar walls, ascend the bronchial tree to the throat, and are swallowed 7. Upon reaching the small intestine, they develop into adult worms 1. Between 2 and 3 months are required from ingestion of the infective eggs to oviposition by the adult female. Adult worms can live 1 to 2 years.

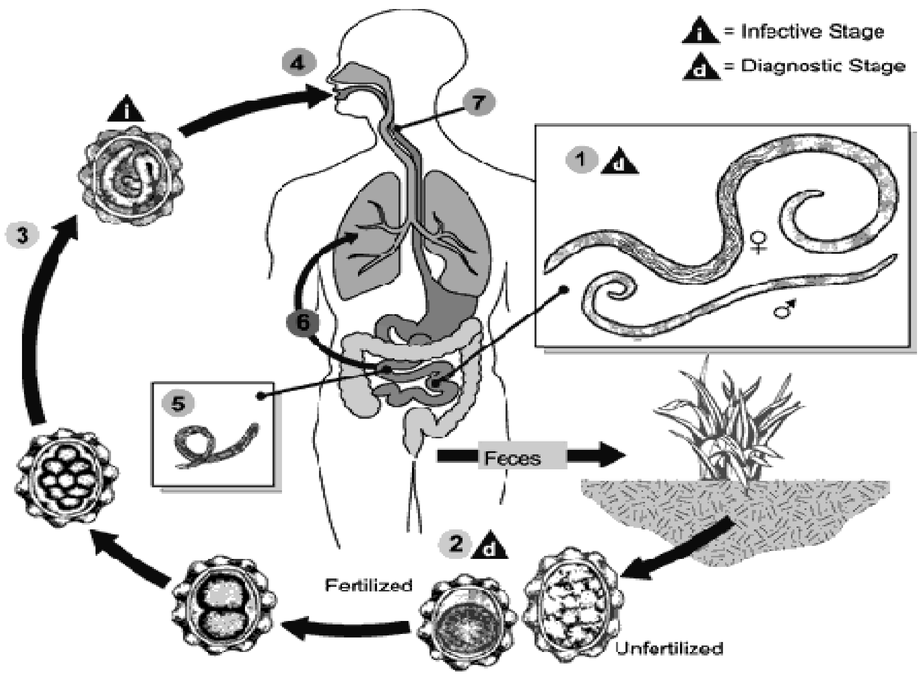

Figure 2.1: The life cycle of roundworms (*Ascaris lumbricoides*).
Source: Parasite images courtesy of the Division of Parasitic Diseases.

2.3.1b Life Cycle of whipworms *(Trichuris trichiura)*

The unembryonated eggs are passed with the stool 1. In the soil, the eggs develop into a 2-cell stage 2, an advanced cleavage stage 3, and then they embryonate 4; eggs become infective in 15 to 30 days. After ingestion (soil-contaminated hands or food), the eggs hatch in the small intestine, and release larvae 5 that mature and establish themselves as adults in the colon 6. The adult worms (approximately 4 cm in length) live in the cecum and ascending colon. The adult worms are fixed in that location, with the anterior portions threaded into the mucosa. The females begin to oviposit 60 to 70 days after infection. Female worms in the cecum shed between 3,000 and 20,000 eggs per day. The life span of the adults is about 1 year.

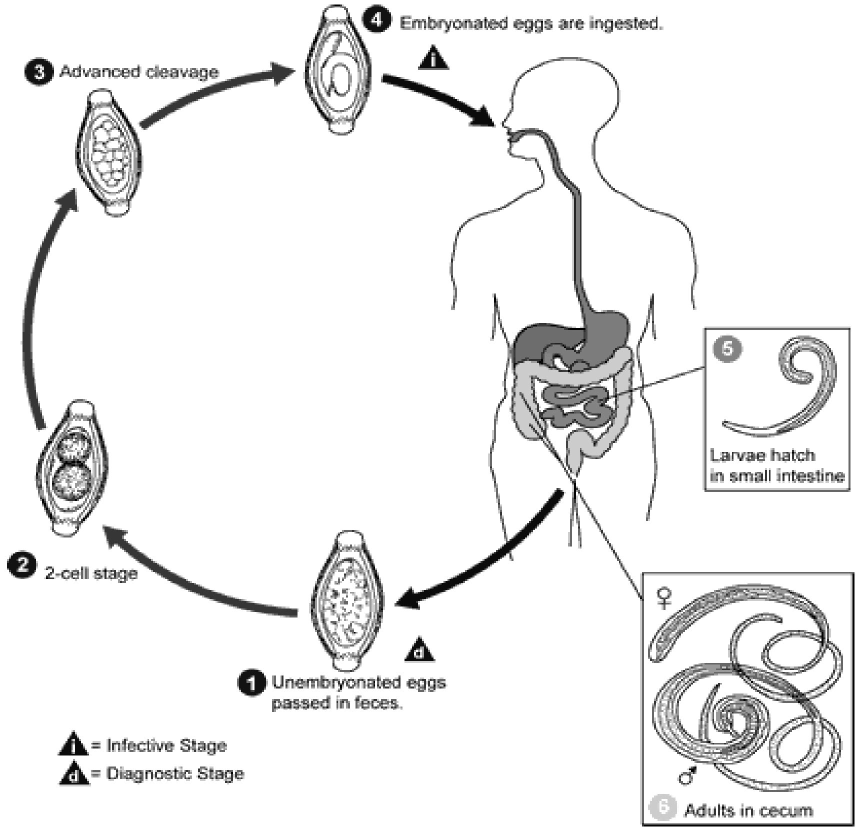

Figure 2.2: The life cycle of whipworms (*Trichuris trichiura*).

Source: Parasite images courtesy of the Division of Parasitic Diseases

2.3.2 Hookworms and the life cycle

Like the other parasites, hookworms are spread when an infected person does not use a latrine but defecates outside. Hookworm larvae can enter the body through any part that comes in contact with infected soil, although most often they penetrate the skin of the feet. In the body they travel through the lungs to the intestine, where they will grow into adults. The soil becomes infected with eggs from the parasite. The eggs hatch into larvae and the larvae burrow through the skin into the body. Others in the village become infected, especially if they do not wear shoes (Crompton and Nesheim, 2002).

Eggs are passed in the stool 1, and under favorable conditions (moisture, warmth, shade), larvae hatch in 1 to 2 days. The released rhabditiform larvae grow in the feces and/or the soil 2, and after 5 to 10 days (and two molts) they become become filariform (third-stage) larvae that are infective 3 These infective larvae can survive 3 to 4 weeks in favorable environmental conditions. On contact with the human host, the larvae penetrate the skin and are carried through the veins to the heart and then to the lungs. They penetrate into the pulmonary alveoli, ascend the bronchial tree to the pharynx, and are swallowed 4 The larvae reach the small intestine, where they reside and mature into adults. Adult worms live in the lumen of the small intestine, where they attach to the intestinal wall with resultant blood loss by the host 5. Most adult worms are eliminated in 1 to 2 years, but longevity records can reach several years. Some *A. duodenale* larvae, following penetration of the host skin, can become dormant (in the intestine or muscle). In addition, infection by *A. duodenale* may probably also occur by the oral and transmammary route. *N. americanus*, however, requires a transpulmonary migration phase.

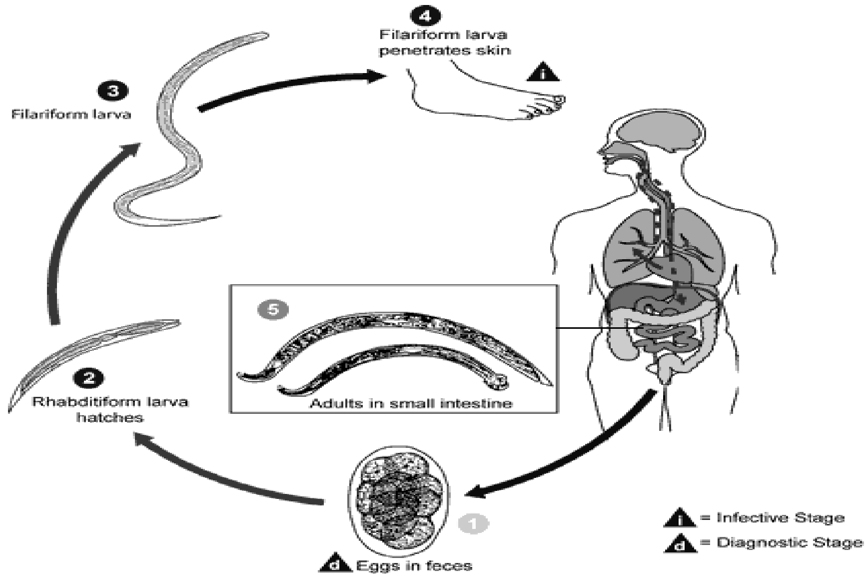

Figure 2.3 The life cycle of hookworms. **Source**: Parasite images courtesy of the Division of Parasitic Diseases

2.4 Diagnosis of Soil transmitted Helminthes

Diagnosis is by use of clinical signs that include; Loss of appetite and reduced absorption of food, Vitamin A deficiency (results in blindness, dry eyes), anemia (hookworm only), malnutrition, intestinal obstruction and abdominal pain result in cases of heavy infection with worms (Edelduok, *et al.,* 2013). Also physical performance decreases and a child does not do well at school (Hall, 2008). Laboratory diagnosis including several egg concentration techniques e.g formalin ethyl acetate sedimentation can detect even light infections. The Kato-Katz faecal-thick smear and the McMaster method are used to measure the intensity of infection by estimating the number of egg counts per gram of faeces. Ultrasonography and endoscopy are useful for diagnostic imaging of the complications of ascariasis, including intestinal obstruction and hepatobiliary and pancreatic involvement (Santos, *et al*., 2005).

2.5 Prevalence of Soil transmitted helminths infections

Worldwide estimates suggest that *A. lumbricoides* infects 1.221 billion people, *T. trichiura* 795 million, and hookworms 740 million (Hotez, *et al*., 2009). More than a billion people are infected with at least one species. The greatest numbers of STH infections occur in the Americas, China and East Asia, and Sub-Saharan Africa. According to WHO, the prevalence of STHs infections in Asia is 52.8%, Europe below 5% and America 6.2% (WHO, 2012). Across Africa, studies conducted on STHs have shown wide distribution. For instance a study conducted in Onicha, south-eastern Nigeria to determine the prevalence of STH infection among schoolchildren found that *Ascaris lumbricoides* was the predominant nematode (10.8%), hookworm (4.3%), *Trichuris trichiura*, (1.2%) and *Strongyloides stercoralis* (0.6%). The males were more infected than the females with 18.3% versus 15.5% for females (Uneke, *et al*.,2006). A study done in Ethiopia as reported by Alemu *et al*., (2011) on soil transmitted helminths, *Ascaris lumbricoides* was the predominant isolate (22%) followed by Hookworms (19%) and *Trichuris trichiura* (2.5%). *Schistosoma mansoni* was also isolated in 37.9% of the study participants. Hookworm and *S. mansoni infections* showed *s*tatistically significant associations with shoe wearing and swimming habit of school children, respectively. In Kenya, intestinal parasites are a public health concern. The table below presents the median prevalence of STHs species infection (inter-quartile range, minimum and maximum) (*n*) by first-level administrative boundary for Kenya (Province), 1980-2009 (Brooker *et al*., 2009).

