PREVALENCE, INTENSITY AND RISK FACTORS OF SOIL TRANSMITTED HELMINTHS AMONG SCHOOL GOING CHILDREN IN LURAMBI SUB-COUNTY, KAKAMEGA, KENYA

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A thesis submitted to the School of Natural Sciences in partial fulfillment of the requirements for the degree of Master of Science in Medical Parasitology of Masinde Muliro University of Science and Technology.

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DECLARATION

This thesis is my original work prepared with no other than the indicated sources and support and has not been presented elsewhere for a degree or any other award

Signature   Date: 06/06/2022

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance of Masinde Muliro University of Science and Technology a thesis entitled, "**Prevalence, Intensity and Risk Factors of Soil Transmitted Helminths among School Going Children in Lurambi Sub-County, Kakamega, Kenya**"

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DEDICATION

I commit this research to any girl child harboring dreams of becoming a great scientist but is struggling with financial support. God will always provide.

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I sincerely give all the honour and glory to God for keeping me alive, strengthening me and giving me all support required to walk through the journey of writing and finishing this document.

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ABSTRACT

Intestinal helminths cause diseases and death in low and middle-income countries. Pupils are among the individuals at high risk of contracting intestinal helminthiasis. The use of contaminated water and improper hygienic practices are drivers leading to the high prevalence of these infections. The aim of this research was to establish the prevalence, intensity, and risk factors associated with STH among school-going children in Lurambi Sub-County, Kakamega, Kenya. A cross-sectional study was conducted from January to February 2020 for two consecutive days in six primary schools among 384 randomly selected pupils aged 5 to 14 years. Risk factors associated with soil transmitted helminths were obtained by administering a structured questionnaire to the parents. Fresh Stool samples were gathered, processed and examined using the standard quantitative Kato-Katz technique. The data were entered and analyzed using SPSS version 20 and Epi Info version 7. 2. 3. 1. Descriptive statistics were performed to obtain the prevalence and infection intensity of the observed intestinal helminths. Multivariate logistic regression was performed to determine the potential risk factors linked to intestinal helminthiasis. A confidence interval of 95% and a p-value of $\leq$ 0.05 were used. The general prevalence of helminthic infections was 14.4%. The prevalence of *Ascaris lumbricoides* was 11.5%, *Schistosoma mansoni* 2.1%, Hookworm 0.4%, and *Trichuris trichiura* 0.4%. The STH accounted for 12.3% whereas *S. mansoni* accounted for 2.1% of the intestinal infection. Multiple infections of Hookworm and *A. lumbricoides* were observed (0.4%). Children aged 11-14 years who attended schools with rural set-up facilities accounted for a higher prevalence of *S. mansoni*. *A. lumbricoides* had the highest mean infection intensity of 3059 epg. Risk factors established in this study were; the behaviour of not washing hands before eating (OR=3.529; CI: 1.0539-11.8175; P= 0.041), consumption of unwashed fruits and vegetables (OR= 2.3129; CI: 1.831-4.1691; p= 0.005), the behaviour of not cleaning hands after handling soil (OR= 2.1529; CI: 0.9618-4.8189 p=0.005). Children who swam in rivers had odds of 3.3235 higher of contracting *S. mansoni* (OR=3.3235, CI: 0.359-30.7515). Age was also observed as a risk factor to *S. mansoni* (Z-statistic= 2.4006; P= 0.0164). This study found out that the prevalence of STH was low and that there was no heavy infection intensity observed. Integration of deworming with proper hygienic and sanitation practices should be done in order to eliminate intestinal helminthiasis in Lurambi Sub-County and at large in Kenya.

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LIST OF ABBREVIATIONS AND ACRONYMS

A. lumbricoides	*Ascaris lumbricoides*
B	Billion
CI	Confidence Interval
DALY's	Disability Adjusted Life Years
EPG/ epg	Egg per gram of faeces
MMUST	Masinde Muliro University of Science and Technology
NTDs	Neglected Tropical Diseases (NTDs)
OR	Odds Ratio
S. mansoni	*Schistosoma mansoni*
SPSS	IBM Statistical Package for the Social Science version 20
STHs	Soil-Transmitted Helminths
T. trichiura	*Trichuris trichiura*
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Soil transmitted helminth (STH) infections are a major source of threat to the well-being of people living in developing countries in tropical and subtropical regions. They include *Ascaris lumbricoides*, *Trichuris trichiura,* hookworms (*Necator americanus* and *Ancylostoma duodenale*), and *Strongyloides stercoralis* (WHO, 2020; Salim *et al*., 2015). Studies worldwide have reported that prevalence, intensity, morbidity, and mortality occur among thousands of people in rural, impoverished villages within the tropics and subtropics (Crompton & Nesheim, 2002). These areas are characterized by poverty and poor sanitation that pose a major risk, implying that health awareness is needed. The average prevalence is 95% in developing countries and 50% in developed countries (WHO, 2009). All these factors are common in many developing countries, as well as Kenya including Lurambi Sub-County, Kakamega.

World health organization (WHO) declared mass treatment of population at high risk of contracting helminthiasis in the year 2001 as the means to regulate and minimize intestinal parasitic infections (WHO, 2002). The strategy only reduces illness caused by STH and intestinal schistosomiasis (Jia *et al*., 2012; Ziegelbauer *et al*., 2012). Obala *et al*. (2013) reported that in Kenya, chemotherapy of intestinal and STH has remained a public health matter of interest at both the national government and stakeholders' levels in the health departments.

1.2 Statement of the problem

Pupils have a high probability of contracting STH infections in Kenya (Ngonjo *et al*., 2016). Despite the continuous and periodic administration of anti-helminthic drugs, STHs infections remain high in Kenya. Kakamega County has a high prevalence of intestinal helminths where *A. lumbricoides* accounts for a prevalence ranging from 26.7% to 62.6 % and hookworms (1.8%). Among the counties within Kakamega, Kakamega Central recorded the highest prevalence (52.1%) (Ngonjo *et al*., 2016). STH causes morbidity, mortality, anaemia, diminish the physical and mental development of a child, impede education progress in childhood, and inhibits economic growth (Bethony *et al*., 2006). Socio-demographic and socioeconomic characteristics in Lurambi Sub-County, Kakamega, are key drivers that may contribute to the spread of STHs among the population at high risk. The school de-worming programme began in the year 2001 and is still ongoing, but the prevalence is still high within Kakamega (Ngonjo *et al*., 2016). Therefore, there is a need to establish an up-to-date prevalence and intensity of STH infections and also to determine the predisposing factors for continuous transmission of STH among school-going children aged 5-14 years in Lurambi Sub-County, Kakamega.

1.3 Justification

One-point five billion People are reported to have been infected with STH infections (Pullan *et al*., 2014; WHO, 2020). In Kenya, STH infections are broadly spread, with approximately ten million cases, and 16.6 million persons estimated to be at risk (WHO, 2006; WHO, 2012). Although WHO declared mass administration of anti-helminthic drugs as the worldwide preventive measure to control intestinal and STH infections, studies have shown that the preventive chemotherapy only reduces illness caused by STH but does not prevent re-infection (Handzel *et al*., 2003; Jia *et al*., 2012; Ziegelbauer *et al*., 2012; Obala *et al*., 2013). Ngonjo *et al*. (2016) carried out a study in an informal urban settlement among school-going children in Kakamega County to establish prevalence before drug administration. In the study, the prevalence was quite high, ranging from 26.7% to 62.6 % for *A. lumbricoides* and low for the hookworms (1.8%). Disease transmission also varies in different geographical settings therefore, for any disease control and intervention programme to be put in place, there is a need for baseline studies to establish its prevalence (Nsubuga *et al*., 2006). No documented evidence shows that such a study has been conducted in Lurambi Sub-County, Kakamega.

Hazards for high intensity, high transmission, and prevalence of STH were established in Lurambi Sub-County, Kakamega, Kenya. This study, therefore, provides up-to-date information on the prevalence, intensity and risk factors associated with STHs in Lurambi Sub-County. The information will be useful to the government, including all interested parties in health care institutions dealing with children for coming up with strategic control measures that can work adjacent to the existing de-worming programs to attain effective management of intestinal helminthiasis in Kakamega.

1.4 General objective

The general objective of the study was to determine the prevalence, intensity, and risk factors of STH among school-going children in Lurambi Sub-County, Kakamega, Kenya.

1.5 Specific objectives

The specific objectives of the study were:

1. To determine the prevalence of STH among school-going children
2. To determine the intensity of STH among school-going children
3. To determine the risk factors of STH among school-going children

1.6 Research questions

1. What is the prevalence of STH infections among school-going children?
2. What is the intensity of STH infections among school-going children?
3. What risk factors can possibly be associated with STH infections among school-going children?

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction to Soil Transmitted Helminths

Soil-transmitted helminths (STH) are nematode worms, which comprises *A. lumbricoides, S. stercoralis, T. trichiura*, *N. americanus,* and *A. duodenale.* They cause human infections, which are identified as neglected tropical diseases (NTDs) (WHO, 2020). STH is included among NTDs because it is known to cause great disability and suffering, which can be easily treated though it seems that, little effort has been directed to it (Montressor *et al*., 2020).

2.2 Global Distribution and Prevalence of STH

Soil-transmitted helminth infections have been reported within tropical and sub-tropical regions. The cases of the disease are more prevalent in Sub-Saharan Africa, the Americas, China, and East Asia (WHO, 2020). The STH survives well in soil that is warm and moist (Knopp *et al*., 2012). Also, it is associated with low hygienic practices as well as regions where human excrement is used as manure.

Twenty-four percent (24%) of the world's population which is equivalent to one-point-five billion human beings have been diagnosed with STH infections (Pullan *et al*., 2014; WHO, 2020). Globally, more than two hundred and sixty-seven million pre-school age children, five hundred and sixty- eight million school-age children and more, do reside in regions where the transmission of STH is high which projects that the children need to be treated and preventive interventions need to be put in place so as to bring down the infectivity rate of STH among the children living in the endemic regions (WHO, 2020; Pullan *et al*., 2014).

Millions of people were reported to have been diagnosed with hookworm (438.9M), *A. lumbricoides* (819.0 million), and *T. trichiura* (464.6 million) by 2010 (Pullan *et al*., 2014). Bisoffi *et al*. (2013) reported about 370 million cases of *S. stercoralis* (strongyloidiasis) worldwide, the estimated prevalence rates were said to go up to 60% in endemic areas specifically in Southeast Asia, sub-Saharan Africa, the West Indies, and Latin America.

