# PREVALENCE, INTENSITY AND RISK FACTORS ASSOCIATED WITH ASCARIASIS AMONG PRE-SCHOOL AGED CHILDREN IN BOMET CENTRAL DIVISION, BOMET COUNTY, KENYA.

**BY**

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Public Health.

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## DECLARATION

This thesis is my original work and has not been presented to any other university for a degree or any other award.

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# DEDICATION

To my family for their moral and financial support, for having instilled in me the spirit of hard work and laid for me a good foundation.

## ABSTRACT

Ascariasis is the most common human helminthic infection; globally an estimated 1.5 billion people are infested with approximately 60,000 deaths annually. Infestation is most prevalent in Southeast Asia and Africa and in children aged 2-10 years. Heavy *Ascaris lumbricoides* worm load in children can lead to intestinal and pancreatic duct obstruction that requires surgical interventions. Although preventable, Ascariasis contributed to 84 (5%) pediatric admissions while, 27(90%) of acute surgical emergencies in pre-school aged children at Tenwek hospital were due to worms obstruction for the period between June 2011and June 2012. Despite causing significant morbidity in this age-group, data on its prevalence, intensities and associated risk factors in pre-school aged children in Bomet Central division, Bomet County Kenya, is lacking, therefore the magnitude of the problem remains unclear. Hence, programs focusing on its prevention and control are also lacking. This was a cross-sectional study that aimed to determine the prevalence, intensities and risk factors associated with Ascariasis in children aged 12-60 months in Bomet Central division, Kenya. Fecal samples were collected from 478 randomly selected pre-school aged children from 478 households and examined by Kato Katz technique. A structured questionnaire was used to collect information on the risk factors associated with Ascariasis. The prevalence of Ascariasis was 42.3%. Of the 202 (42.3%) children who were infected, 75 (37.1%) had light *Ascaris lumbricoides* infestations and 127 (62.9%) had moderate to heavy intensities. Chi-square test analysis revealed that age, education level, occupation and monthly income of the caregivers, place of residence and family size (≥7 members) are the socio-demographic factors that significantly increased the likelihood that a child would be infected with ascariasis. Drinking water source, treatment method and storage; absence of toilet facility, sharing of latrines and improper latrine utilization; poor caregivers hand washing practices, not using of soap for washing hands, child's stool disposal practices and lack of child deworming were risk factors significantly (P values $<0.005$) associated with Ascariasis among these pre-school aged children. According to WHO classification, our study area is a medium risk community. These findings suggest a moderate prevalence and a high intensity level of Ascariasis thus the need to implement community-based de-worming programs targeting pre-school aged children and control measures like proper sanitation, treated drinking water supply and proper health education on hygiene practices. Integrated control program will significantly reduce the prevalence and intensity of Ascariasis among communities that live in Bomet central division and largely Bomet County.

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## OPERATIONAL DEFINITIONS

Ascariasis: - refers to the disease cause by the nematode *Ascaris lumbricoides*.

Asymptomatic: - without sign and symptoms.

Endemic areas: - geographical regions where particular diseases like Ascariasis *Ascaris lumbricoides* is prevalent.

Incidence rate: - refers to the proportion of people becoming newly infected over a defined period of time.

Sub-clinical infection: is an infection that is staying below the surface of clinical detection.

Intensity: the burden of infection in terms of the number of worms either few, moderate or heavy infections measures in eggs per gram.

Infection: - occurs when a person harbors living parasites like *Ascaris lumbricoides*

Intestinal parasites: - these are the parasites that may cause harm to the intestine of an individual

Parasites: -are organisms that live inside humans or there organisms who act as hosts and cause harm to them.

Parasitic disease: - occurs when the infection actually harms the hosts.

Parasitic infections:-diseases caused by protozoan and helminth parasites

Prevalence: - refers to the number of old and new cases of Ascariasis.

Household: - a house, hut in which a family members live together with any relatives and prepare food, eat and sleep together under that roof.

Pre-school aged child: - refers to a person whose is 6-60 months and does not attend any formal schooling.