Table 2.1: The median prevalence of STHs species infection in Kenya by Province 1980-2009

	Hookworm	***A. lumbricoides***	***T. trichiura***
National level	**12.5 (4-33, 0, 100) (847)**	**14.3 (3-36, 0, 91) (842)**	**6.9 (2-20, 0, 98) (785)**
Province level			
Nairobi	-	-	-
Central	5.1 (1-13, 0, 44) (176)	15.0 (1-46, 0, 75) (176)	0.9 (0-2, 0, 20) (161)
Coast	15.1 (1-50, 0, 100) (173)	9.1 (2-29, 0, 69) (173)	15.7 (6-40, 0, 98) (163)
Eastern	5.3 (3-11, 0, 41) (58)	3.2 (1-9, 0, 27) (50)	1.8 (1-3, 0, 32) (47)
North Eastern	0.0 (0-0, 0, 0) (17)	0 (0-0, 0, 2) (17)	0.0 (0-0, 0, 1) (15)
Nyanza	17.6 (8-33, 0, 91) (349)	18.5 (7-37, 0 , 91) (352)	11.9 (4-20, 0, 71) (329)
Rift Valley	1.3 (0-7, 0, 30) (23)	0.9 (0-12, 0, 43) (21)	0.3 (0-2, 0, 13) (20)
Western	79.4 (65-85, 31, 95) (51)	32.0 (25-55, 0, 89) (53)	40.2 (29-70, 9, 96) (50)

Studies conducted on school children in poor peri-urban and urban communities in Nairobi showed high prevalence of *Ascaris lumbricoides* (82%) and *Trichuris trichiura* (60%) (Rijsptra *et al*, 2000). A study to determine the prevalence of soil-transmitted helminth (STH) among school children aged 5-15 years in Bondo district, Nyanza Province, Kenya revealed an overall STH prevalence of 18.4%. *Ascaris lumbricoides* had the highest prevalence at 8.6% followed by Hookworms 5.7%, *Trichuris trichuria* 3.7% and *Strongyloides stercoralis* 0.2% respectively. Children belonging to the age group of 5-7 years were more infected with STHs than those of older age groups (William, 2007). Recent studies carried out at various locations in Western highlands of Kenya, showed that there was high prevalence of many intestinal parasites such as *Ascaris lumbricoides* (10%), hookworm (4%) and *Trichuris trichuria* (0.1%) (Akhwale *et al*., 2004). 63% overall prevalence of STHs reported by Handzel *et al*., (2003) on implications for anthelminthic mass treatment in western kenya, *Ascaris lumbricoides (*25.9%) hookworm (42.5%) and *Trichuris trichuria* (17.9%) .

2.6 Risk Factors for Soil transmitted Helminths

Both host-specific and environmental factors have been identified that may affect the risk of acquiring or harboring heavy intensity helminth infections**.**

2.6.1 Genetics

Genes that control human helminth infection have not been identified. However, recent genome scans have identified a locus possibly responsible for controlling *S. mansoni* infection intensity on chromosome 5q31-33 and loci controlling *A. lumbricoides* intensity on chromosomes 1 and 13. There is also evidence for genetic control of pathology attributable to *S. mansoni,* with linkage reported to a region containing the gene for the interferon gamma receptor 1 subunit (Quinnell, 2003).

2.6.2 Behavior, Household Clustering and Occupation

Specific occupations, household clustering, and behaviors influence the prevalence and intensity of helminth infections (Bethony *et a*l., 2006). particularly for hookworm, in which the highest intensities occur among adults Engagement in agricultural pursuits, for example, remains a common denominator for hookworm infection. Behavioral and occupational factors, through their effect on water contact, interact with environmental factors to produce variation in the epidemiology of schistosomiasis (Brooker *et al.,* 2006).

2.6.3 Poverty, Sanitation, and Urbanization

Soil transmitted helminths and schistosomiasis depend on environments contaminated with egg-carrying feces for transmission. One indicator of state of living in society in regard to environmental sanitation and socioeconomic status is prevalence of soil transmitted helminthes (Vikram *et al*., 2008). Consequently, helminths are intimately associated with poverty, poor sanitation, and lack of clean water. For instance; According to Andrea *et al., (*2012), social determinants for example poverty that mostly lead to low level of education of mothers has been associated with STHs in children. Parents with high levels of education provide good sanitary practices to their children as compared to children whose parents have low levels of education especially in socio economic challenged areas. Improper hygiene in children is closely associated with parents level of education. Environmental factors known to cause STHs are related to water supply and availability of toilets and behavioral habits. According to Ziegelbauer *et al*. (2012), systematic review and Meta-Analysis study on effect of Sanitation on Soil-Transmitted Helminth Infection found that the availability and use of sanitation facilities were associated with a reduction in the prevalence of infection with soil-transmitted helminths. Therefore, the provision of safe water and improved sanitation are essential for the control of helminth infection. Although the STH and schistosome infections are neglected diseases that occur predominantly in rural areas, the social and environmental conditions in many unplanned slums and squatter settlements of developing countries are ideal for the persistence of *A. lumbricoides* (Crompton and Savioli 1993). Schistosomiasis transmission can also occur in urban areas.

2.6.4 Climate, Water and Season

Adequate warmth and moisture are key features for each of the STHs. Wetter areas exhibit increased transmission, and in some endemic areas, both STH and schistosome infections exhibit marked seasonality (Brooker and Michael 2000). Recent use of geographical information systems and remote sensing has identified the distributional limits of STH and schistosomes on the basis of temperature and rainfall patterns (Brooker and Michael 2000). For schistosomiasis, specific snail intermediate hosts prefer certain types of aquatic environments. Construction of dams is known to extend the range of snail habitats, thereby promoting the reemergence of schistosomiasis. Lack of health promotion and nutritional interventions are great risk factors that have been associated with STHs infections.

2.7 Public health significance of STHs in children

STHs present a major public health challenge by virtue of their high prevalence, widespread distribution and consequences on health (WHO, 2012). However its challenging to assess their significance on public health since most infections are asymptomatic and have low mortality and morbidity. Risks associated with STHs are high in children below 14 years compared to other age groups due to their less mature immune system and high nutritional requirements (Brooker *et al.,* 2006). This in turn affects metabolism, excretion, transport, energy and nutrient intake. Epidemiological data show that infections occur at very young age between one and two years and intensity and prevalence increase with age (Hall, 2008). Research has shown that children infected with roundworms are more likely to suffer from stunting compared with non- infected children. One major causations of anemia in the world is infection with hookworm. Infection with this parasite cause inflammation of intestinal lining causing gastrointestinal bleeding. Loss of blood rich in major nutrients cause poor child growth. The effects of roundworms and hookworms has been shown to affect cognitive functions and school performance of children .

2.8 Control and prevention of STHs

A high prevalence of STHs, poor hygiene and malnutrition is an indicator of a country's future economical, social and physical problems. This is an indication that priority should be given to eradicating STHs worldwide. World Health Organization has recommended three interventions measures to control morbidity due to STH infections. This includes regular drug treatment of high-risk groups for reduction of the worm burden over time, health education and sanitation supported by personal hygiene aimed at reducing soil contamination. In areas where transmission of STHs is intense, drug treatment offers the best approach. School based deworming is preferable for areas where rates of transmission and reinfection are high. Drugs such as albendazole, levamisole, mebendazole and pyrantel are reccomended for public health treatment of STH infections (WHO, 2006). For deworming to be effective and sustainable, environmental health, access to safe water and improved hygienic behavior are essential. Health education aims to improve health and increase hygiene awareness and to change health-related behavior in the population (Ziegelbauer *et al*., 2012).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted in four public rural primary schools namely, Kikumini, Makila, Ulutya and Tulimyumbu in Kikumini sub-location of Masinga district in Machakos county. Kikumini primary school had 203, Makila primary school had 186, Ulutya had 209 and Tulimyumbu had 213 children aged 5-10 years . All the four schools had improved toilet facilities that had cemented floors and walls with slabs. In addition all the four schools had at least a tank for water but the tanks only stored water during rainy seasons meaning that during dry seasons there was no water in the schools.

The sub-location has a population of 4,514 (KNBS, 2009). It covers an area of 51.71 Km^2 with population density of 87.29 persons/km^2. Kikumini sub-location is mainly inhabited by the Kamba community. The main economic activities in the area include: Small scale farming (maize, beans, peas and fruits), mining of building stones, sand harvesting and livestock keeping. Most of Machakos county is generally semi-arid and suffers from regular droughts, with a severe impact on the livelihood of the community.

Regarding environmental issues, drought, soil erosion, deforestation, and desertification are all current problems in the county. The poverty levels in the County are at 59.6 % (KIHBS, 2009). Soil transmitted helminths (STH) infections affect more than one-third of the world's population with the highest rates in school-age children (WHO, 2012), epidemiological information on prevalence status and associated factors is scanty at the lowest sub-national administrative levels. For instance in the county within which the region of study is covered, no prevalence data at county level and/or sub-county level on prevalence exist yet the entire Eastern region of Kenya is among the top four STHs prevalent areas in Kenya (Brooker *et al.*, 2009). The county is considered a hardship region due to the vast terrain and hot weather rendering many people susceptible to drought, malnutrition and parasitic infection due to water scarcity and the availability of few clean water sources (RoK, 2009).

Figure 3.1. Map of the Study Area

3.2 Study Design

This was descriptive cross sectional study which utilized quantitative techniques.

3.3 Study population

The study population included children aged 5 - 10 years. The population was drawn from four primary schools selected randomly among six schools in Kikumini sub-location.

3.3.1 Inclusion Criteria

1. Within targeted age category of 5 to 10 years
2. Eligible children whose caregivers gave assent to the study in full

3.3.2 Exclusion Criteria

1. Not within targeted age category of 5 to 10 years.
2. Eligible children whose caregivers declined assent.
3. Ailing children who were not in position to give stool.

3.4 Sample Size Determination

Fisher formula (Fisher *et al.,* 1998) was used to determine the desired sample size. The samples size allowed for estimation of prevalence of Soil Transmitted Helminths infection (STH).

$$n = \frac{Z^2{}_{1-\alpha/2} P(1-P)}{d^2}$$

Where;

n= Minimum sample size required

α= Level of significance (0.05)

$Z_{1-\alpha/2}$= Standard normal deviate at 95% Confidence Interval (1.96)

P = Assumed prevalence of STH among school going children in Machakos County, Kenya (50%)

d= Absolute precision/Margin of error (0.05). The minimum sample size required for the study was 385 children. Allowing for 10% non-response, the sample size was adjusted upwards to 424 children.

3.5 Sampling procedure

The study utilized cluster approach defined here as schools due to homogeneity. Based on the central limit theorem, the number of clusters were determined by dividing the sample size (n=424) with the minimum acceptable sample per cluster (100 pupils) yielding 4 clusters that formed the study sampling frame.

The study adopted a 2-stage sampling procedure from selection of school to pupils. **Level 1:** A list of all schools in Kikumini sub location, Machakos county was obtained from the District Education office. Four (4) out of six (6) schools within Kikumini sub location were randomly selected. **Level 2:** A registration list of pupils (aged 5 – 10 years) from the selected schools was obtained from the principal's office. The sample size which was determined earlier was used to calculate the proportion of pupils to be selected from each school using Probability proportional to size allocation (PPS). Using registration list, simple random sampling method was employed to select pupils from each school using a table of random numbers and when the selected pupil was absent student before or after the indicated one was sampled for replacement. The head teachers of the selected schools assisted in recruitment of parents of the selected children by sending the parents a request note through their children to come to school on the days agreed on with the principal investigator. Upon the parents turn out in the school, the principal investigator explained to them about the study in confidential manner. Issue of informed consent risks and benefits, voluntariness, confidentiality and procedure of the study were well explained to the care givers of the children .Thereafter, the parents were requested to consent on behalf of their children.

3.6 Data collection methods

3.6.1 Structured questionnaire

This was a school-based study that used structured interviewer administered questionnaire for collection of data, which was mainly quantitative. After written consent and finger print (for a few who did not know to read and write) was obtained from the caregivers of participating children, the caregivers were interviewed using a pre-tested structured administered in English, Swahili or the local language for those who did not understand English or Swahili languages (translated by the interviewers who read and understood the local language) at school. The questionnaire captured issues relating to the household Socio demographics, economic, hygiene practices, environmental sanitation information and health history status of children aged 5 to 10 years in the selected schools. All questionnaires were labeled well with each participant identification number (Appendix III).