2.3 Prevalence of STH in Sub-Saharan Africa

Intestinal helminthic diseases occur broadly in Sub-Saharan regions where personal and environmental hygienic practices are low (WHO, 2002). By the year 2018, children aged five to fourteen years that had been diagnosed with different species of STH within sub-Saharan Africa were thirty-five million. The prevalence of hookworm in Africa reduced from 30% to 5% for the period 2000-2018 in Africa (Sartarius *et al*., 2021). Two-point nine million cases of moderate to heavy infection intensity were observed among children who were going to school for the period between the years 2000-2018 in sub-Saharan Africa (Sartarius *et al*., 2021).

2.4 Prevalence of STH in Kenya

Ten million and above cases of STH infections have been recorded in Kenya. Roughly, Sixteen-point six million people are exposed to high risks of contracting STH infections (MOH, 2016). 5.9 million children (School going and preschool) are infected with STH infections and require preventive chemotherapy. 1,845, 296 pre-school-aged children are in dire need of treatment (WHO, 2020). The STH infections are more predominant in western Kenya, some parts of South Rift Kenya, Central (a small region), Eastern and North Eastern Kenya (Pullan *et al*., 2011), and the Coastal region (cases have been reported though they don't merit for Mass drug administration as per the WHO, 2020 decision tree.

2.5 Prevalence of STH in Kakamega County

In the year 2016, a prevalence of 44.05% of STH was reported in Kakamega County with the prevalence of *A. lumbricoides* ranging from 26.7% to 62.6 %, Hookworm ranging from 0% to 1.8%, and *T. trichiura* (0.82%). The STH infections are more prevalent in Kakamega Central (52.1%) compared to the other sub-counties within Kakamega (Ngonjo *et al*., 2016). Further research is required in order to establish the reasons associated with the high prevalence of STH and also the current prevalence of STH among school-going children in Lurambi Sub-County, Kakamega.

2.6 Intensity of STH

Intensity is defined as the number of worms or number of eggs observed in the stool of an infected person. It is established by counting the number of eggs released in human stool times 24 (standard value established by WHO, (2002)).

World health organization came up with strategic goals in the year 2030 to ensure that moderate to heavy intensity of STH infection is brought down up to less than 2% in all regions (WHO, 2020). Infection intensities usually recover slower than prevalence post-treatment which might play an important role in STH infection and re-infection (Montressor *et al*., 2020), hence the need to determine the intensity of STH infection among School going children in Lurambi Sub-County, Kakamega. Table 2.1 shows the threshold for the three classes of intensity of infection as outlined in the WHO, 2002 guidelines.

Table 2.1:Threshold for the three classes of infection intensity

Helminthic parasite	Light-infection intensity	Moderate-infection intensity	Heavy-infection intensity
Ascaris lumbricoides	1-4,999 epg	5000-49,999 epg	>50000 epg
Trichuris trichiura	1-999 epg	1000-9,999 epg	>10000 epg
Hookworms	1-1,999 epg	2000-3,999 epg	>4000 epg
S. mansoni	1-99 epg	100-399 epg	>400 epg

2.7 Risk Factors Associated with Soil Transmitted Helminthiasis

Risks associated with STH infection include poor sanitation, use of unsafe water, poor hygiene, low socioeconomic lifestyle, and rural areas (Mehraj *et al*., 2008). The child's playground, hygiene of the parent, and densely populated home environment are key drivers in the transmission of the STHs (Aleka *et al*., 2015).

2.8 Mode of Transmission of Soil Transmitted Helminthes

Soil-transmitted helminthic parasites are passed on in two modes; faecal-oral and transdermal. Faecal-oral transmission occurs through infective eggs that are ingested through contaminated food, water, or vegetables (Booth *et al*., 2004). The eggs break and contrive larvae while in the ileum as in *T. trichiura* in which the larvae mature and live in the colon. Larvae of *A. lumbricoides* usually go through the stomach wall to the bloodstream, move to the liver, travel to the lung via the bloodstream. Immediately after getting into the lungs, they go through the respiratory tract and are swallowed again, and go back to the ileum where they grow to maturity and begin laying eggs (Koukounari *et al*., 2008). The factors favoring transmission are generally found in developing countries, including Kenya, especially rural regions including Lurambi Sub-County, Kakamega.

Transdermal transmission occurs when the eggs released in faeces to soil hatch and develop to first and second larval stages (rhabditiform larvae) that feed on bacteria in the faecal material. The rhabditiform larvae molt into filariform larvae (L_3), which are motile and infective (Koukounari *et al*., 2008). Once the filariform larvae get into contact with human skin, it penetrates and goes through the pulmonary stage. On reaching the bloodstream and lungs, the larvae finally pass up to the respiratory tract, and it is then swallowed (Koukounari *et al*., 2008). The larvae mature into adult worms when it enters the ileum and then it starts laying eggs. This is seen in *A. duodenale*, *N. americanus,* and *S. stercoralis.*

2.9 Effects of Soil Transmitted Helminthes

STH infections cause morbidity, mortality, iron deficiency anemia, impair physical development, loss of appetite, competition for micro-nutrients, blood loss (anaemia), and mal-absorption of nutrients (Hall *et al*., 2008), which affect child growth, development, educational performance and also suppress the immune system. *A. lumbricoides* lead to complications that can require surgical emergencies on the abdomen, actually, the complication rate can go as high as 67%, this occurs as a result of an obstruction in the intestinal and biliary tract (Chan, 1997; Bethony *et al*., 2006; Hotez *et al*., 2006; Steinmann *et al*., 2006; WHO, 2006; Pullan & Brooker, 2008; Hotez & Kamath, 2009; Murray *et al*., 2012).

Hookworms are estimated to drain blood from 1.5 million people daily (Adu-Gyasi *et al*., 2018). Heavy infection of *T. trichiura* leads to diarrhoea, hypoalbuminaemia, and *Trichuris* dysentery syndrome (TDS) which is chronic. It is also linked with stunted growth, anaemia and impedes the brain development of the infected child (de Silva *et al*., 2003).

2.10 Control and Treatment of STH Prevalence and Intensity of Infections

An integrated approach that includes access to appropriate sanitation, improved hygienic practices, education, and preventive chemotherapy was enumerated by WHO as the sustained effective way of controlling intestinal infections (Montressor *et al*., 2020; WHO, 2011). Preventive chemotherapy involves the administration of anti-helminthic drugs (albendazole and mebendazole). The rate of administration of the anti-helminths is carried out one or two times in a year (WHO, 2006; Gabrielli *et al*., 2011). Pupils and women at active child bearing age are groups that are at high risk and require treatment for STH (Gabrielli *et al*., 2011; Gyorkos *et al*., 2018).

2.11 National School-Based Deworming Programme in Kenya

Following the effects of STH infections on children's physical and mental growth, the Ministry of Health and the Ministry of Education in Kenya began a National School-Based Deworming Programme (NSBDP) in the year 2009 (MOH, 2014). The NSBDP adopted preventive chemotherapy where the school-age children, preschool-aged children, those children who weren't going to school were administered anti-helminthic drugs (albendazole and Praziquantel annually).

Reduction in the prevalence and intensity of STH and Schistosome infection was recorded which was an observation made from thorough and continuous monitoring of the efficacy of mass deworming programme from 2012-2017 under extensive monitoring and evaluation led by Kenya Medical Research Institute (KEMRI) which included pre and post mass drug administration interventions and repeated cross-sectional surveys as described and demonstrated by several researchers (Mwandawiro *et al*., 2013; Okoyo *et al*., 2016; Mwandawiro *et al*., 2019). Okoyo *et al*. 2020 indicated that the NSBDP program should encourage interventions aimed at improving coverage among preschool-age children, school-going children and improving access to clean and safe water, improved sanitation, and hygienic practices as long-term infection control strategies.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

This research was carried out in Lurambi Sub-County, Kakamega County, Kenya. It has approximately a population of 160,229 people with an approximate area of 161.8Km^2. Lurambi Sub-County has a total of 161 primary schools. The study area map is as shown in Figure 3.1

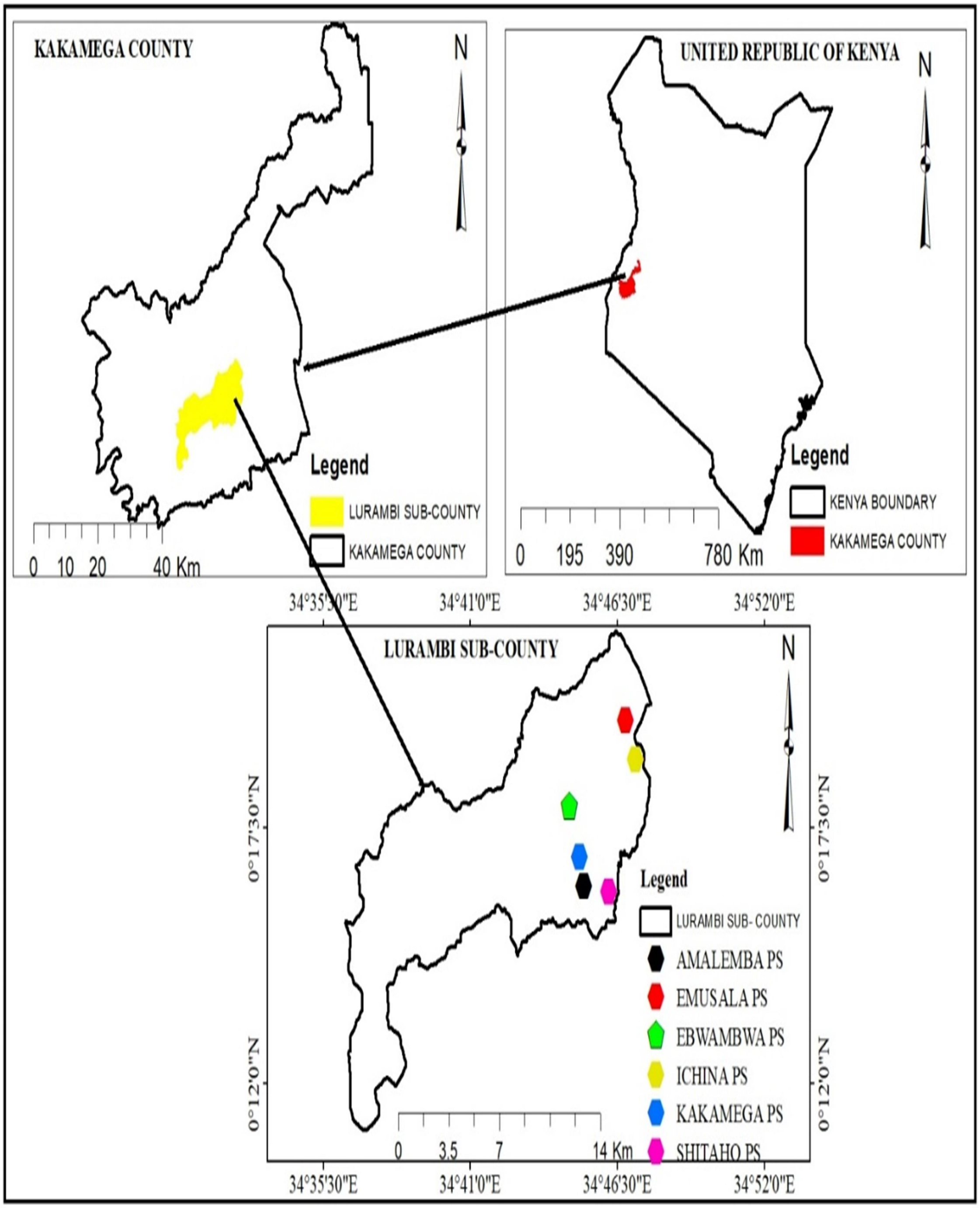

Figure 3.1: The study area

3.2 Study Design

A cross-sectional study was conducted from January to February 2020. It involved both qualitative and quantitative techniques.

3.3 Study Population

The study population was composed of primary school-going children in Lurambi sub-County, Kakamega, who were five to fourteen years old and those whose parents consented to participate in the study. Those who didn't fit the inclusion criteria were excluded from the study.

3.4 Sample Size Determination

The sample size was estimated using the single proportion formula for estimating proportion. $(n) = \frac{Z^2Pq}{d^2}$, (n) represents the minimal sample size required for this study, Z stands for confidence level (Z=1.96), the confidence level was assumed to be 95%; the allowable error of estimation (d) was taken as 5%; p=assumed prevalence (52.1%) obtained from a previous study performed by Ngonjo *et al.* (2016). Therefore, n was estimated to be 384

$$n = \frac{1.96^2 \times 0.521(1 - 0.521)}{0.05^2}$$

$$n = \frac{1.96^2 \times 0.521(0.479)}{0.0025}$$

$$n = \frac{0.96}{0.0025}$$

$$n = 384$$

Table 3.1: Sample size and study population

School	Description	Boys	Girls	Total
Kakamega primary	Urban setting	32	32	64
Amalemba primary	Urban setting	32	32	64
Ebwambwa primary	Urban setting	32	32	64
Ichina primary	Rural setting	32	32	64
Emusala primary	Rural setting	32	32	64
Shitaho primary	Rural setting	32	32	64

3.5 Sampling Procedure

The type of sampling used in this study was cluster sampling. Each cluster was made up of at least 64 pupils per school in six primary schools which established the sampling frame. The Kakamega County Education Officer provided a list of primary schools within the Lurambi Sub-County. A table of random number generators was used to randomly choose six primary schools where three had rural set-up equivalent facilities and the other three had urban set-up facilities.

The headteachers from the selected primary schools gave a nominal roll of children aged five to fourteen years. The pupils were chosen randomly from the list. In situations where the child was absent, the child below or above the chosen one in the nominal roll was picked. Each child was given an invitation letter to take it to their parents. The letter was requesting their parents to meet the principal investigator on the date indicated on the letter. During the meeting, the principal investigator elaborated the purpose of the study, confidentiality concerns, gains, and risks of the study clearly. Afterward, the guardians were asked to consent sign a written consent on behalf of their children, and also assent was sought from the children.

3.6 Parasitological examination

3.6.1 Determination of the prevalence and intensity of STH among school-going children in Lurambi Sub-County, Kakamega, Kenya

The Pupils were directed on how to collect a stool sample of 2 grams. Every child in the study population provided a fresh stool sample for Kato-Katz analysis for two successive days. The Kato-Katz standard technique was used to establish the presence of eggs and counts of STH in defined quantities (Katz *et al*., 1972). Two microscope slides for Kato Katz were prepared per stool sample as per the WHO kit. Then it was covered with malachite green impregnated cellophane. Then observed under the microscope at a magnification of x40. The observation was done immediately for hookworm while *A. lumbricoides*, *T. trichiura,* and perhaps any other helminth eggs were examined 60 minutes later and the proportion of pupils infected with each soil transmitted helminth or any other intestinal helminth was calculated by using the following formula;

$\frac{Number\ of\ children\ infected\ with\ the\ STH}{Total\ sample\ size} \times 100 = prevalence\ (as\ \%)$ and also the total number of eggs counted was multiplied by 24 (standard value as per WHO, 2002) to give eggs per gram of faeces per child. Quality control was performed by a systematic random examination.

3.6.1.1 Stool Analysis Using Kato-Katz Technique

Two grams of stool sample were scooped and put on a sieve, then it was sieved in order to obtain a smooth stool sample. Thereafter the sieved stool was placed into a hole of a template placed on top of a slide (2 slides were used per stool sample), then after filling the hole, the template was carefully lifted and removed. The sieved stool left on the slide was then covered with a cellophane strip that had been soaked in glycerol malachite green (soaked at least for 24 hours). The over-spilling glycerol malachite green was cleared off by wiping with an absorbent tissue. Afterward, the microscope slide containing the sample was inverted and the stool on the slide was pressed against the cellophane strip on a smooth surface to ensure that the stool was evenly spread. The slide was then observed under a microscope (x40), immediately for hookworms and after sixty minutes for other helminthic parasite eggs.

3.6.2 Determination of the risk factors associated with STH among school-going children in Lurambi Sub-County, Kakamega, Kenya.

Structured questionnaires (Appendix III (English Version) and Appendix V (Swahili version)) were administered to the parents/guardians who had consented (consent Form-Appendix II-English Version; Appendix IV-Swahili version) to participate in the study. The pre-tested structured questionnaire was administered in Swahili, English, and the local language of the parent/guardian.

The questionnaire captured issues related to household Socio-demographics, economic, hygiene practices, environmental sanitation information, and health history status of children aged 5 to 14 years in the selected schools. All questionnaires were coded well with each children's identification number.

3.7 Data analysis

The data was captured in Microsoft excel® and analyzed using SPSS version 20 and Epi Info version 7. 2. 3. 1. Descriptive statistics were performed in order to provide the prevalence of intestinal helminths observed in this study. The intensity of infection for intestinal helminths was calculated by getting a product of observed eggs of each helminth and 24 to give eggs per gram of faeces (EPG). Risk factors associated with any helminthic infection recorded in this study were obtained using a multivariable logistic regression at a 95% confidence level. Inclusion criteria of p-value < 0.2 during univariable analysis was used to qualify a factor to proceed to multivariable analysis. At the end of the analysis, a variable was considered as a risk factor associated with any intestinal helminth infection observed in this study when the $p \leq 0.05$. Potential risk factors involved in the study were; parents' education and occupation levels, sex, age, age group, sanitary and hygienic practices of the child, and the school set-up where the child studies from (rural and urban set-up).

3.8 Ethical approval, Consent and assent

The research permit was obtained from National Commission for Science, Technology & Innovation (NACOSTI) (Appendix I). The study protocol was approved by Masinde Muliro University of Science and Technology Ethical Review Committee Reference number: MMUST/IERC/64/19, Kakamega, Kenya. Parents/guardians and pupils aged between five to fourteen years gave written informed consent and oral assent respectively. Pupils whose samples had any STH were treated using albendanzole. Those positive with *Schistosoma mansoni* were administered with Praziquantel by a Clinician as per the world health organization instructions.

CHAPTER FOUR

RESULTS

4.1 Descriptive statistics

Three hundred and eighty-four children were registered for the study and their parents gave consent. Two hundred and seventy-eight (72.40%) children managed to participate fully in the study by providing fresh stool and their parents filled out the questionnaire. Out of the 278 children, girls were 51.8% whereas boys were 48.2% though the difference was statistically insignificant (p= 0.557). Fifty-four percent of the stool samples were obtained from those aged 5 to 10 years. The frequency of Self-employed parents was 40.6%. 63.7% of the children who participated fully in the study were going to rural primary schools (Table 4.1).

Table 4.1: Socio-demographic characteristics of the parent and the school going children enrolled in the study

Variables	Level	Frequency	Percent (%)
Gender of the child	Male	134	48.2
	Female	144	51.8
Age group	5 - 10 Years Old	150	54.0
	11+ Years Old	128	46.0
Education level of the parents	Informal	25	9.0
	Primary	150	54.0
	Secondary/above	103	37.1
Occupation status of parents	Farming	67	24.1
	Self-employed	113	40.6
	Formal employment	42	15.1
	Unemployed	56	20.1
School setup	Urban school	101	36.3
	Rural school	177	63.7

4.2 Observations

Different types of eggs were observed under a microscope (Figure 4.1).

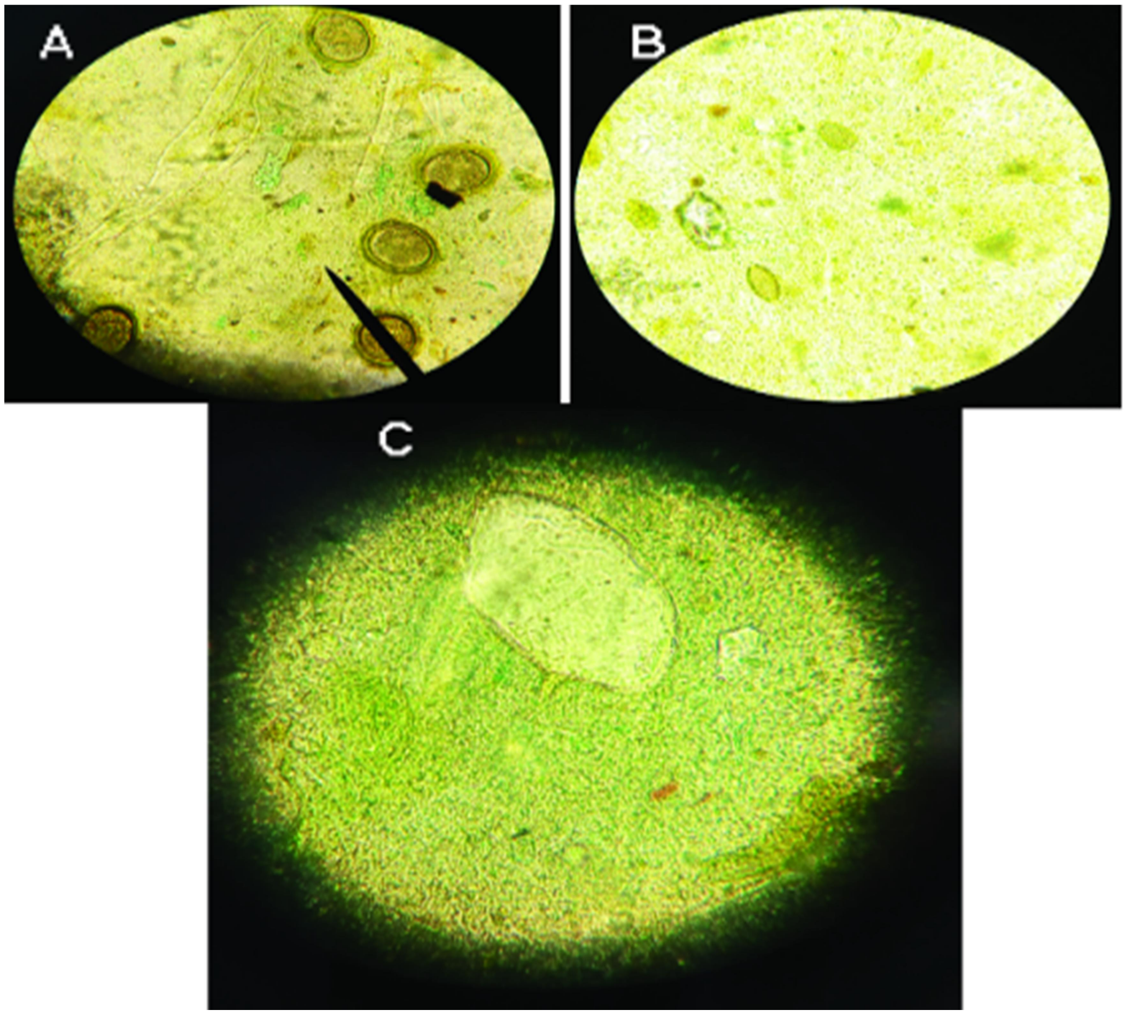

Figure 4.1: Eggs observed in this study

Key: *A=A. lumbricoides B=T. trichiura C=S. mansoni*.