3.6.2 Stool Sample collection

Stool samples were collected from children who met inclusion criteria in the selected schools by trained personnel. Upon explanation of the procedures to caregivers, children were requested to provide stool samples into a tight fitting lid plastic cup containing 10% formalin. In cases where the stool was not available immediately, arrangements were made to pick the stool sample at an agreed time. All stool specimens were properly labeled with the subject's identification number, age, sex and date of collection. Since two of the schools had source of power, stool samples of children who schooled there were analyzed from the schools. The other two schools, the stool samples were transported to the area health centre (Kikumini) laboratory for processing within 30 minutes of collection from the school.

3.6.3 Analysis of stool samples

About 20-40 grams of stool was used for examination for STHs parasites at the two schools that had electricity and at Kikumini health centre laboratory for the other two schools since they did not have electricity. Stool samples were processed and examined using the qualitative formol-ether concentration method for the presence of STHs parasites (Appendix IV).

3.7 Data management and analysis

Quantitative data from the field (Questionnaires) was double entered into a computer database designed using MS-Access application. Regular file back-up was done to avoid any loss or tampering. Data cleaning and validation was performed in order to achieve a clean dataset that was exported into a Statistical Package format (SPSS version 20.0) to be analyzed. All questionnaires were stored in a lockable drawer for confidentiality. Quantitative data analysis was conducted using SPSS version 20.0 statistical software. Univariate analysis: Descriptive statistics such as proportions were used to summarize categorical variables while measures of central tendency such as mean, standard deviation, and range for continuous variables. Bivariate Analysis: Pearson's Chi-square test was used to test for association between categorical variables. All independent variables were associated with the dependent variable (*occurrence of a STH*) to determine which ones had significant association. The threshold for statistical significance was set at $\alpha = 0.05$. The threshold for statistical significance was at $\alpha = 0.05$ and a two-sided *p* value at 95% confidence interval (CI) reported for corresponding analysis.

3.8 Ethical Considerations

Clearance for the study was sought from the Scientific Steering Committee and Ethical Review Committee of KEMRI. District Education officer and headmasters of different schools of study were informed about the study and permission to conduct the study in their selected primary schools sought. Caregivers were informed so that they fully understood the nature, objectives and possible benefits of the study to them and the community as well as any possible harm. The risks and benefits of participation in the survey were explained to caregivers. In this particular study, no harm was anticipated. The caregivers of the children were explained about the data collection including stool collection procedures. Assent to collect the data was obtained from caregivers using consent form. Advice was given to caregivers of children who were found to be sick to take them for medical examination and or treatment in the nearest health facility. Caregivers were assured of confidentiality; none of their names or those of their children were to be used in any report and that any other detail concerning the data would be kept in confidence.

CHAPTER FOUR

4.0 RESULTS

4.1 Selected Socio-Demographic characteristics of children and caregivers

In this study, a total of 441 school going children aged 5-10 years were recruited from four primary schools (Makila, Kikumini, Ulutya, Tulimyumbu) randomly selected within Kikumini Sub-Location, Masinga District, Machakos County.

4.1.1 Distribution of the study children by school

Among the 441 school going children; 23.4% were from Makila, 24.9% from Kikumini, 25.6% from Ulutya and 26.1% from Tulimyumbu primary schools (Table 4.1).

Table 4.1: Distribution of study children by school

School	Number	%
Makila	103	23.4
Kikumini	110	24.9
Ulutya	113	25.6
Tulimyumbu	115	26.1
Total	441	100

4.1.2 Sex and Age of the children

Approximately fifty one (50.6%) of the children were male and 49.4% were female. Overall mean age of the children was 7.86 ±1.80 ranging from 5-10 years. Majority (25.5%) of the children were aged 10 years while 12% were aged 6 and 7 years (Table 4.2).

4.1.3 Relationship of caregivers to the children

Majority (85.5%) of the caregivers were mothers to the children, grandfathers comprised 0.7%, neighbours comprised 0.7% and the least proportion comprised 0.2% who were uncles (Table 4.2).

4.1.4 Marital status of Caregivers

Majority of the caregivers of the children were married 90.9% (Table 4.2).

Table 4.2 Selected socio demographic characteristics of the children and caregivers

Gender of the children	**Number**	**%**
Male	223	50.6
Female	218	49.4
Total	441	100
Age of children in years		
5	70	15.9
6	53	12
7	53	12
8	67	15.2
9	85	19.3
10	112	25.5
Total	440	100
Caregiver relationship to child		
Mother	377	85.5
Father	17	3.9
Sibling	20	4.5
Grandmother	16	3.6
Aunt	4	0.9
Grandfather	3	0.7
Uncle	1	0.2
Neighbour	3	0.7
Total	441	100
Marital status of the caregivers		
Single	17	3.9
Married	401	90.9
Separated and divorced	13	2.9
Widowed	10	2.3
Total	441	100

4.2 Selected Socio-Economic characteristics of caregivers

4.2.1 Level of education of the caregivers

The majority (41.4%) of the caregivers had completed primary level education while 26.8% had not completed primary school education, 21.1% had secondary education and 7.3% had tertiary education. However, 3.4% did not have any formal education (Figure 4.2).

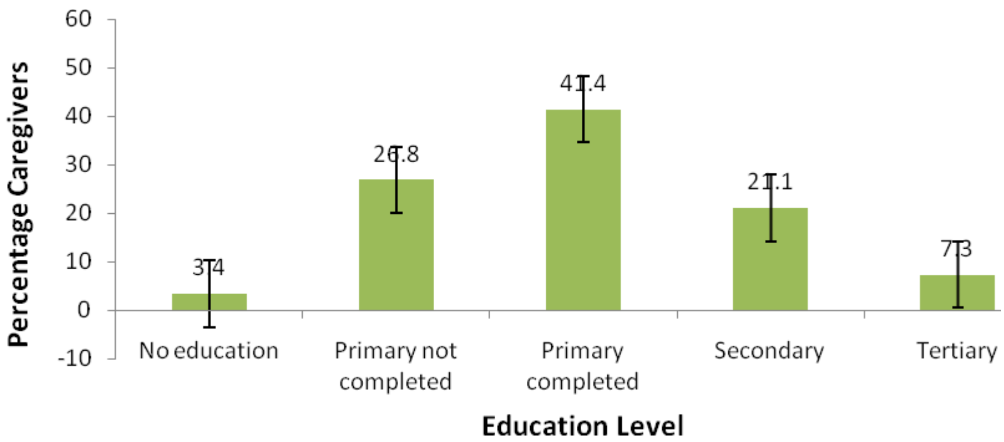

Figure 4.1: Distribution of caregivers by the level of education

4.2.2 Occupation of Household heads

The majority (28.6%) of household heads reported being casual laborers, 27.2% were self-employed and farmers comprised 26%, the unemployed were 7.3% as shown in the table below (Table 4.3).

Table 4.3: Distribution household heads by occupation

Occupation of Household heads	Number	%
Farming	111	26
Formal employment	47	11
Self-employment	116	27.2
Casual laborer	122	28.6
Unemployed	31	7.3
Total	427	100

4.3 Hygiene practices among the children

4.3.1 Washing of hands after defecation/toilet among the children

Majority (66.7%) of the children reported washing of hands occasionally after defecation and 29.9% did not wash their hands. However 3.4% always washed their hands after defecation. Among those who washed hands, 77.7% used plain water while 20.4% used water and soap. Children who used ash, soil and sand were 0.6% for each (Table 4.4).

4.3.2 Hand washing before meals among the children

Children who washed hands before meals were 11.7% while those who did not wash hands comprised 14.9%. However, majority (73.4%) of children reported washing their hands occasionally before meals. Further, 70.7% of the children sometimes washed fruits before eating while 23.8% did not wash fruits before eating and 5.5% of the children always washed fruits before eating (Table 4.4).

4.3.3 Wearing shoes while on soil grounded areas among the children

Majority (83.2%) of the children reported wearing shoes occasionally with 7.7% children who always wore shoes and 9.1% did not wear shoes while on grounded areas (Table 4.4).

Table 4.4: Hygiene practices among the children

Washing hands after defecation	Number	%
Yes	15	3.4
No	132	29.9
Sometimes	294	66.7
Total	441	100
Mode of hand washing among the children		
Plain water	240	77.7
Water and soap	63	20.4
Ash	2	0.6
Soil	2	0.6
Sand	2	0.6
Total	309	100
Washing hands before meals among the children		
Yes	51	11.7
No	65	14.9
Sometimes	320	73.4
Total	436	100
Washing fruits before eating among the children		
Yes	24	5.5
No	103	23.8
Sometimes	306	70.7
Total	433	100
Wearing shoes when and to soil grounded areas among the children		
Yes	33	7.7
No	39	9.1
Sometimes	357	83.2
Total	429	100

4.4 Environmental sanitation in the households

4.4.1 Household source of drinking water

Majority 50.9% of the children households' source of water was dug well followed by borehole (19.6%) and surface water (16.9%). 12.6% of the households had piped water as source of drinking water. Of the total 50.9% of the households that used dug well water, 17.9% dug wells were protected/covered while 82.1% were unprotected. 38.6% of the households treated their water before drinking while 61.4% did not. Most (82.7%) of the households used commercially available tablets to treat their water and 0.6% used ash to treat water among others (Table 4.5).

4.4.2 Ownership of toilet facility

Households that had toilet facility were 95.2% while 4.8% did not have toilet facility hence practiced open defecation (Table 4.5).

4.4.3 Type of toilet facility in the households

The majority (99.8%) households had pit latrines and only one household had flush toilet. With regard to ventilation status, households with improved ventilated pit latrines were 72.8% and 27.2% latrines were not well ventilated. Regarding floor and wall type, majority 49.2% of pit latrines were earthed without slab and few 2.1% of the pit latrines were cemented with slab (table 4.5).

4.4.4 Sharing of toilet facility with other households

Majority (83.1%) households did not share their toilet facility with other households. However, some 16.9% of the households shared toilet facility with others (Table 4.5).

Table 4.5: Distribution of Water and sanitation facilities in the households

Household Water source	Frequency	%
Piped water	55	12.6
Bore hole	86	19.6
Surface water	74	16.9
Dug well	223	50.9
Total	438	100
Well protection status		
Protected	40	17.9
Unprotected	183	82.1
Total	223	100
Treatment of water before drinking		
Yes	169	38.6
No	269	61.4
Total	438	100
Mode of water treatment		
Boiling	24	14.3
Commercially available tablets/liquids	139	82.7
Filtering	4	2.4
Ash	1	0.6
Total	168	100
Ownership of toilet facility		
Yes	420	95.2
No facility/open defecation	21	4.8
Total	441	100
Kind of toilet facility		
Flush or pour flush toilet	1	0.2
Pit latrine	419	99.8
Total	420	100
Improved ventilated latrine status		
Yes	278	72.8
No	104	27.2
Total	382	100
Kind of pit latrine		
Pit latrine cemented with slab	9	2.1
Pit latrine cemented without slab	150	35.8
Pit latrine earthed with slab	54	12.9
Pit latrine earthed without slab	206	49.2
Total	419	100
Sharing of toilet with other households		
Yes	71	16.9
No	349	83.1
Total	420	100

4.5 Health History of children

4.5.1 Intestinal worms drug administration for the past six months

Children who had taken drugs for intestinal worms in the past six months were 52.3% while 47.7% of the children had not (Table 4.6).

4.5.2. Drugs for any illness in the last two weeks among the children

59.3% of the children had not taken any drugs for any illness for the last two weeks at the time of study while 40.7% of the children had taken. Antimalarial drugs were the most taken drugs with 69.8% of the children. Anti-diarrhoea with 18.4%, painkillers with 10.1% of the children and other (herbal) drugs accounted for 1.7% of the children (Table 4.6). Drugs especially anti-parasitic ones taken in a maximum of two weeks period deter detection of intestinal parasites during stool analysis and hence this information was important to consider during stool analysis.