Note: Hookworm eggs cleared immediately before being captured using the camera

4.3 The Prevalence of STH among school-going children

The general prevalence of intestinal helminths was 14.4%. *A. lumbricoides* was the most occurring intestinal helminth where it had a prevalence of 11.5%, followed by *S. mansoni* (2.1%), Hookworm (0.4%), and *T. trichiura* (0.4%). The STH accounted for 12.3% while *S. mansoni* accounted for 2.1% of the intestinal infection (Table 4.2). Multiple infections of Hookworms and *A. lumbricoides* was observed in one child at Emusala primary school amounting to a proportion of 0.4% (Table 4.2).

Table 4.2: Prevalence of intestinal helminths by species

Intestinal worms	Frequency	Percentage (%)
A. lumbricoides	32	**11.5**
Hookworms	1	0.4
T. trichiura	1	0.4
S. mansoni	6	2.1
Hookworm and *A. lumbricoides*	1	0.4

Children aged 11-14 years had a lower prevalence of 4.3%. A higher prevalence of *A. lumbricoides* (9.0%) was observed among pupils aged five to ten years than those aged 11-14 years (2.5%). One-point-four percent of the *S. mansoni* infection was observed among pupils who were eleven to fourteen years old (Table 4.3).

Table 4.3: Prevalence of intestinal helminths by age groups

Intestinal helminths	5-10 years (%)	11-14 years (%)
Ascaris lumbricoides	9.0	2.5
Schistosoma mansoni	0.7	1.4
Trichuris trichiura	0.4	0.0
Hookworms	0.0	0.4

Amalemba Primary school and Kakamega Primary accounted for the lowest prevalence (0.4%) of intestinal parasites, with Shitaho Primary School showing the highest prevalence of 8.2% followed by Emusala (2.1%), Ichina (1.5%), and Ebwambwa (1.8%) primary schools (Table 4.4).

Table 4.4: Prevalence of intestinal worms per school in Lurambi Sub-County in Kakamega

School	Frequency (n=40)	Percentage (%)
Amalemba Primary	1	0.4
Ebwambwa Primary	5	1.8
Emusala Primary	6	2.1
Ichina Primary	4	1.5
Kakamega Primary	1	0.4
Shitaho Primary	23	8.2

Boys had a prevalence of 5.0% which was higher than girls (3.2%) in Shitaho primary school. Girls in Emusala primary school recorded a higher prevalence (1.4%) compared to boys (0.4%). There were no observed helminthic infections among girls in Amalemba primary school and among boys in Kakamega primary school (Table 4.5).

Table 4.5: Prevalence of intestinal helminths by gender (boys versus girls)

School	Boys (%)	Girls (%)
Amalemba Primary	0.4	0.0
Ebwambwa Primary	1.1	0.7
Emusala Primary	0.7	1.4
Ichina Primary	0.4	1.1
Kakamega Primary	0.0	0.4
Shitaho Primary	5.0	3.2

Boys showed a higher prevalence of intestinal helminths infections (7.6%) than that of girls (6.8%). Children aged 5-10 years recorded a higher prevalence of 10.1%. Those children whose parents were unemployed had the prevalence of intestinal helminth infections of 10.4% while that of those whose parents were formally employed was the lowest (0.4%). A prevalence of 12.6% and 11.9% was observed among children who cleaned hands without soap after handling soil and visiting the toilet respectively (Table 4.6). A substantially higher prevalence of 11.9% was observed among children who attended schools with rural setup (Table 4.6).

Table 4.6: Prevalence of intestinal worms in Lurambi Sub-County in Kakamega, Kenya by socio-demographic factors

Variable	Level	Frequency	Percentage (%)
Gender	Male	21	7.6
	Female	19	6.8
Age-group	5-10 years	28	**10.1**
	11 + Years	12	4.3
School setup	Urban School	7	2.5
	Rural School	33	**11.9**
Occupation of parents	Farming	5	1.8
	Self-employed	5	1.8
	Formal employment	1	0.4
	Unemployed	29	10.4
Education level of parents	Informal	5	1.8
	Primary	34	**12.2**
	Secondary/above	1	0.4
Washing of hands after soil contact	Yes, with water and soap	0	0.0
	Yes, with water only	35	**12.6**
	No	5	1.8
Washing of hands after visiting the toilet	Yes, with water and soap	2	0.7
	Yes, with water only	33	**11.9**
	No	5	1.8

4.4 Intensity of STH infections among school-going children in Lurambi Sub-County, Kakamega, Kenya

The infection intensity was established as per WHO standards (Table 2.1). the mean intensity of *A. lumbricoides* was the highest (3059 epg) in this study (Figure 4.2) whereas *S. mansoni* showed the lowest mean infection intensity of 96 epg (Figure 4.2).

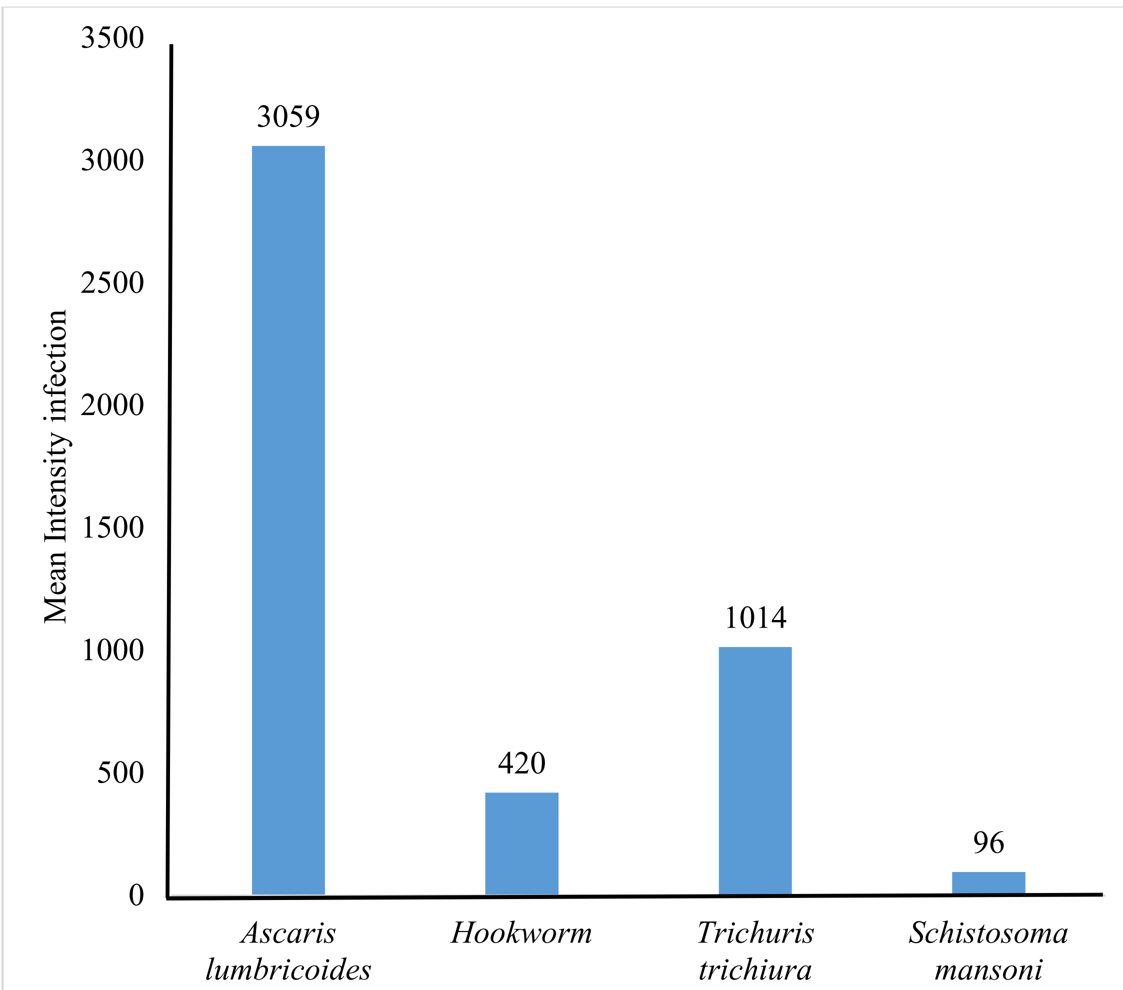

Figure 4.2: The mean infection intensity of the observed intestinal worms by species

The mean intensity of *A. lumbricoides* was highest in Shitaho primary school (2264 epg), followed by Ebwambwa primary school (409 epg) (Figure 4.3).

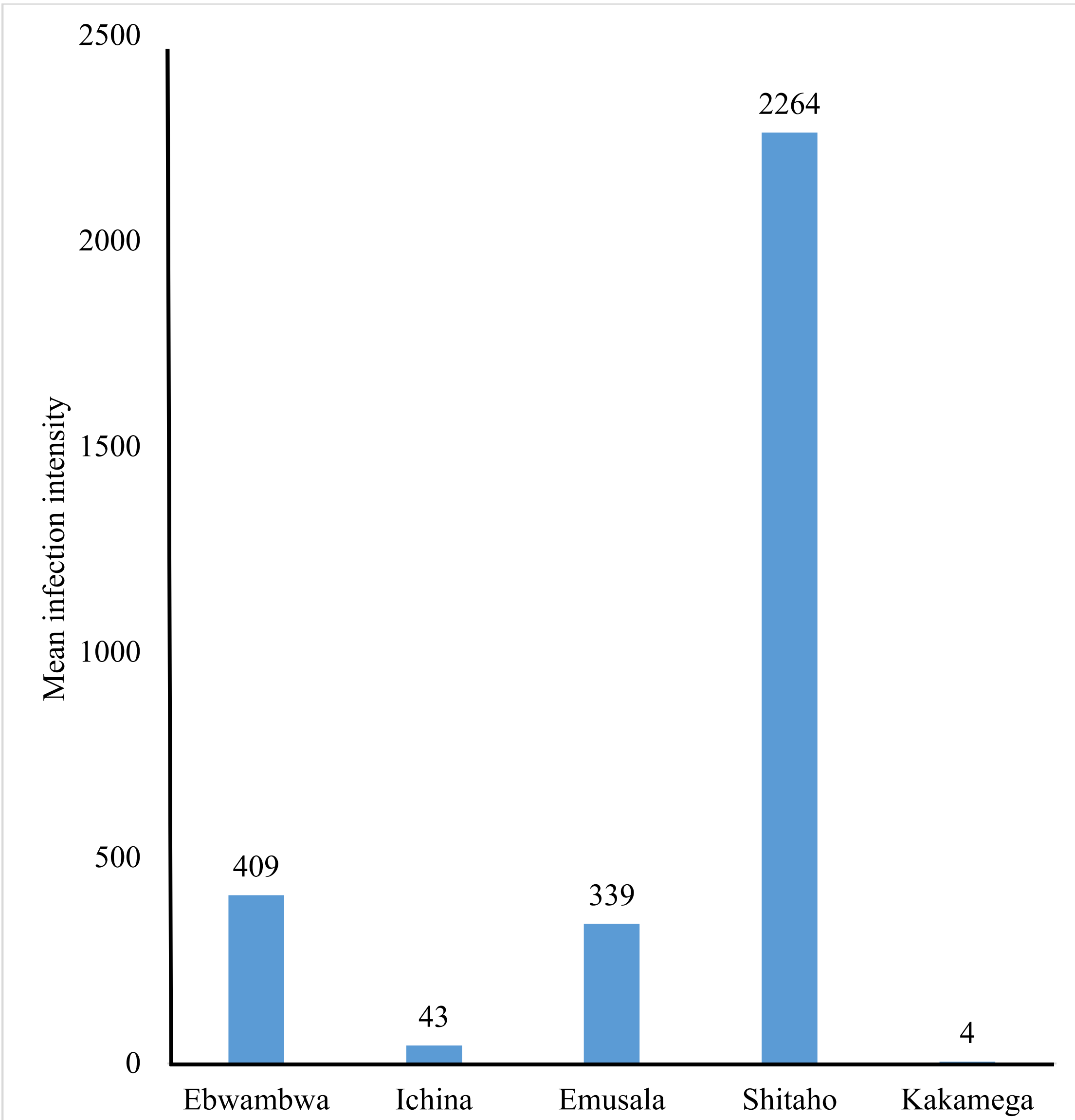

Figure 4.3: Mean intensity of *Ascaris lumbricoides* by primary school

Children aged 11 years and above who attended urban schools were not diagnosed with any intestinal helminth in this study. However, children aged between 5-10 years in urban schools reported a slightly lower percent of light mean intensity (16 epg) and moderate mean infection intensity of (397 epg) infection intensity of *A. lumbricoides*. Primary schools located in the rural region showed both moderate mean intensity (1889 epg) and light mean intensity (757 epg) infections whereas those aged 5-10 years showed higher cases of light mean intensity of 627 epg and mean moderate intensity of 844 epg (Figure 4.4).

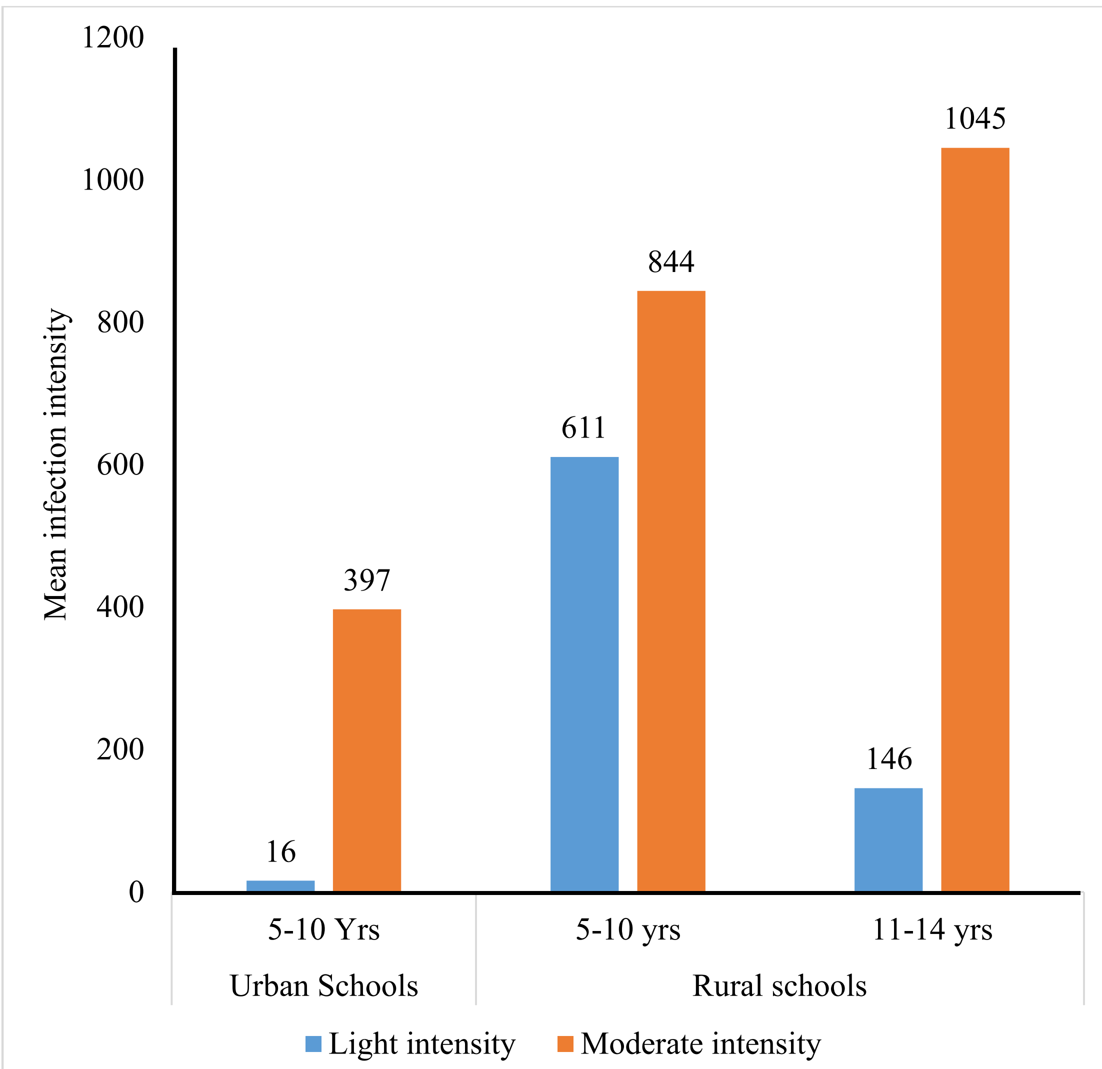

Figure 4.4: *Ascaris lumbricoides* infection intensity per school set-up and age group

Light infection intensity (44epg) and moderate-intensity (52epg) were observed among children diagnosed with *S. mansoni*. Those aged 11+ years had a higher mean intensity of 78 epg compared to those aged 5-10 years (18epg) with rural schools having a higher mean intensity of *S. mansoni* (Figure 4.5).

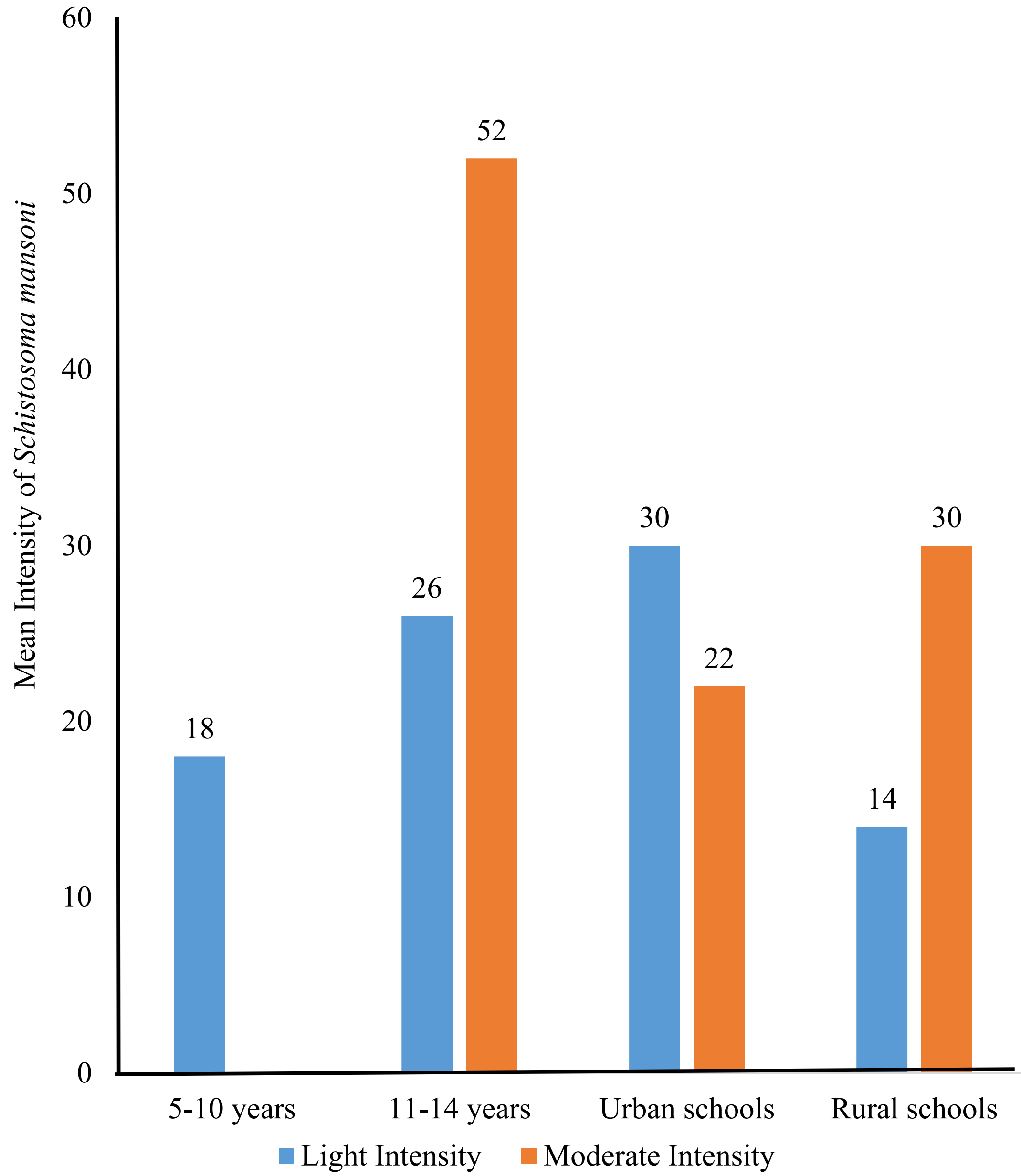

Figure 4.5: *Schistosoma mansoni* mean infection intensity by school set-up and age group