Table 4.6: Health history of the children

Drugs taken for intestinal worms in the past six months	**Number**	**%**
Yes	229	52.3
No	209	47.7
Total	438	100
Drugs for any illness in last two weeks		
Yes	179	40.7
No	261	59.3
Total	440	100
Drugs taken for any illness in last two weeks		
Antimalarial	125	69.8
Anti-diarrhoeal	33	18.4
Painkiller	18	10.1
Others(herbal)	3	1.7
Total	179	100

4.6 Prevalence of STHs among school going children

Out of 441 school going children in the study, 394 (89%) stool samples were analyzed. With regard to visual inspection, a total of 7 (2%) stool samples were in a form that could not be analyzed hence excluded from analysis. A total of 40 (9%) school going children did not manage to give stool samples even after follow up (Figure 4.2).

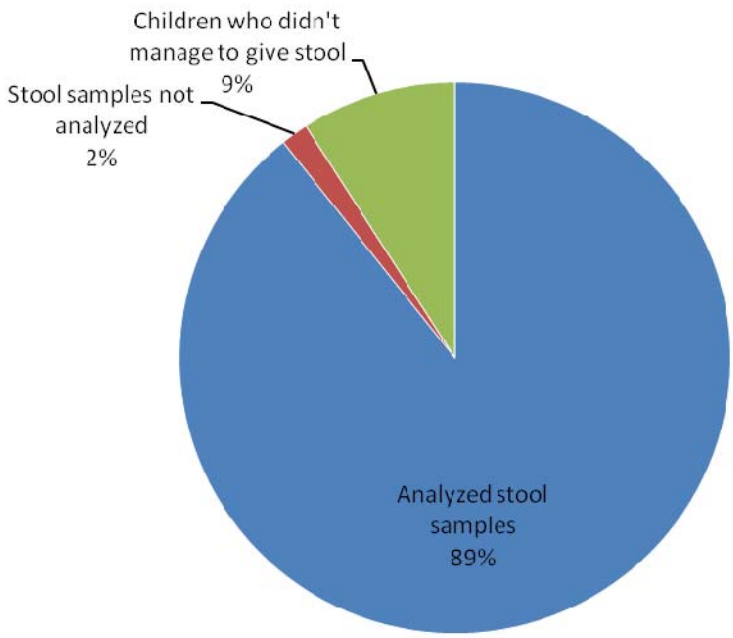

Figure 4.2: Stool samples collected from the children

Of the 394 school going children 77 (19.5%) were from Makila, 101 (25.6%) from Kikumini, 102 (25.9%) from Ulutya and 114 (28.9%) from Tulimyumbu primary schools. 152 (38.6%) out of 394 stool samples tested positive for either of the three STHs (*A.lumbricoides*, *T. trichiura* or hookworm. Overall prevalence of STHs by school was 38

(25%) Makila, 35 (23%) Kikumini, 26 (17.1%) Ulutya and 53 (34.9%) for Tulimyumbu primary school (Figure 4.3) while prevalence of each of the three STHs by school were as shown in the Figure 4.4.

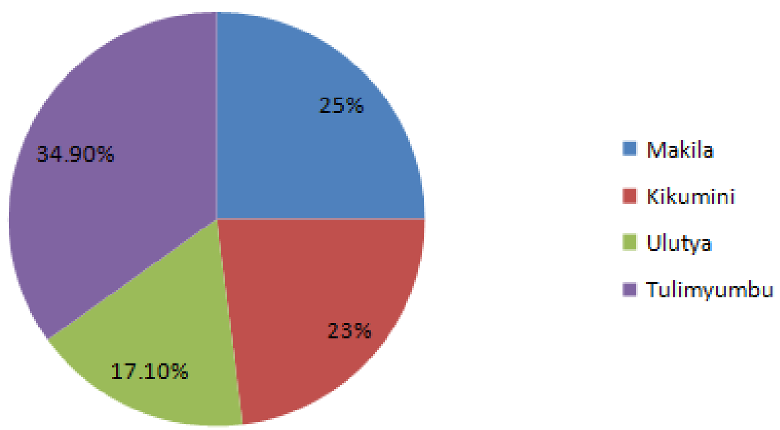

Figure: 4.3: Overall STHs prevalence by school

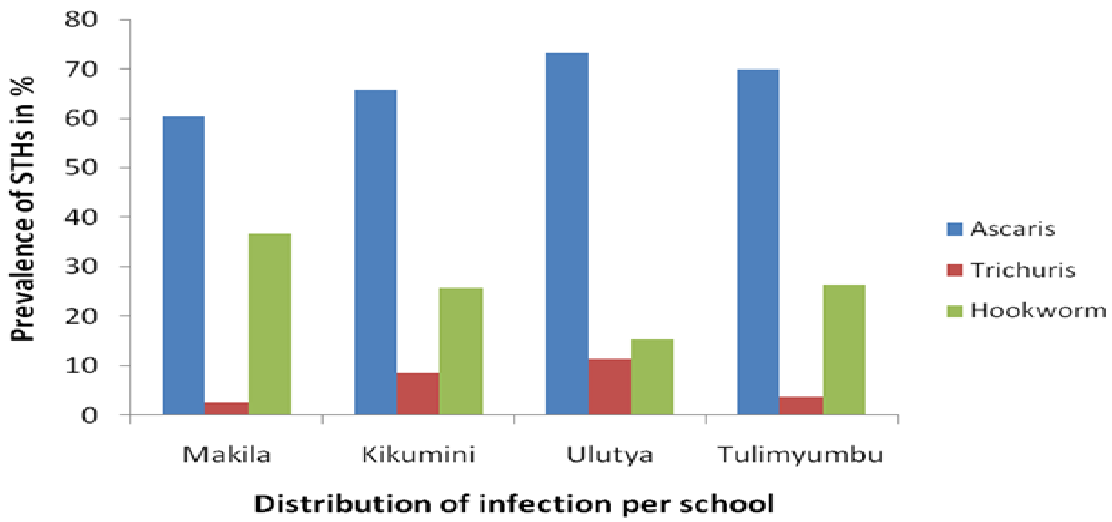

Figure 4.4: Prevalence of the three STHs by school

The most frequent STHs were *A.lumbricoides* 102 (25.9%), followed by Hookworms 41 (10.4%) and *T. trichiura* 9 (2.3%) (Figure 4.5).

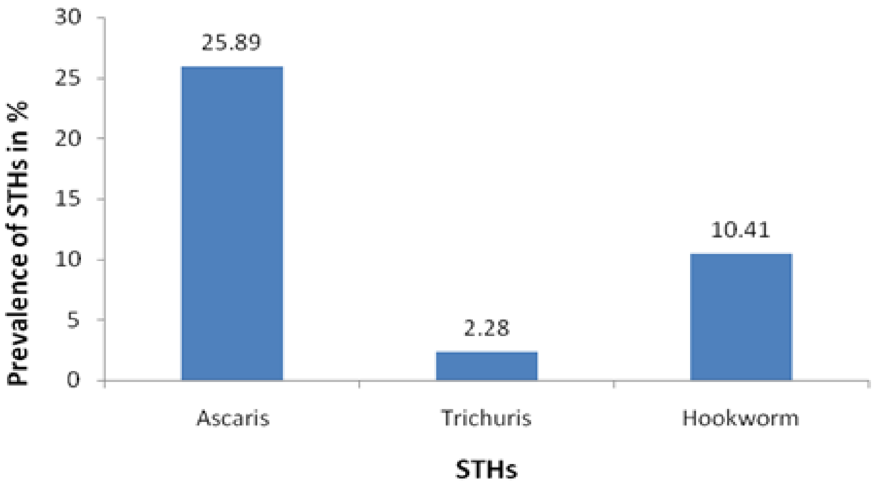

Figure 4.5: Prevalence of STHs

A total of 124 pupils reported single or double STHs infection. None of the pupils had triple infection. 96 (77%) of the children had single infection with high rates being infection of *A. lumbricoides* 74 (59.7%), followed by hookworm 15 (12.1%) and *T. trichiura* 7 (5.7%). On the other hand, 28 (23%) of the children had double infection. The most frequent combinations of helminths were double infection of *A. lumbricoides* and hookworm 26 (20.97%) followed by both *A. lumbricoides and T. trichiura* and *T. trichiura* and hookworm with 1 (0.8%) each (Figure 4.6).

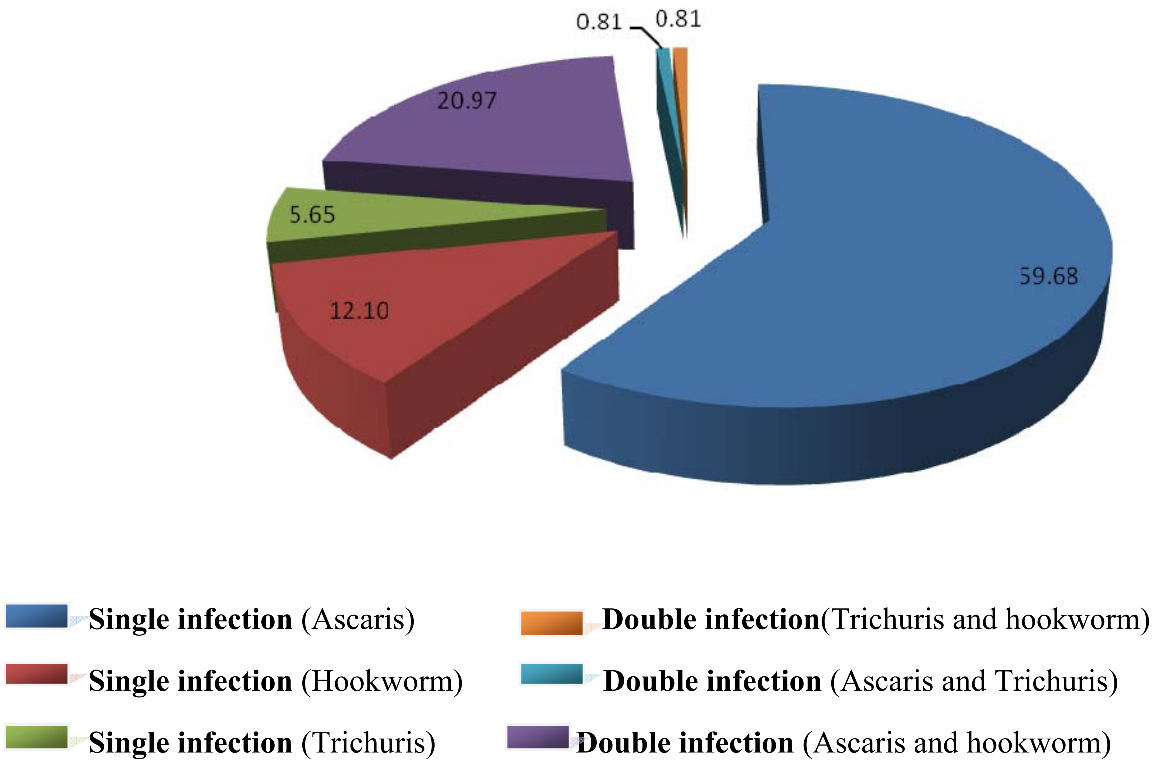

Figure 4.6: Distribution of STHs single and double infection among school going children

4.7 Association of the risk factors with the prevalence of STHs among school going children

4.7.1 Socio demographic characteristics and prevalence of STHs

Bivariate analysis using chi square test on the socio-demographic characteristics of the children revealed that sex was not significantly associated with prevalence of any of the three STH. However females were at higher risk of STHs infection compared to males with (29%) and (22.9%) females and males respectively infected with *A. lumbricoides*, (2.6%) females and (2%) males infected with *T.*

trichiura and (11.4%) females (9.5%) males infected with hookworm (Table 4.7). Age of the children did not have any significant association with infection by any of the three STHs. Marital statuses of the caregivers were not significantly associated with infection by any of the three STHs among the school going children (Table 4.7).

4.7.2 Socio economic factors and prevalence of STHs

Education level of caregivers was significantly associated with hookworm infection (χ^2 =92.19; df=14; p<0.02) and insignificantly associated with *A. lumbricoides* or *T. trichiura* infection. Moreover, the occupation of the household head was significantly associated with hookworm infection (χ^2 =17.34; df=8; p=0.027).

Table 4.7: Relationship between Socio demographic, economic factors and prevalence of STHs among children

Variable	Number of subjects tested	Number Infected			% infection			Test statistic	P value
		A	T	H	A	T	H		
Sex of children								**A** χ^2 =5.68; df=2	0.058
Male	201	46	4	19	22.9	2.0	9.5	**T** χ2 =3.72;df=2	0.156
Female	193	56	5	22	29.0	2.6	11.4	**H** χ2 =1.36; f=2	0.506
Age of children									
5 years	54	13	0	3	5.6	0.0	5.6	**A** χ^2 =6.45; df=10	0.776
6 years	46	12	0	7	15.2	0.0	15.2		
7 years	49	12	1	8	16.3	2.0	16.3	**T** χ^2 =8.38; df=10	0.592
8 years	56	20	1	7	12.5	1.8	12.5		
9 years	80	15	2	3	3.8	2.5	3.8	**H** χ^2=13.52; df=10	0.196
10 years	108	29	5	12	11.1	4.6	11.1		
Marital statuses of caregivers									
Single	14	6	0	0	42.9	0.0	0.0	**A** χ^2 =4.77; df=6	0.574
Married	358	90	8	38	25.1	2.2	10.6		
Separated and divorced	13	4	1	2	30.8	7.7	15.4	**T** χ^2 =3.99; df=6	0.678
Widowed	9	2	0	1	22.2	0.0	11.1	**H** χ^2 =2.88; df=6	0.824
Occupation of Household Heads									
Farming	85	25	1	16	29.4	1.2	18.8	**A** χ^2 =10.74; df=8	0.217
Formal employment	42	11	0	5	26.2	0.0	11.9		
Self-employment	109	20	4	4	18.3	3.7	3.7	**T** χ^2=7.49; df=8	0.485
Casual labourer	114	36	3	12	31.6	2.6	10.5		
Unemployed	30	7	0	3	33.3	0.0	10.0	**H** χ^2 =17.34; df=8	**<0.027****
Education level of caregivers									
None	15	6	0	2	40.0	0.0	13.3	**A** χ^2 =11.07; df=10	0.352
Primary Incomplete	108	25	3	12	23.1	2.8	11.1		
Primary Completed	165	43	3	11	26.1	1.8	6.7		
Secondary	75	15	2	10	20.0	2.7	13.3	**T** χ2=18.18; f=10	0.052
Post -secondary	9	4	1	0	44.4	1.1	0.0		
College	21	9	0	6	42.9	0.0	28.6	**H** χ2=21.15; f=10	**<0.020****

A for ***A.lumbricoides*** **T** for ***T.trichiura*** **H** for **hookworm**

** Statistically significant

4.7.3 Child hygiene practices and prevalence of STHs among the children

The potential risk factors for STHs infection, washing of hands before meals and washing of fruits before eating of school going children were significantly associated with *A. lumbricoides* infection (χ^2 =73.98; df=4; p<0.01) (χ^2 =16.70; df=4; p=0.002) respectively. However these two factors were not significantly associated with infection by *T. trichiura* or hookworm. Although washing of hands after defecation/toilet did not have significant association with infection by any of the three STHs, mode/what used in hand cleaning showed significant association with hookworm infection (χ^2 =19.18; df=8; p=0.014). Wearing shoes when and to soil grounded areas did not have any significant association with any of the three STHs.

Table 4.8: Relationship between children hygiene practices and prevalence of STHs

Variable	Number of subjects tested	Number Infected A	T	H	% infection A	T	H	Test statistic	P value
Washing hands after defecating								**A** χ^2 =4.17; df=4	0.384
Yes	13	2	0	3	15.4	0.0	13.1	**T** χ^2 =3.86; df=4	0.425
No	121	36	5	11	29.8	4.1	9.1		
Sometimes	260	64	4	27	24.6	1.5	10.4	**H** χ^2 =5.86; df=4	0.210
Mode of hand washing									
Plain water	212	55	4	28	25.9	1.9	13.2	**A** χ^2 =14.30; df=8	0.074
Water & soap	55	8	0	1	14.5	0.0	11.8	**T** $\chi2$ =1.17; df=8	
Ash	2	1	0	1	50.0	0.0	50.0	**H** $\chi2$ =19.18; df=8	0.997
Soil	2	1	0	0	50.0	0.0	0.0		**<0.014****
Sand	2	1	0	0	50.0	0.0	0.0		
Washing hands before meals								**A** $\chi2$ =73.98; df=6	**<0.01****
Yes	44	11	1	0	25.0	18.2	0.0	**T** $\chi2$ =1.82; df=6	
No	57	40	1	9	70.2	14.0	28.1	**H** $\chi2$ =8.11; df=6	0.936
Sometimes	290	50	6	27	17.2	13.1	20.3		0.230
Washing fruits before eating								**A** χ^2 =16.70; df=4	
Yes	22	3	0	3	13.6	0.0	13.6		**<0.002****
No	92	35	5	9	38.0	5.4	9.8	**T** χ^2 =5.67; df=4	
Sometimes	274	61	4	27	22.3	1.5	9.9		0.225
								H χ^2 =0.98; df=4	
									0.913
Wearing shoes among children when and to soil grounded areas									
Yes	31	6	0	3	19.4	0.0	9.7	**A** χ^2 =2.62; df=4	0.623
No	33	10	0	6	30.3	0.0	18.2	**T** $\chi2$ =1.84; df=4	0.765
Sometimes	320	82	9	30	25.6	2.8	9.4		
								H $\chi2$ =5.46; df=4	0.243

A for ***A. lumbricoides*** **T** for ***T. trichiura*** **and H** for **hookworm**

** Statistically significant

4.7.4 Environmental sanitation and prevalence of STHs

The main source of household water for drinking was significantly associated with *A. lumbricoides* infection in school going children (χ^2 =20.86; df=6; P=0.002) while infection by hookworm or *T. trichiura* was not significantly associated with household water source. However, treatment of water before drinking did not have significant association with any of the three STHs infection in school going children. Ownership of toilet facility of the households was significantly associated with *T. trichiura* infection (χ^2 =6.41; df=2; P=0.040) and no significant association was revealed with infection by Hookworm or *A. lumbricoides*. Moreover, kind of toilet facility revealed a significant association with infection by Hookworm (χ^2 =13.54; df=2; P=0.001) but no significant association showed between kind of toilet facility and infection by *A. lumbricoides* or *T. trichiura*. Other factors with regard to toilets like well ventilation, sharing of toilet with other household members and kind of pit latrine did not have any significant association with any of the three STHs infections as shown in table 4.9.

Table 4.9: Relationship between eenvironmental sanitation and prevalence of STHs among children

Variable	Number of subjects tested	Number Infected			% infection			Test statistic	P value
		A	T	H	A	T	H		
Water source for household use									
Piped water	52	1	0	4	1.9	0.0	7.7	**A** χ^2=20.86; df=6	**<0.002****
Borehole	78	27	0	13	34.6	0.0	16.7		0.473
Surface water	58	15	3	4	25.9	5.2	6.9	**T** χ^2=5.57; df=6	
Dug well	204	59	6	19	28.9	2.9	9.3		0.471
								H χ^2=5.59; df=6	
Well protection								**A** χ^2=2.26; df=2	0.323
Protected	39	15	1	3	35.5	2.6	7.7	**T** χ^2=0.563; df=2	0.755
Unprotected	166	44	5	17	26.5	3.0	10.2		
								H χ^2=0.29; df=2	0.866
Water treatment before drinking								**A** χ^2=0.81; df=2	0.667
Yes	145	34	4	13	23.4	2.8	9.0	**T** χ^2=0.46; df=2	0.795
No	247	68	5	28	27.5	2.0	11.3		
								H χ^2=1.68; df=2	0.431
Mode of water treatment									
Boiling	18	7	1	4	38.9	5.6	22.2	**A** χ^2=4.61; df=6	0.595
Commercially available tablets/liquids	121	26	3	8	21.5	2.5	6.6	**T** χ^2=1.46; df=6	0.962
								H χ^2=10.79; df=6	0.095
Filtering	4	1	0	1	25.0	0.0	25.0		
Ash	1	0	0	0	0.0	0.0	0.0		

Ownership of toilet facility								**A** χ^2 =2.75; df=2	0.253
								T χ^2 =6.41; df=2	**<0.040******
Yes	377	96	1	39	25.5	0.3	10.3		
No	17	6	8	2	35.3	47.0	11.8	**H** χ^2 0.30; df=2	0.861
Kind of toilet facility								**A** χ^2 =0.343; df=2	0.843
Pit latrine	376	96	8	38	25.5	2.1	10.1	**T** χ^2 =0.02; df=2	0.989
Flush/pour flush	1	0	0	1	0.0	0.0	100.0	**H** χ^2 =13.54; df=2	**<0.001******
Latrine improved ventilation								**A** χ^2 =0.998; df=2	0.607
Yes	252	68	6	28	27.0	2.4	11.1	**T** χ^2 =2.13; df=2	0.344
No	88	19	0	5	21.6	0.0	5.7	**H** χ^2 =2.37; df=2	0.306
Kind of pit latrine									
Cemented with slab	8	1	0	0	12..5	0.0	0.0	**A** χ^2 =3.92; df=6	0.688
Cemented without slab	139	36	6	16	25.9	4.3	11.5	**T** χ^2 =6.09; df=6	0.413
Earthed with slab	44	9	0	3	20.5	0.0	6.8	**H** χ^2 =3.30; df=6	0.770
Earthed without slab	185	50	2	19	27.0	1.1	10.3		
Sharing toilet with other households								**A** χ^2 =1.66; df=2	0.435
Yes	64	16	3	5	25.0	4.7	7.8	**T** χ^2 =2.74; df=2	0.254
No	313	80	5	34	25.6	1.6	10.9	**H** χ^2 =1.99; df=2	0.370

A for ***A. lumbricoides*** **T** for ***T. trichiura*** **and H** for **hookworm**

** Statistically significant

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 DISCUSSION

STH infections during childhood remain a major public health challenge in developing countries, including Kenya where school going children have been reported to be at highest risk age (Bundy *et al.*, 2003). STHs infection burden in Kenya is being addressed mainly through deworming programs, Although this strategy reduces illness caused by soil-transmitted helminths, other studies have shown that it does not prevent rapid reinfection. To interrupt transmission and to achieve local elimination of helminthiasis, integrated control approaches that include access to sanitation and other complementary interventions of a primary prevention nature are needed. This study hence sought to establish prevalence and factors associated with STHs infections among children aged 5 – 10 years from selected schools in Kikumini sub-location in Machakos county, Kenya.

5.1.1 Prevalence of STHs among school going children

The study findings revealed that, the overall prevalence of the three STHs infection was (38.6%) in the study area. The findings were comparable with previously reported 40.1% prevalence based on a study concerning soil-transmitted helminth infections in school children (aged 3-10 years) in rural Southwest China (Wang *et al.,* 2012). On contrary, the attested prevalence was lower compared to other previous studies done in different regions of Kenya. For instance, in a study done in Webuye on STHs and intestinal protozoa among children below five years, an overall prevalence of STHs was found to be 52.3%

(Obala *et al.,* 2013) while Handzel *et al.,* 2003 reported 63% prevalence of STHs on implications for anthelminthic mass treatment in western kenya. Studies conducted on school children in poor peri-urban and urban communities in Nairobi showed high prevalence (71%) of STHs (Rijsptra, *et al.*, 2000). This observed rate in the current study as compared to high rates in the above mentioned Western studies could be attributed to climate/ecological or geographical differences found in different study areas. Epidemiological studies show that soil moisture and relative atmospheric humidity are known to influence the development and survival of ova and larvae, higher humidity is associated with faster development of ova, and at low humidity (<50%) the ova of *A. lumbricoides* and *T. trichiura* do not embryonate (Brooker and Michael, 2000). According to Udonsi, *et al*., (1980), field studies show that the abundance of hookworm larvae is related to atmospheric humidity. These differing rates of development and survival will influence parasite establishment in the human host and hence the infection levels.