Emusala primary school recorded the highest mean infection intensity of *S. mansoni* (44epg) whereas the lowest mean infection intensity was observed in Amalemba Primary (14 epg). There was no Schistosome case in Shitaho, Kakamega, and Ichina Primary Schools (Figure 4.6). Light infection intensity of hookworm (420epg) was observed among children aged 11-14 years in Emusala primary school. A moderate mean infection intensity of *T. trichiura* (1014 epg) recorded in this study was observed in Shitaho primary school.

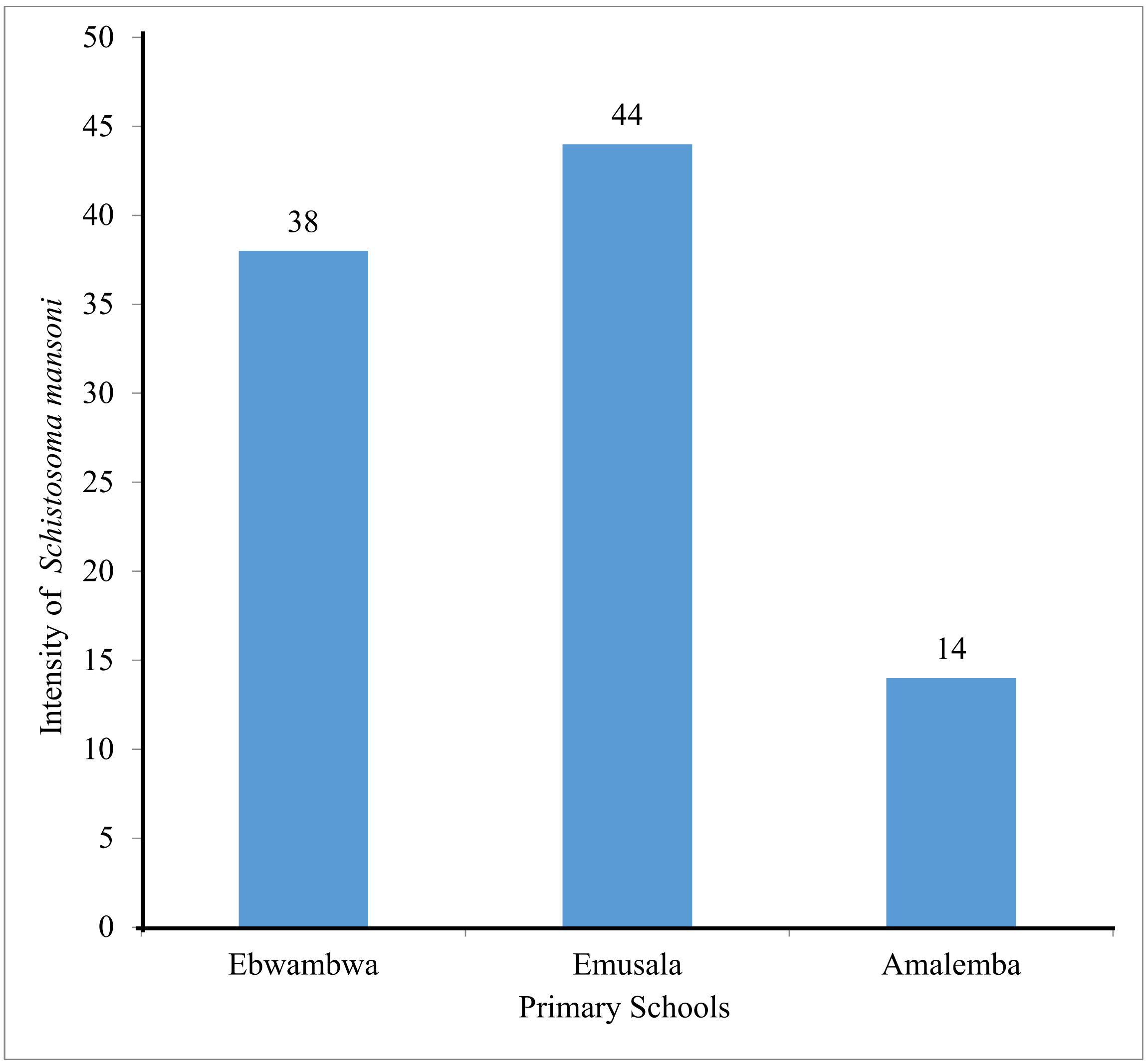

Figure 4.6: Mean infection intensity of *Schistosoma mansoni* per Primary School

4.5 Risk factors associated with STH among school-going children in Lurambi Sub-County Kakamega, Kenya

Pupils who ate food without washing hands had the highest odds of contracting STH infections (OR=114.4709; P=0.0001). pupils who didn't clean their hands using soap were 9.8107 (p=0.0118) more times likely to be diagnosed with intestinal helminths. The behaviour of not washing fruits and vegetables showed odds of 1.3583 more times likely for a child to contract STH, however, this was statistically insignificant (P= 0.5906) (Table 4.7).

Children who didn't practice washing of hands before and after handling cooked and uncooked food had odds of 4.9104 likely to contract STH. Pupils who never cleaned their hands after using the toilet had odds of 29.8023 more likely to be diagnosed with STHs (p=0.1041) (Table 4.7).

The factor of swimming in rivers in this study recorded odds of 13.1318, this indicates that swimming in rivers was statistically related to contracting *S. mansoni* (P=0.0121). Applying human excrement as manure was 2.0967 more times likely to lead to STH infection, though this factor was statistically insignificant (P=0.3755). Schooling from primary schools with rural set-up facilities showed odds of 4.9733, which meant that children who went to such schools were 4.9733 more times likely to test positive for intestinal helminths. However, statistically, this was insignificant (P= 0.1041). Sharing of bathroom materials such as towels among family members recorded odds of 4.573 greater than for those children whose family didn't share bathroom materials though statistically, this factor was not significant (P=0.1383). Unemployment was also a risk linked to intestinal helminthiasis in this study (OR= 34.2137; P=0.0033). Children whose parents had attained Informal and primary education had odds of 11.0997 greater to contract intestinal helminths than those whose parents had acquired formal education though statistically, this factor was insignificant (P=0.0553). Pupils who wore shoes in this study had low chances of contracting STH (OR= 0.0302; P= 0.0004) (Table 4.7).

Table 4.7: Multivariate analysis of risk factor and the presence of intestinal worm

Variables	OR	Confidence interval		P-value
Sharing bathroom material	**4.573**	0.6126	34.1386	0.1383
Age of child	1.0609	0.7156	1.5726	0.7687
Age group	0.3771	0.041	3.4674	0.3889
Education level of parent (Informal& primary education)	**11.0997**	0.9473	130.052	0.0553
Occupation level of parent (Unemployed)	**34.2137**	**3.2451**	**360.7212**	**0.0033**
School setup (Rural)	**4.9733**	0.7186	34.417	0.1041
Use of night soil	**2.0967**	0.4077	10.7815	0.3755
Sex of child	0.9463	0.2613	3.4273	0.9331
Wearing of shoes	**0.0302**	**0.0044**	**0.2076**	**0.0004**
Swimming in rivers	**13.1318**	**1.7566**	**98.1682**	**0.0121**
unwashed fruits &vegetables	1.3583	0.4451	4.1451	0.5906
Not washing of hands after soil contact	**9.8107**	**1.659**	**58.0187**	**0.0118**
Not washing hands between handling raw& cooked food	4.9104	0.6636	36.3343	0.1191
Not washing hands after using toilet	**29.8023**	**3.7106**	**239.3613**	**0.0014**
Hands unwashed before eating	**114.4709**	**10.436**	**1255.6153**	**0.0001**

4.6 Risk factors associated with the light-moderate intensity of the *A. lumbricoides* and *S. mansoni*

The light and moderate infection of *A. lumbricoides* was associated with risk factors such as not washing hands before taking meals (OR=3.529; P= 0.0408). feeding on fruits and vegetables that weren't washed was also a risk factor that was statistically significant (P=0.0053) to light and moderate-intensity infection with odds of 2.3129 more times likely for the pupils to be diagnosed with light and moderate infection intensity. Failing to clean hands after holding soil and using the toilet had odds of 2.1529 and 1.5729 more times likely to lead to light and moderate-intensity infection of *A. lumbricoides* respectively, however, these factors were not statistically significant (Table 4.8). Age was statistically significantly associated to light and moderate-intensity infection of *A. lumbricoides* (P =.005) (Table 4.8).

Table 4.8: Multivariate analysis of the *Ascaris lumbricoides* intensity (low and moderate intensity)

Variables	OR	Confidence interval		P-value
Age	0.8194	0.7131	0.9415	0.005
Not washing hands between handling raw and cooked food	0.9577	0.3347	2.7401	0.9358
Not washing hands after visiting toilet	**1.5759**	0.7747	3.2055	0.2093
Not washing hands after soil contact	**2.1529**	0.9618	4.8189	0.0621
Eating with unwashed hands	**3.529**	1.0539	11.8175	**0.0408**
Eating unwashed fruits &vegetables	**2.3129**	1.2831	4.1691	**0.0053**

Key: OR= Odds ratio; 95% Confidence Interval

The place of swimming was highly correlated to the high infection intensity of *S. mansoni*. Those pupils who swam in rivers had odds of 3.3235 higher of being diagnosed with light to moderate intensity of *S. mansoni* though this factor was not statistically significant. Age was also observed as a risk factor for schistosomiasis (P=0.0164) (Table 4.9)

Table 4.9: Multivariate analysis of *Schistosoma mansoni* intensity and its associated risk factors

Variable	Odds ratio	Confidence interval		P-value
Sharing bathroom	**2.821**	0.302	26.3944	0.3633
Age	**3.1241**	**1.233**	**7.9187**	**0.0164**
Age group	0.0456	0.001	1.6996	0.0944
Place of swimming	**3.3235**	0.359	30.7515	0.2901
Water treatment	0.7157	0.12	4.2546	0.713

CHAPTER FIVE

DISCUSSION

5.1 The Prevalence of STH among school-going children

According to this research, the overall prevalence of STH was considerably lower than what was observed by Ngonjo *et al*. (2016) in Kakamega Central. This is in agreement with a baseline study conducted from 2012-2017 in some regions of Kenya (16 counties) (Mwandawiro *et al*., 2019) that recorded a substantially reduced percentage of STH and schistosomes from 2012 to 2017. These findings imply that the deworming programme is significantly playing a role in lowering the prevalence of STH infections among the school-going children. The low prevalence of STH observed in this study could have also occurred because of the sensitivity levels of the Kato-Katz technique used in this study, low sensitivity has been observed when using the technique in stool samples that have light intensity infection.