Low rate of STHs found in the current study as compared to the high rate observed in peri urban and urban communities of Nairobi could be attributed to the rural setting in relation to STHs infection. Studies which surveyed similar age groups and socio-economic areas indicate that the prevalence of *A. lumbricoides* and *T. trichiura* differ between urban and rural communities. By contrast, hookworm appears to be equally prevalent in both urban and rural settings (Crompton and Savioli,1993). The precise reasons for the urban-rural dichotomies for *A. lumbricoides* and *T. trichiura* are as yet unclear. Differences in prevalence of *A. lumbricoides* and *T. trichiura* in urban and rural areas may reflect differences in sanitation or population density; socio-economic differences will also play an important role. According to Crompton and Savioli,(1993), in common with many other parasitic infections, STH infections flourish in impoverished areas characterized by inadequate sanitation and overcrowding. Another reason that would attribute to prevalence differences in the current study and aforementioned webuye findings is the study population age. Webuye findings having been conducted among less than five years children could explain the high prevalence rate as compared to low rates seen in the current study among children aged 5-10 years. Younger children are not hygiene conscious and they are very playful where they interact with contaminated soil as compared to older children (Henry, 1981). The

Prevalence rate in the current study could also be affected by drugs taken by the children. Drugs especially anti-parasitic ones taken in a maximum of two weeks period deter detection of intestinal parasites during stool analysis

The findings of the present study showed that of the three common STH infection identified in school children, *A. lumbricoides* and hookworm were predominant with prevalence rate of 25.9% and 10.4% respectively followed by *T. trichiura* 2.3%. This trend was consistent with other previous studies done in Kenya and across Kenya where *A. lumbricoides* was shown to be the most prevalent followed by hookworm (Akhwale *et al*., 2004, Uneke *et al*., 2006, Alemu *et al*., 2011 and Obala *et al*., 2013). However, findings of this study were contrary to some previous reports where hookworms were reported as the most prevalent species (Handzel *et al*., 2003, Wang *et al.,* 2012 and Belyhun *et al*., 2010).

The prevalence of *A. lumbricoides* (25.9%) was found to be consistent with other studies with 22.9%, 22% and 26.1% as reported by Handzel *et al*., (2003), Alemu *et al*., (2011) and Wang *et al.,* (2012) primary respectively. However, the prevalence of *A. lumbricoides* (25.9%) on contrary, was higher compared to other studies done in Kenya and other neighboring countries. For instance a study done in Western highlands Kenya revealed 10% prevalence of *A. lumbricoides* (Akhwale *et al*., 2004). One possible reason for the difference could be attributed to the fact that the study subjects of the present study were school going children while in Western highlands study involved adults. Children being less conscious of hygiene, very active in playing and interacting with contaminated soil, not washing hands before meals among others explain the high prevalence. Other studies done in Nigeria and Ethiopia also showed lower prevalence of *A. lumbricoides* compared to the current study rate; 10.8% reported by Uneke *et al*., (2006) and 1.5% reported by Belyhun *et al*., (2010) respectively. On contrary a study by Rijsptra *et al*, (2000) among school going children in peri urban and urban communities in Nairobi showed a very high (82%) prevalence of *A. lumbricoides* as compared to 25.9% of the present study. The high prevalence could be attributed to urban setting of the study where parasitic infections flourish well in overcrowded areas with regard to inadequate sanitation.

The second most prevalent STH was hookworm (10.4%). The hookworm infection reported in this study was not differentiated into species level since it is impossible to differentiate without stool culture. This was in agreement with studies done among school going children that reported 13.1% and 14.3% prevalence of hookworm in Sudan

(Magambo, *et al.,* 1998) and Southern Ethiopia (Gezahegn, 2008) respectively. However, hookworm prevalence in the present study was lower compared to 42.5% hookworm a study in Western Kenya by Handzel *et al*., (2003). The observed prevalence difference could be attributed to geographical and environmental differences of the study sites. The current study site being located in hot and dry zones of Kenya in comparison to wet and high humid western Kenya where the growth of hookworms is favored with regard to moist soil. Field studies show that the abundance of hookworm larvae is related to atmospheric humidity. Soil moisture and relative atmospheric humidity are also known to influence the development and survival of ova and larvae: higher humidity is associated with faster development of hookworm (Udonsi, *et al*., 1980). Other authors reported in their studies low prevalence rates of hookworm as compared to the present study. For instance the study done in western highlands of Kenya revealed 3.8% hookworm prevalence (Akhwale *et al*., 2004). Other low rates of hookworm in comparison to the current study were 4.3% as reported by Uneke *et al*., (2006) and 2.3% as reported by Belyhun *et al*., (2010).

The least encountered STHs in the present study was *T. trichiura* occurring 2.3%. This result was in line with other studies conducted across the world; 2.2% as reported by Wang *et al.,* (2012), 2.5% by Alemu *et al*., (2011) and 1.2% by Uneke *et al*., (2006). The low prevalence rate is explained by the fact that the study was done in a lower altitude and dry area of the country as egg development in the soil is dependent upon a number of factors including optimal temperature, and adequate shade and moisture (Brooker and Micheal, 2000). This can be argued by high prevalence of *T. trichiura* (17.9%) reported by Handzel *et al*., (2003) in western part of the country with high altitude, humidity and rainfall. However, it is inadequate to conclude that this low prevalence rate of *T. trichiura* and also *A. lumbricoides* and hookworms in the present study was only due to site differences with regard to environment and climate. Therefore, further studies must be conducted maybe with larger sample size to investigate other factors before coming with any conclusions.

Single (77.42%) and double (22.58%) STHs infections in children were more common and none of the pupils had triple infection in the present study. This trend was in consistent with a study done among school going children in Ethiopia where only single and double STHs were found with 0% triple infection (Belyhun, *et al*., 2010). In addition, in the Webuye Health and Demographic Surveillance Systems Baseline survey reported by Obala *et al*., (2013), it was found that Single and double parasitic infections per child were more common compared to polyparasitism. The most frequent combinations of helminths were double infection of *A. lumbricoides* and Hookworm (20.97%) followed by both *A. lumbricoides and T. trichiura* and *T. trichiura* and Hookworm with (0.81%) each. There is inadequate published information on multiple infections and their causes to support the concept of polyparasitism hence is thought that probably is due to the restricted transmission potential, which limit triple infections. Local risk factors for STHs for instance, hygiene practices and socio economic status of the study population could also explain the most observed combinations of the STHs. Overall prevalence of STHs by school was 38 (25%) Makila, 35 (23%) Kikumini, 26 (17.1%) Ulutya and 53 (34.9%) for

Tulimyumbu primary School. The study did not associate the potential risk factors for STHs with the prevalence findings with regard to each school to support the revealed prevalence differences. However, the difference in overall and specific helminth prevalence rates per school could be attributed to local risk factors for STHs found in different villages of the schools.

5.1.2 Factors associated with STHs infection among school going children

The factors associated with STHs infection were grouped into four categories; selected socio-demographic characteristics of the children and their caregivers, selected socio-economics of the caregivers, hygiene practices of the children, and environmental sanitation of the children households.

5.1.2a Selected Socio-demographic characteristics of the children and their caregivers

In consideration of socio demographic characteristics of the children, although the results of this study showed that there was no significant relationship between sex of the children and infection by any of the three STHs, it was found that females were at higher risk of infection by any of the STHs than males . This was in line with other studies that have shown no gender differences in parasitic infections (Obala *et al.*, 2013; Elkins, *et al.*,1988). The sex insignificance in relation to STHs infection of the current study could be influenced by cultural values of Kamba community that both males and females have no family chores specifications and are all involved in the routine duties from farming to kitchen regardless of gender which may expose them equally to STHs infections. In contrast, other studies have shown statistically significant difference in gender with regard to STHs infections of which most have found males to be highly affected (Magambo, *et al.,* 1998; Mehraj, *et al.,* 2008).

Age of the child did not have any significant association with infection by any of the three STHs as opposed to many studies that have reported that STHs infection in children decrease with increase of child age for *A.lumbricoides* and *T. trichiura.* and vice versa for hookworm infection. For instance a study conducted among children aged 5-15 years old in Nyanza region of Kenya showed that children belonging to the age group of 5-7 years were more infected with STHs than those of older age groups (William, 2007). Caregivers' marital status was not significantly associated with any of STHs infection among the children. Most of the caregivers being married could be the reason for lack of significance since there is economic support by the other partner financially as compared to widowed or single partners. This can be supported by the fact that epidemiological studies have shown that economic status of individuals is linked to STHs infections (Vikram, *et al*., 2008).

5.1.2b Selected Socio-economics of the caregivers

Focusing on socio economics, education level of the caregivers was significantly associated with infection by hookworm among the children but insignificantly associated for *A.lumbricoides* and *T. trichiura.* The results were comparable to a study by Halpenny *et al.,* (2013), Wang *et al.,* (2012) studies among preschool and school aged children that revealed caregivers education was significantly associated with STHs infections. In the current study majority of caregivers had only complete/incomplete primary education hence low education levels among caregivers could be the reason for significance. It is commonly known that caregivers particularly mothers are often responsible for both food preparation and the health education of children in the family; they significantly influence the health of their children. If a child's mother is educated, she is more likely to know about the dangers of STH infections and how to prevent it, and thus more likely to incorporate safe health behaviors into the home, including boiling water. Occupation/ Source of income of the household head was significantly associated with infection by hookworm among the children while it was insignificantly associated for *A.lumbricoides* and *T. trichiura.* The revelation is in line with a study done in Côte d'Ivoire in school going children that showed occupation of the parents was significantly associated with infection by STHs in their children (Coulibaly *et al.,* 2012). The trend in the current study is probably due to low levels of economic status of household heads. Majority with children infected being casual labourers and subsistence farmers hence financially challenged to access footwear for their children, soap and other sanitation protective factors for STHs infection.

5.1.2c Hygiene practices of the children

Analysis on hygiene practices of the school going children in relation to STHs infections found a significant relationship between hand washing before meals and *A.lumbricoides* infection. Higher risk of infection was in those children who did not and occasionally washed their hands before meals. However washing of hands after defecation/toilet did not have significant association with any of the three STHs infection. Mode of hand washing before meals and after defecation revealed a significant association with hookworm infection (with high infection among those children who used water without soap to clean their hands). Washing of fruits before eating was significantly associated with infection by *A.lumbricoides* with high infection among those children who did not and occasionally washed their fruits before eating. Wearing of shoes by children while on soil grounded areas did not have any significant association with any infection by any of the three STHs infection. The significance of hygiene practices in relation to STHs infection is supported by many studies that revealed relationship between STHs infection and either washing of hands before meals, mode of hand washing or washing of fruits before eating in children (Gezahegn, 2008, Wang, *et al.,* 2012 and Nasr, *et al.,* 2013,) among others. The finding might be due to lack of regular health education program in the school which can enhance their awareness in the transmission and control mechanism of STHs infection. In addition, lack of sufficient water to practice standard hygiene like washing of fruits and hands always could contribute to infection considering that the climate of the study area is hot and dry. Low socio economic status of the parents as revealed by the results of this study (with regard to education and finances where buying of items like soap could be a challenge) could also attribute to the high rates of infection.