The most occurring STH observed was *A. lumbricoides* which was a similar observation made by other scholars (Mwandawiro *et al*., 2013; Ngonjo *et al*., 2016; Mwandawiro *et al*., 2019). However, the findings didn't augment Loukouri *et al*. (2019) and Halliday *et al*. (2019) findings, where the prevalence of *A. lumbricoides* ranged from 0%-6.2% and 0.4% respectively in south coastal Kenya. Sang *et al*. (2014) findings revealed that, *A. lumbricoides* had a lower prevalence of 5.4% in a research carried out in Kisumu. The high prevalence of *A. lumbricoides* is associated to its highest frequency of re-infection after treatment when compared to other intestinal helminths as observed by several researchers (Jia *et al*., 2012; Zerdo *et al*., 2016;

Mwandawiro *et al*., 2019) and the conducive ecological niche within Lurambi Sub-County, Kakamega. In this study, the predominance of *A. lumbricoides* could have occurred as a result of the observed risk factors linked to intestinal helminth infections in this research which includes; not washing hands and consumption of unwashed vegetables and fruits. The type of weather in the Lurambi Sub-County is warm and moist which has a high probability of promoting the existence of *A. lumbricoides*. Its eggs can survive under strained ecological settings for about a duration of ten years (Chong, 2003).

This study recorded a low prevalence of hookworms (0.4%) which contrasts Ngonjo *et al*. (2016) whose baseline study showed the absence of hookworm in Kakamega Central. The spread of hookworm can possibly occur in Lurambi Sub-County if the control measures aren't put in place, this is because once dispersal limitations of the hookworms are overcome its propagation can be successful. *T. trichiura* had a low prevalence in this study which differed from Sang *et al*. (2014) findings in South Nyanza, and Loukouri *et al*. (2019) observations in Eastern Cote d'Ivoire. *S. mansoni* had a prevalence of 2.1% which was comparable to Mwandawiro *et al*. (2019) findings in his baseline study conducted from 2012-2017 in some regions of Kenya (16 counties). *S. mansoni* had a lower prevalence than that recorded in Kisumu (13%) by Sang *et al*. (2014), the observed variation could have occurred as a result of the focal distribution of *S. mansoni* in the two regions. The co-infection recorded in this research was comparable to several assessments (Montresor *et al*., 2002; Ahmed *et al*., 2011; Mekonnen *et al*., 2016; Ngonjo *et al*., 2016; Mwandawiro *et al*., 2019; Tekalign *et al*., 2019) where polyparasitism was observed.

A high prevalence of intestinal helminth infections was seen in Shitaho primary which is comparable to Ngonjo *et al*. (2016) findings. Notably, the prevalence was lower which could have occurred as a result of annual national school deworming practices. Those children aged eleven to fourteen years had a higher prevalence of *S. mansoni*, this is comparable to Sang *et al*. (2014). This higher prevalence could have resulted because as the children grow older, the chances of being exposed to coming into contact with water in water-bodies increases.

5.2 Intensity of STH infections among school-going children in Lurambi Sub-County, Kakamega, Kenya

In this study, only light and moderate-intensity were observed which agrees with Ngonjo *et al*. (2016) and Mwandawiro *et al*. (2019). Light intensity infection of hookworm was observed in the study area for the first time. *T. trichiura* was categorized in only moderate-intensity infection as observed in this study which differs from Chadeka *et al*. (2017) findings, where he recorded light intensity infection in Kwale, Kenya. *A. lumbricoides* showed both light and moderate mean intensities which are similar to the infection intensity observed by Ngonjo *et al*. (2016). The light and moderate infection intensity could have been observed due to continuous deworming of the school-going children which reduces and maintains the intensity of infection (Montressor *et al*., 2020).

5.3 Risk factors associated with STH among school-going children in Lurambi Sub-County Kakamega, Kenya

Integration of deworming and adherence to hygienic practices should be embraced by all in order to eliminate intestinal helminths (Ranjan et al., 2015). The parent's education level which is linked to the level of awareness towards the elimination of STH was observed as a risk to the transmission of STH which agrees with Naish *et al*. (2004). Unemployment among parents was linked to intestinal infections which agrees with Naish *et al*. (2004). This is because unemployment contributes to poor income in the family hence leading to an increase in levels of poverty which is directly linked to STH infections (Montressor *et al.,* 2020).

Consumption of fruits and vegetables without washing was associated to intestinal helminth infections, which augments Ojja *et al*. (2018) findings at Hoima district, rural western Uganda, and Tekalign *et al*. (2019) whose studies highlighted the same as a risk factor. This is because fruits and vegetables can be soiled with intestinal parasites (Bekele *et al*.,2017; Tefera *et al*., 2014).

Going to primary schools with rural setup facilities had higher odds of testing positive for intestinal helminths in this study which was comparable to Ranjan *et al*. (2015). This results from the variations in the facilities such as toilets, availability of soap for washing hands after using the toilet and playing. Children who swam in rivers were at a higher risk of contracting *S. mansoni* in this study, which agrees with other researcher's findings (Kloos *et al*., 2004; Damen *et al*., 2007; Chadeka *et al*., 2017) who reported that its intensity of infection subjective to time spent and continuance contact with water invaded with Schistosomes. Gender as a factor in this study did not influence the prevalence of intestinal helminth infections which is in tandem with Alemu *et al*. (2011); Ranjan *et al*. (2015); Ngonjo *et al*. (2016). This implies that both boys and girls had equal exposure to the risk of contracting intestinal helminths. The child age was also a risk linked to *S. mansoni* mean intensity (P= 0.0164). This is because children aged 11-14 are usually involved in various outdoor activities, they have high mobility and frequently come into contact with the river while swimming and playing which can expose them to water infested with cercariae. Wearing of shoes among school-going children in this study was highlighted as a factor that contributes positively to lowering the prevalence and intensity of intestinal helminths which is in tandem with Halliday *et al*. (2019). This is because wearing shoes effectively prevents STH from penetrating the skin, as an observation made in this study, many school-aged children were reported to be wearing shoes.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study found out that the prevalence of STH was low in Lurambi Sub-County, Kakamega. *T. trichiura* and hookworm had a prevalence of below 1% which implied that the WHO 2030 goal for the two species had been attained within the Lurambi Sub-County. Children who tested positive for Hookworm and *Schistosoma mansoni* had no recorded history of travel to regions where the helminths have been reported within Kakamega and other regions in Kenya. This implies that necessary precautions should be put in place and also preventive chemotherapy for controlling the transmission of *S. mansoni* and hookworm because if left unchecked the transmission of these intestinal worms may build up.

Factors that were statistically associated with the STH and *S. mansoni* transmission in this research were; failure to wash hands before eating, after using the toilet, after soil contact, occupation of the parents, eating unwashed fruits and vegetables. The place of swimming was a risk factor for *S. mansoni* transmission in this study. Shoe wearing was recorded as a preventive risk factor to contracting intestinal helminths in this study.

6.2 Recommendations

The study recommends the following;

1. Continuous monitoring of the prevalence of STH in Shitaho primary by the ministry of health.
2. Integration of preventive chemotherapy and other control strategies in order to eliminate STH in Lurambi Sub-County, Kakamega.
3. Control strategies for preventing Schistosomes should be put in place.
4. Research on the spatial distribution of *Schistosoma mansoni* can be conducted within Kakamega County.
5. Further research on STH can be conducted in the Shitaho community with consideration of taking soil as also a sample.
6. A survey on the effectiveness of hand-washing as a preventive control measure should be conducted during and after the covid-19 outbreak.

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APPENDICES

Appendix I: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
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Date of Issue: **10/October/2019**

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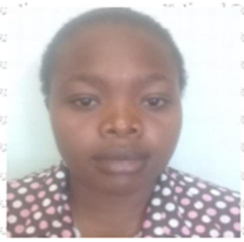

This is to Certify that Miss.. RUTH KITTI of Masinde Muliro University of Science and Technology, has been licensed to conduct research in Kakamega on the topic: Prevalence, Intensity And Risk Factors Of Soil Transmitted Helminths Among School Going Children In Lurambi Sub-County, Kakamega, Kenya. for the period ending : 10/October/2020.

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Appendix II: Informed consent

<u>Prevalence, Intensity and Risk Factors of Intestinal Worms Among School Going Children in Lurambi Sub-County, Kakamega, Kenya</u>.

Investigator: Ruth Wairimu Kiiti

Introduction

My name is Ruth Wairimu Kiiti, I study from Masinde Muliro University of Science and Technology. I'm doing a research on above mentioned title. I kindly request you to cooperate with me during this activity. This form seeks your written consent of agreeing to take part in this assessment. Your participation will be of great help.

Aim of the study

It aims at establishing the frequency of intestinal infections as well as identifying the drivers linked to their transmission among the selected primary school children in Lurambi Sub-County, Kakamega, Kenya.

Procedure

Please answer a questionnaire that will be administered to you (for 10-20 minutes), and ask you to allow us collect fresh stool sample from your child.

Risks and benefits

No harm is associated with this research. Any information you will provide in this study will be of help to you, aid in coming up with more effective strategic plans and control interventions for STH infections in Kakamega and Kenya at Large. I will use the results in developing a thesis in order to fulfill the prerequisites of the University for completion of my degree.

Confidentiality

Codes will be used as identification details for the child therefore no data will be accessed with the guardians' permission.

Contact information

Please, in case of any inquiries related to this research, kindly contact the following person;

Investigator: Ruth Wairimu Kiiti

Telephone: +254794163470 **Email**: *ruthkben@gmail.com*

The parent's submission:

I have understood the information given by researcher and I willingly choose to play a part in this study.

Signature of parent and date: ....