5.1.2d Environmental sanitation of the children households

In respect to environmental sanitation, the present study found a significant relationship between household water source for drinking and *A.lumbricoides* infection among the school going children. Although this did not show significant association for hookworm and *T. trichiura,* infections, children were still infected with these worms in relation to water source. The findings were in agreement with studies done in Kenya and across Kenya which documented significant relationship between poor water source and infection by STHs infections (Handzel *et al.,* 2003, Gezahegn, 2008, Wang *et al.,* 2012, and Edelduok *et al.,* 2013). The results revealed that using of dug well and borehole water had the highest prevalence of *A.lumbricoides.* This could be due to the fact that from the findings most of the wells were uncovered and hence high chances of environmental contamination. Moreover, water from boreholes and wells could have been taken unboiled/ untreated thus enhancing STH infection. Those who used piped water in contrast had very low prevalence of STH infection suggesting that piped water was safer with regard to STH infections. However, water treatment, coverage/protection of wells did not have significant difference on STH infections. There was a significant difference between household availability of toilet/latrine and *T. trichiura* infection among the children. However there was no significant difference in hookworm and *A.lumbricoides* infection infection in relation to availability of toilet/latrine.Type of defecation facility showed a significant association with hookworm infection and no significant association with *T. trichiura* and *A.lumbricoides* infection among the children. This is supported by previous studies that revealed a significant association between availability and kind of toilet/latrine facility and STHs infection in children (Gezahegn, 2008, Wang *et al.,* 2012, Edelduok *et al.,* 2013). Based on the findings, higher infection by *T. trichiura*, was among the children in the households who did not have defecation facility and practiced open defecation as compared to those that had defecation facility. This is however expected as Hotez *et al*., (2005) demonstrated, in a setting in which indiscriminate defecation prevails, it is easy for the general surroundings to become polluted or contaminated with human wastes containing infective agents like eggs of parasitic worms which enhance the spread of helminth infections. Majority of the households possessed pit latrine which was expected considering the study was conducted in rural area. The significant relationship found between hookworm infection and type of toilet could be further attributed to the fact that most infection revealed among the children were in the households with pit latrines that were earthed/mud without slab. Use of these kind of latrines that do not have improved flooring can favor hookworm eggs that hatch in soil, releasing mobile larvae that can penetrate the skin hence infection. Further statistics on toilets such as sharing of toilets, kind and improved ventilation status of pit latrines did not have significant relationship with STHs infections.

The prevalence of STHs and the associated factors reveal that important factors like hygiene practices of the children, drinking water sources and sanitation facilities in the study subjects households and economic statuses of the caregivers affect the prevalence of STHs. Absolute elimination of helminthiases not only requires antihelmintic drug treatment but most importantly adoption of primary preventive nature that include provision of safe water for drinking and improved toilet facilities alongside public health education to raise awareness on transmission and prevention of STHs.

5.2 CONCLUSIONS

- Soil-transmitted helminth infections are prevalent among school children (aged 5-10 years) in the study area.
- The study revealed that *A.lumbricoides* was the most prevalent parasite.
- The present study has also pinpointed caregiver education level, habit of hand washing before meal, washing of fruits before eating, lack of access to safe water, availability and type of defecation facility as risk factors that are significantly associated with STH infection, and play an important role in affecting prevalence of STH infections.
- Despite the identified chemotherapy approach of STHs infection in the study area, the STHs infection remain a public health problem as was attested by the prevalence findings.

5.3 RECOMMENDATIONS

- School based deworming programs should be done regularly to control morbidity due to STH infection
- The study highlights that the practice of preventive measures alongside chemotherapy approach should be adopted inorder to interrupt transmission and to achieve local elimination of helminthiasis and other related intestinal parasites.
- The appropriate government bodies, for instance the health sector and other concerned stakeholders, should intervene and undertake adequate control measures against soil-

transmitted helminth parasites by making sure there is access to safe water and improved sanitation facilities in the area.

- Health education programs should be intensified in the area and beyond to bring awareness of STH transmission and prevention such as high standard of hygiene practices to both the children and the parents. The endeavor to achieve the above will enhance reduced morbidity, and DALYs associated with soil-transmitted helminth infections in children nationally.

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APPENDICES

APPENDIX I: Informed consent and consent form

Title: PREVALENCE AND FACTORS ASSOCIATED WITH SOIL TRANSMITTED HELMINTH INFECTION AMONG PRIMARY SCHOOL CHILDREN IN KIKUMUNI SUB-LOCATION, MACHAKOS COUNTY, KENYA

Investigator: PHOEBE MUTILA KISAVI

INTRODUCTION

My name is Phoebe Mutila and I am a student at the Jomo Kenyatta University of Agriculture and Technology (JKUAT), Institute of Tropical Medicine and Infectious Diseases (ITROMID) based at Kenya Medical Research Institute (KEMRI). I am here with my team to conduct a research on factors associated with STHs among 5 to 10 years children in selected primary schools in Kikumini sub-location, Masinga district, Machakos county, kenya.. I would like to seek your cooperation regarding this exercise. Please the consent form below will be read out for you. I would be very glad if you accept my request to participate in this study.

THE PURPOSE OF THE STUDY

The aim of this study is to establish the prevalence and risk factors associated with soil transmitted helminths infections in selected primary schools in Kikumini sub-location Masinga district, Machakos county, kenya.

PROCEDURE

The purpose of this form is to obtain your permission to participate. If you agree to participate, a questionnaire will be administered to you and the interview will take between 20 and 30 minutes to complete. In addition stool specimens will be collected from 5- 10 years children.

Participation is voluntary and you can choose not to answer any individual question or all of the questions as well as not get stool specimen from your child. However, we hope you will participate in this interview since the information you provide will aid policy makers in designing and evaluating interventional programs for prevention and control of intestinal helminthic infections.

RISKS AND BENEFITS

Apart from the inconveniences caused by taking part of your time, the process is safe and there are no risks involved. There are no direct benefits to you by choosing to participate in this study. However, the results of this study will be communicated back to the health facility for necessary action by the health authority. The information you provide will therefore be of benefit not only to you but also other people and aid in planning strategic interventions for prevention and control of intestinal helminthic infections in Kenya. The results will also be used in writing my thesis as part of requirements by the university.

CONFIDENTIALITY

Strict confidentiality will be maintained, all the personal identifiers will be removed from the data. Participants in the study will be identified only by specific numbers. No data will be released outside the study without explicit consent of my study team.

CONTACT INFORMATION

For any inquiries in the event of any research related questions, comments or complaints, the following persons will be available for contact:

Investigator: Phoebe Mutila

Telephone: 0728114949

Email: *mutilak@gmail.com*

OR

The Secretary,

KEMRI Ethics and Research Committee

P.O. BOX 54840-00200 Nairobi

Tel: (254) (020) 2722541, 0722-205 901, 0733-400003

Email: erc@kemri.org

At this point, do you have any question about the study?

Participant submission:

I have understood the above information which has been read and explained to me by the researcher. I have been given the chance to ask any questions I may have and I am content with the answers to all of my questions. I know that my records will be kept confidential and that I may leave at any time. The name, Phone Number and address of whom to contact in case of any emergency has been given to me. I agree to take part in this study and will be given a copy of this informed consent to keep.

Name of Participant (optional) ....

Signature of Participant and date ....

Name of interviewer obtaining consent…………………………………

Signature of interviewer and date ………………………………………

RIDHAA YA KUSHIRIKI KWENYE UTAFITI

Kichwa: Mambukizi na mambo yanayohusika na mambukizi ya minyoo kutoka kwa mchanga miongoni mwa watoto wa shule za msingi zilizomo kata ndogo ya kikumini,,kaunti ya Machakos Kenya.

Mtafiti: PHOEBE MUTILA KISAVI

UTANGULIZI

Jina langu ni Phoebe Mutila na mimi ni mwanafunzi katika Chuo Kikuu cha Jomo Kenyatta cha Kilimo na Teknolojia (JKUAT), Taasisi ya Tiba ya Tropikal na magonjwa ya kuambukiza (ITROMID) katika Kenya Medical Research Institute (KEMRI). Mimi niko hapa pamoja na timu yangu kufanya utafiti juu ya mambo yanayohusiana na minyoo kutoka kwa mchanga kati ya watoto wa miaka mitano hadi kumi(5-10) katika shule za msingi zilizomo kata ndogo ya Kikumini, wilaya ya Masinga Kaunti ya Machakos, Kenya. Ningependa kupata ushirikiano wako kuhusu hili zoezi. Tunakuomba kukusomea fomu hii ya ridhaa kwako. Tutafurahia ukikubali kushiriki katika utafiti huu.

KUSUDI LA UTAFITI

Lengo la utafiti huu ni kuchunguza nambari na mambo yanayo husiana na hadhari ya maambukizi ya minyoo kutoka kwa udongo katika baadhi ya shule za msingi zilizomo kata ndogo ya kikumini, wilaya ya Masinga kaunti ya Machakos, Kenya.

UTARATIBU

Madhumuni ya fomu hii ni kupata ruhusa yako ya kushiriki. Kama unakubali kushiriki, fomu ya maswali itashirikishwa kwako na anayekuhoji, itachukua kati ya dakika 20 na 30 kukamilisha. La ziada kiasi cha kinyesi kitachukuliwa kutoka kwa watoto wa miaka mitano hadi kumi. Ushiriki ni wa hiari na unaweza kuchagua kutojibu swali au maswali yote na pia kutochukuliwa kwa kiasi cha kinyesi kutoka kwa mtoto wako. Hata hivyo, tunatumaini kushiriki katika mahojiano kwa sababu habari utakayotupa , itatoa mwelekezo kwa wale wanaobuni sera kwa kubuni mikakati ya ya kuzuia na kudhibiti maambukizi ya minyoo.

HATARI NA FAIDA

Mbali na tatizo ndogo linalo sababishwa na kuchukua muda wako, mchakato ni salama na hakuna hatari ya kushiriki. Hakuna faida ya moja kwa moja kwa kuchagua kushiriki katika utafiti huu. Hata hivyo, matokeo ya utafiti huu yatatolewa kwa kituo cha afya kwa ajili ya hatua muhimu kwa mamlaka ya afya. Habari utkayo itoa itakuwa ya faida si kwako tu ila hali kwa watu wengine na itaelekeza mipangilio ya kuzuia na kudhimbiti maambukizi ya minyoo nchini Kenya. Matokeo pia yatatumika katika kuandika Thesis yangu kama sehemu ya matarajio ya chuo kikuu.

USIRI

Usiri kali utadhibitishwa, vitambulisho binafsi vyote vitatolewa kutoka ujumbe wako. Washiriki katika utafiti watambuliwa kwa nambari maalum. Hakuna ujumbe utatolewa nje bila ridhaa ya wazi kutoka kwa timu yangu.

MAELEZO YA MAWASILIANO

Kwa maswali yoyote kuhusu utafiti huu, maoni au malalamiko, watu wafuatao watakuwa wanapatikana kwa nambari zifuatazo.:

Mtafiti: Phoebe Mutila

Simu: 0728114949

Barua pepe: *mutilak@gmail.com*

au

Katibu Mkuu,

KEMRI Maadili na Kamati ya Utafiti
S.L.P 54,840-00,200 Nairobi
Simu: (254) (020) 2,722,541, 0722-205 901, 0733-400003
Barua pepe: erc@kemri.org

Katika hatua hii, je, una swali kuhusu utafiti?

Mshiriki kuwasilisha:
Nimeelewa na ujumbe uliosomwa na kuelezewa kwangu na mpelelezi. Nimepewa nafasi ya kuuliza maswali yoyote na nimeridhika na majibu yote ya maswali yangu . Najua kwamba rekodi zangu zitawekwa siri na ninaweza kutoka wakati wowote. Jina, Nambari ya Simu na anuani ya kuwasiliana wakati wa dharura yoyote nimepewa. Nakubali kushiriki katika utafiti huu na nitapewa nakala ya ridhaa niweke.

Jina la Mshiriki ....
Sahihi ya Mshiriki na tarehe ....
Jina la anayehoji kupata idhini ....
Sahihi ya anayehoji na tarehe ....