Appendix III: Questionnaire-English version

Prevalence, Intensity and Risk Factors of STH among School Going Children in Lurambi Sub-County, Kakamega, Kenya.

Child code _____________ Name of the school _____________Date___________

No.	Question	Answer	Code	Specify
1	Age of your child			
2	Sex of the child?	Male Female	1 2	
3	What's your highest level of educational?	Informal Primary Secondary Professional	1 2 3 4	
4	What is the occupation of the parent? / What does the parent do for daily living?	Farming Self-employed Formal employment unemployed	1 2 3 4	
5	How many are you in your family?			
6	Where do you get/obtain your food?	Cooked at home From hotel Sometimes at home some times in hotel	1 2 3	
7	Does your child eat raw fruits/vegetables?	Yes, always Yes, sometimes No	1 2 3	
8	Does your child wash raw fruits before eating them?	Yes, always Yes, occasionally No	1 2 3	
9	Does your child eat beef which is not well cooked?	Yes, always Yes, occasionally No	1 2 3	
10	Does your child eat fish which is not well cooked?	Yes, frequently Yes, occasionally	1 2	

		No	3	
11	Does your child clean his/her hands after handling soil?	Yes, using water and soap Yes, uses water only No	1 2 3	
12	Does your child wash hands in between handling raw and cooked food?	Yes, using water and soap Yes, only with water No	1 2 3	
13	Does your child wash hands before and after eating?	Yes, (using water and soap) Yes, only with water No	1 2 3	
14	Does your child wash hands after using the toilet?	Yes, using water and soap Yes, only with water No	1 2 3	
15	Does your child have a hand washing habit after touching toilet materials e. g tissue, towel, shower, detergents?	Yes, with water and soap Yes, only with water No	1 2 3	
16	Where do you get water for washing clothes from?	Pipe water River Spring Rain water	1 2 3 4	
17	Where do you get water which you use for bathing/showering?	Pipe water River Spring Rain water	1 2 3 4	
18	Source of drinking water?	Pipe water River Spring Rain	1 2 3 4	

19	Do you have a habit of treating the water?	Yes No	1 2	
20	If yes in 019 above, what method do you use to make the water safe for drinking?	No treatment is done Boiling Filtering Commercially	0 1 2 3	
21	Does your child swim?	Yes, frequently Yes, occasionally No	1 2 3	
22	Where does he/ she swim?	River Lake Swimming pool Other	1 2 3 4	
23	How frequent does your child wear shoes?	Yes, always Yes, occasionally No	1 2 3	
24	Do you do cattle keeping?	Yes No	1 2	
25	Do you practice sheep/goat farming?	Yes No	1 2	
26	Do you keep cat/dog?	Yes No	1 2	
27	Do you have latrine?	Yes No	1 2	
28	Ownership of the latrine	Private Shared with neighbours	1 2	
29	Do you use night soil for farming?	Yes No	1 2	
30	Does everyone in your family have his/her own bath room?	Yes No	1 2	
31	Did your child diarrhoea in the last 3 months?	Yes No	1 2	
32	If yes above, after how long did the diarrhoea stop	Did not diarrhoea More than a month < a month < a week	0 1 2 3	

33	Did he/she complain of any other gastro-intestinal discomfort in the last 3 months?	Yes No	1 2	
34	Did you take the child to the hospital during the last GIT problem?	Yes No	1 2	
35	Was she/he diagnosed of any intestinal parasitic worm?	Yes No	1 2	
36	Did the child take anti–parasitic drug?	Yes No	1 2	
37	Will you allow us to take the stool sample from the child?	Yes No	1 2	

Appendix IV: Consent form- Swahili version

RIDHAA YA KUSHIRIKI KWENYE UTAFITI

Kichwa: Kusambaa kwa minyoo

Mtafiti: Ruth Wairimu Kiiti

UTANGULIZI
Jina ni Ruth Kiiti, mkufunzi wa Chuo Kikuu cha Sayansi na Teknolojia cha Masinde Muliro, Kenya. Niko hapa kufanya utafiti kuhusu mambo yahusikanayo na minyoo baina ya watoto walio na umri kati miaka 5-14 katika shule za msingi zilizomo kaunti ndogo ya Lurambi, Kakamega, Kenya. Nitashukuru sana nikipata ushirikiano wako kuhusu hili zoezi.

MADHUMUNI YA UTAFITI
Ninachunguza aina tofauti za minyoo inayoabukizwa kwa udongo katika kaunti ndogo ya Lurambi, Kakamega, Kenya.

UTARATIBU
Hili fomu tumekukabidhi wewe kwa ajili ya kukuomba pamoja na mtoto wako mshiriki kwenye huu utafiti. Unaombwa ujibu maswali utakayoshirikishwa na anayekuhoji kwa muda wa dakika chache (dakika10-20). Kama umekubali kushiriki, baadaye tutakuomba uturuhusu kuchukua kiasi kidogo cha kinyesi kwa mwanao.

HATARI NA FAIDA
Hamna hatari ya kushiriki kwenye ili suala. Ujumbe tutakaopata kutoka kwako utatumika kwenye vituo vya afya nchini ili kusaidia kutengeneza njia mwafaka ambayo itatumika kukomesha minyoo inayosabaa kupitia kwa udongo.

USIRI
Washiriki katika utafiti watatambuliwa kwa nambari maalum.

MAELEZO YA MAWASILIANO
Kwa mawasiliano zaidi, tafadhali piga namba zifuatazo;
Mtafiti: Ruth Kiiti
Simu: +254794163470

Barua pepe: *ruthkben@gmail.com*

Mshiriki kuwasilisha:

Nimekubali kushiriki kwenye huu utafiti.

Sahihi na tarehe ....

Appendix V: Questionnaire in Swahili Version

Nambari	Swali	Jibu	Msimbo	Taja
1	Mtoto wako ana miaka ngapi?		_	
2	Jinsia ya mtoto	Mwanaume Kike	1 2	
3	Ngazi la masomo la mtunzaji mtoto?	Hajasomea kwenye shule Shule ya msingi Shule ya upili Malum	1 2 3 4	
4	Je, anayemlea mtoto anafanya nini kuakikisha mahitaji ya familia yametimizwa?	Kulima Kujiajiri Kuajiriwa Bila kazi yoyote	1 2 3 4	
5	Je, mko wangapi nyumbani kwenu?			
6	Je, chakula mnachokila huwa mnakitoa wapi?	Kupika nyumbani Kununua kwa hoteli Wakati mwingine kutoka kwa hoteli na mwingine huwa tunapika.	1 2 3 4	
7	Je, mtoto wako hula matunda yasiyopikwa?	Ndio, amezoea Ndio, wakati mwingine La	1 2 3	
8	Je, mtoto wako huosha matunda kabla ya kuyala?	Ndio, kila wakati Ndio, wakati mwingine La	1 2 3	
9	Je, mtoto hula nyama ambayo haijapikwa na kuwa tayari?	Ndio, kila wakati Ndio, wakati mwingine La	1 2 3	
10	Je, mtoto wako hula samaki ambayo haijapikwa ikawa tayari?	Ndio, kila mara Ndio, wakati mwingine La	1 2 3	

11	Je, mtoto wako ana tabia ya kunawa mikono baada ya kushika mchanga?	Ndio kwa maji na sabuni Ndio, kwa maji tu La	1 2 3	
12	Je, mtoto wako anatabia ya kunawa mikono baada ya kushika matunda yasiyopikwa na anapotaka kula chakula?	Ndio, kwa maji na sabuni Ndio, kwa maji tu La	1 2 3	
13	Je, mtoto anatabia ya kunawa mikono baada ya kula chakula?	Ndio, kwa maji na sabuni Ndio kwa maji tu La	1 2 3	
14	Je, mtoto wako hunawa mikono baada ya kutumia choo?	Ndio, kwa kutumia sabuni na maji Ndio kwa kutumia maji tu La	1 2 3	
15	Je, (mtoto), hunawa mikono baada ya kutumia vifaa vinavyotumika kwenye msala?	Ndio na kwa maji na sabuni Ndio na kwa maji tu La	1 2 3	
16	Je, maji ya kuoshea nguo mnayatoa wapi?	Kutoka kwa mfereji mtoni kisima cha kuchimbwa maji ya mvua	1 2 3 4	
17	Je, mnachota maji ya kuonga wapi?	Kutoka kwa mfereji Mtoni Kisima cha kuchimbwo Maji ya mvua	1 2 3 4	
18	Je, maji mnayoyanywa huwa mnayatoa wapi?	Kutoka kwa mfereji Mtoni Kisima cha kuchimbwa Maji	1 2 3 4	
19	Je, mnatumia njia yoyote kuhakikisha kuwa maji yako salama kwa kunywa?	Ndio La	1 2	

20	Kama ndio, mnatumia njia ngani?	Kuchemsha kichungi Dawa ya kinga Hatuyafanyi chochote	1 2 3 0	
21	Je, mtoto wako huwa anaongelea?	Ndio, mara mingi Ndio, si kila mara La	1 2 3	
22	Je, mtoto wako anaongelea wapi?	Mto ziwa bwawa la kuogelea Haogelei	1 2 3 0	
23	Je, mtoto wako ana tabia ya kuvalia viatu?	Ndio, kila wakati Ndio, hutegemea La	1 2 3	
24	Je, mnafanya utunzaji wa ng'ombe?	Ndio La	1 2	
25	Je, mnawatunza mbuzi au kondoo?	Ndio La	1 2	
26	Je, kwenu mna choo?	Ndio La	1 2	
27	Je, hio choo inatumikaje?	Ni ya familia tu Hutumika hadi na majirani	1 2	
28	Je, mna tabia ya kutumia udongo wa usiku kwa shamba?	Ndio La	1 2	
29	Je, kila mtu ana bafu yake binafsi?	Ndio La	1 2	
30	Huwa mnatumiaje (taulo, sabuni...)?	Kila mtu ana yake Moja hutumiwa na familia yote	1 2	
31	Je, kwa miezi iliyopita tatu, mtoto wako aliendesha?	Ndio La	1 2	
32	Je, aliendesha kwa mda mgani?	Zaidi ya mwezi moja Chini ya mwezi mmoja Wa wiki moja hakuendesha	1 2 3 0	
33	Je, mtoto alilalamika	Ndio	1	

	kuwa na shida yoyote ya tumbo??	La	2	
34	Je, ulimpeleka mtoto hospitali?	Ndio Hapana	1 2	
35	Je, uliambiwa yakuwa mtoto alikuwa na shida ya minyoo yoyote?	Ndio La	1 2	
36	Je, mtoto alikunywa dawa za kuzuia hio minyoo?	Ndio La	1 2	
37	Je, utaturuhusu tuchukue sehemu ndogo ya kinyesi cha mtoto wako kwa ajili kufanya utafiti?	Ndio La	1 2	