APPENDIX II: Questionnaire

PREVALENCE AND FACTORS ASSOCIATED WITH SOIL TRANSMITTED HELMINTH INFECTION AMONG PRIMARY SCHOOL CHILDREN IN KIKUMUNI SUB-LOCATION, MACHAKOS COUNTY, KENYA

Questionnaire serial no________________

1. Interviewer visits

Name of interviewer_____________________

Visit date (dd/mm/yy) __________

Outcome__________

Outcome codes: 1. Completed 2. Declined 3. Other (mention)

2. Identification

Cluster / School name _____________________

Province __________________ County________ District ______________

Location_______________________ Sublocation_____________________

Residence (Rural= 1, Urban= 2) ________________________

Child identification number_______________________________

Socio-demographic characteristics

3.Name of the child ____(Optional)

4. Sex of the child (Male = 1, Female = 2) _________________

5. How old is the child? (years) ____________________

6. Caregiver's name____

7. Caregiver relationship to the child _________________________1.Mother 2.Father 3.Sibling 4. Grandmother 5.Aunt 6.Grandfather 7. Uncle 8. Neighbour

8. What is your marital status?_________ 1. Single /never married 2. Married 3. Separated/Divorce 4.Widowed 5. Other specify

Socio- Economic Factors

9. Education of caregiver_______________1.No education, 2. Primary education(not completed) 3. Primary education (completed) 4. Secondary 5. Post secondary 6. College 7. Other specify

10. Occupation of the Household head?_______________________

1. Farming 2. Self employed 3. Formal employment 4. Unemployed 5. Other specify

Hygiene practices

11. Do you (child) or have you witnessed your child wash hands always after defecation/toilet?______________ 1. Yes 2. No 3. Sometimes

12. If yes or sometimes, what does the child use in washing hands?________________ 1. Plain water 2. Water and soap 3. Other specify

13. Do you (child) wash or have you witnessed your child wash hands always before eating? ___________ 1. Yes 2. No 3. Sometimes. And fruits? __________ 1. Yes 2. No 3. Sometimes.

14. Do the child wear shoes when/to on soil grounded areas?_________ 1. Yes 2. No 3. Sometimes.

Environmental Sanitation

15. What is the main source of water used by your household members for drinking _______________ 1. Piped water 2. Bore hole 3. Surface water 4. Dug well 5. Other specify

16. If well is it 1. Protected 2. Unprotected? ___________________

17. Do you do anything to the water to make it safer to drink ? ___________ 1. Yes 2. No

18. If yes what do you usually do to make the water safer to drink?___________

1. Boiling 2. Commercially available tablets/liquids 3. Filtering 4. Other specify

19. Do you have a toilet facility? ___________ 1. Yes 2. No facility/ Open defection

20. If yes what kind of toilet facility do members of your household usually use?_______________

1. Flush or pour flush toilet 2. Pit latrine

21. If pit latrine what kind inside ? ________________ 1. Cemented with slab 2. Cemented without slab 3. Earthed with slab 4. Earthed without slab

22. Improved ventilated latrine?__________________ 1. Yes 2. No

23. Do you share this toilet facility with other households?__________ 1. Yes 2. No

Child health

24. Did the child take any drugs for intestinal worms in the past 6 months? ________1. Yes 2. No

25. Has the child taken any drugs for any illness in the last 2 weeks?_________ 1. Yes 2. No

26. If yes what drugs did the child take in the last 2 weeks?_________1. Antimalarial drugs

2. Antidiarrhoeal 3. Other specify

Stool sample collection

27. Was stool sample collected?___________Yes=1, No=2

SWAHILI VERSION

HOJAJI

Kichwa: Mambo yanayohusika na mambukizi ya minyoo kutoka kwa mchanga kati ya watoto wa miaka mitano hadi kumi(5-10yrs) katika shule za msingi kata ndogo ya kikumini, wilaya ya Masinga,kaunti MachakosKenya.

Nambariya fomu la maswali__________________

1.Ziara anayehoji

Jina la anayehoji_____________________

Tarehe ya ziara _____________________

Matokeo _________________________

Numbari za matokeo : **1**. imekamilika **2**. Kukataa **3.** Mengine (taja)

2.Kitambulisho

Kikundi/Jinahhhg la shule _____________________

Mkoa __________________ County________ Wilaya ______________

Kata___________________ Kata ndogo____________________

Mahali pa kuishi (Kijiji = 1, Mjini = 2) _______________________

Nambari ya kitambulisho ya mtoto_______________________________

Sifa ya kijamii

3. Jina la mtoto (Nichaguo) _______________________________________

4. Jinsia ya mtoto _________________ 1. Mwanaume 2. Kike

5. Mtoto ana miaka mingapi? ___________________

6. Jina lako? ____

7. Je, uhusiano wako na mtoto ni gani? __________ 1**.** Mama 2. Baba 3. Ndugu/Dada 4.

Nyanya 5. Shangazi 6. Mengine (taja)

8. Hali ya ndoa yako ni gani _________ 1. Pekee/ Bado kuolewa 2. Umeolewa 3. Talaka 4. Mjane 5. Nyingine (taja)

Mambo ya Kijamii na Kiuchumi

9. Ngazi la masomo la mtunzaji mtoto? _________________ 1. Bila masomo yoyote 2.Shule ya msingi(kumaliza) 3**.** Shule ya msingi(kutomaliza) 4. Shule ya upili 5**.** Kuzidi shule ya upili 6. Chuo 7**.** Nyingine bainisha

10. Kazi ya mkubwa wa nyumba? ______________________

1. Kulima 2. Kujiajiri 3**.** Kuajiriwa taratibu 3**.** Huna kazi 4**.** Nyingine taja

Mazoezi ya Usafi

11. Je, (mtoto), ama umeshuhudia mtoto wako akinawa mikono yako baada ya kwenda choo? ______________ 1. Ndio 2. La 3. Wakati mwingine

12. Kama ndiyo, mtoto anatumia nini kuosha mikono? _______________ 1. Maji pekee 2. Maji na sabuni 3. Nyingine taja

13. Je, (mtoto), ama umeshuhudia mtoto wako akinawa mikono kabla ya kula chakula?_________ 1. Ndio 2. La 3. Wakati mwingine. Na kabla ya kula matunda?______________ 1. Ndio 2. La 3. Wakati mwingine.

14. Je mtoto anavaa viatu kutoka nje ama kwenda shule?_____________ 1. Ndio 2. La 3. Wakati mwingine.

Usafi wa Mazingira

15. Je, chanzo kikuu cha maji ya yakunywa kinachotumiwa na watu wako ni gani? _______________?

1**.** Kutoka kwa mfereji 2. Borehole 3. Maji ya sakafu 4. Kisima cha kuchimbwa 5. . Nyingine taja

16 . Je kisima 1. kimelindwa au 2. hakijalindwa? ___________________

17. Je unafanya kitu chochote kwa maji ili yawe salama kwa kunywa? ___________ 1. Ndio 2. La 18. Kama ndio nini kawaida unafanya ili kufanya maji yako salama kunywa ___________?

1.Kuchemsha 2. Dawa ya kinga 3 .Kichungi 4. Nyingine taja

19. Je una choo? ___________1. Ndio 2. La hakuna / kichaka / uwanja

20. Kama ndio ni aina gani ya choo watu wako wanyumba kawaida hutumia 1. Flush au pour flush choo 2. Choo cha shimo

21. Kama choo cha shimo ni aina gani ndani? ________________________

1.Imekorogewa na kikanyagio 2. Imekorogewa bila kikanyagio 3. Matope na kikanyagio 4. Matope bila kikanyagio

22. Je choo imeboreshwa kuingiza hewa? ______________ 1. Ndio 2. La

23. Je unatumia choo chako na watu wa nyumba zingine? __________ 1. Ndio 2. La

Afya ya mtoto

24. Je mtoto amekunywa dawa yoyote ya minyoo katika kipindi cha miezi 6 iliopita? _____ 1. Ndio 2. La

25. Je mtoto amekunywa dawa yoyote ya ugonjwa yoyote katika wiki mbili zilizopita? __________ 1. Ndio 2. La

26. Kama ndio madawa gani mtoto alikunywa kwa wiki mbili zilizopita ? _____________

1. Dawa za kutibu malaria

2.Dawa za kutibu kuhara

3. Zingine taja___________

Uchukuaji wa sampuli ya kinyesi

27. Je sampuli ya kinyesi ilichukuliwa ___________1. Ndio 2. La

APPENDIX III: Stool analysis technique

Formal- ether concentration method- qualitative

Material and reagent needed

a. 4% formalin
b. Di-ether
c. Gauze
d. Scissors
e. Funnel
f. Centrifuge
g. Applicator stick
h. Centrifuge tubes 15ml

Procedures

a. Emulsify about 1 gm of stool in 7mL of 4% formol-saline solution.
b. Filter through the gauze into a centrifuge tube (using a funnel).
c. Add 3mL of ether and insert rubber stopper. Shake vigorously for one minute.
d. Centrifuge with gradual acceleration for 2-3 minutes at 2000 rpm. Allow to come to a complete stop.
e. Dislodge plug of ether/debris with applicator stick and Decant supernatant.
f. Add iodine and place on slide with cover slip.
g. Observe the deposit carefully and report the number parasites seen using the X 40 objective

APPENDIX IV: KEMRI SSC Letter of Approval

KEMRI RECEIVED 11 DEC 2012

KENYA MEDICAL RESEARCH INSTITUTE

P.O. Box 54840-00200, NAIROBI, Kenya
Tel (254) (020) 2722541, 2713349, 0722-205901, 0733-400003; Fax: (254) (020) 2720030
E-mail: director@kemri.org info@kemri.org Website:www.kemri.org

ESACIPAC/SSC/101244 **7th December, 2012**

Phoebe Mutila

Thro'
Director, CPHR
NAIROBI

forwarded 11/12/12

REF: SSC No. 2356 (Revised) – Factors associated with soil transmitted helminths infection among children aged 5-10 years in Lower Eastern Province, Kenya

Thank you for your letter received on 30th November, 2012 responding to the comments raised by the KEMRI SSC.

I am pleased to inform you that your protocol now has formal scientific approval from SSC.

The SSC however, advises that work on the proposed study can only start after ERC approval

for

Sammy Njenga, PhD
SECRETARY, SSC

In Search of Better Health

APPENDIX V: KEMRI ERC Letter of Approval

KEMRI RECEIVED 26 APR 2013

KENYA MEDICAL RESEARCH INSTITUTE

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KEMRI/RES/7/3/1 **April 23, 2013**

TO: **PHOEBE MUTILA (PRINCIPAL INVESTIGATOR)**

for **THROUGH :** **DR. YERI KOMBE;** forwarded
DIRECTOR, CPHR 30/4/2013

RE: **SSC PROTOCOL NO. 2356 – REVISED (*RE-SUBMISSION*): FACTORS ASSOCIATED WITH SOIL TRANSMITTED HELMINTH INFECTIONS AMONG CHILDREN AGED 5-10 YEARS IN KIKUMINI SUB-LOCATION, MASINGA DISTRICT, MACHAKOS COUNTY, KENYA**

Make reference to your letter dated 15th April, 2013, Received on April 16, 2013.

We acknowledge receipt of;

a. The Revised Study Protocol.
b. The informed consent Document.

This is to inform you that the Ethics Review Committee (ERC) reviewed the document listed above and is satisfied that the issues raised at the 211th meeting held on 6th February, 2013 have been adequately addressed.

The study is granted approval for implementation effective this **23th day of April 2013**. Please note that authorization to conduct this study will automatically expire on **April 22, 2014**. If you plan to continue with data collection or analysis beyond this date, please submit an application for continuing approval to the ERC Secretariat by **March 12, 2014**.

Any unanticipated problems resulting from the implementation of this protocol should be brought to the attention of the ERC. You are also required to submit any proposed changes to this protocol to the ERC prior to initiation and advise the ERC when the study is completed or discontinued.

You may embark on the study.

Yours sincerely,

EAB

Dr. Elizabeth Bukusi,
ACTING SECRETARY,
KEMRI/ETHICS REVIEW COMMITTEE

In Search of Better Health