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## ACRONYMS AND ABBREVIATIONS

WHO: World Health Organization

STH: Soil Transmitted Helminth

CDC: Centre for Disease Control

NTD: Neglected Tropical Diseases

USAID*:* United States Agency for International Development

KNBS: Kenya National Bureau of Statistics

EPG: Egg per Gram

MOMS: Ministry of Medical Services.

MOPHS: Ministry of Public Health and Sanitation

MDG: Millennium Development Goals.

ABZ: Albendazole

# CHAPTER ONE: INTRODUCTION

## 1.1 Background Information

Prevalence of *Ascaris lumbricoides*

Ascariasis is an infection of the small intestine caused by *Ascaris lumbricoides.* It is one of the most prevalent intestinal helminthes, estimated to infect 1.5 billion humans (Mangiavillano, 2009) and cause approximately 60,000 deaths per year worldwide (WHO, 2001). Majority of these infections occur in developing regions of Southeast Asia, Central America, and sub-Saharan Africa (Berger, 2006). Ascariasis is associated with substantial acute and chronic morbidity, particularly among children, in whom the highest intensities of infection are found(Hall, 2008). Populations that are at high risk of morbidity include pre-school children aged one to five years (Chiranjay Mukhopadhyay, 2008; Kirwan *et al*., 2009; Ogunkanbi and Sowemimo, 2014) and school children (Kirwan *et al*., 2009).

Routine mass drug administration (MDA), the major tool used to control Ascariasis burden, has undergone expansion and received increasing guidance from WHO over the past decade(WHO, 2006). However, key issues in mass drug administration policy remain unsettled. One such issue deals with the most appropriate target groups for routine deworming. Several demographic groups are considered eligible, including pre-school age children and school-age children. However, School age children are the focus of WHO's most recent guidelines (WHO, 2011) and the Kenyan national programs also targets the School age children. This is due in part to the logistical advantages of school-based treatment, and in part to a perception of greater benefit connected with deworming in School Age Children (WHO, 2011.)

Majority of research defining burden has also been performed in School age children (Brooker, 2009), however pre-school age children can also have considerable prevalence of ascariasis infection(Awasthi *et al*., 2008) and experience morbidity. Despite WHO advocating deworming of populations at risk (Eziefula and Brown, 2008; Ravindran, 2013), there is a paucity of data on the prevalence and infection intensities of ascariasis among the pre-school aged children in Bomet County and Kenya at large. The national deworming programs in Kenya are still focused on the school aged children leaving out the pre-school aged children, who can be a potential link for re-infection of their older school going siblings. Infected individuals excrete ova thus constituting a link in the transmission chain, aiding in the perpetuation of the parasite's life cycle (Brooker, 2010; USAID, 2012). Thus, data on the prevalence and intensities of ascariasis among pre-school aged children in Kenya, Bomet County is needed for any relevant intervention to be made.

Pre-school aged children were selected for this study based on the fact that research has shown that they suffer severe consequences from ascariasis infection (Wani *et al.,* 2010). Infection usually begins at 6 months and peaks at 5-10years (Hotez *et al.*, 2006). The WHO has highlighted both pre-school aged children aged 6 months – 60 months and school aged children as at risk of ascariasis infection (WHO, 2012). Despite this school aged children have continued to be the center of focus in prevention and control programs neglecting the pre-school aged children. Over time the pre-school aged children have continued to suffer the devastating complications from ascariasis (Tenwek mission hospital, 2012). In Kenya and in Bomet county the ministry of health has also concentrated on the school going children neglecting the pre-school aged children leaving them as a potential pool of re-infecting their school going siblings thus this could serve as an obstacle in achieving success in the ongoing school deworming program. This age group was selected because they have been identified as at risk group yet they are receiving little or no attention.

**Intensity/ ova load of *Ascaris lumbricoides***

Although ascariasis continues to threaten the health of many people, especially children in impoverished tropical settings (Mishra *et al*., 2008), it is still one of the Neglected Tropical Diseases (NTD's) in Kenya (MOPHS, 2011). The ministry of public health and sanitation national multiyear strategic plan of action for control of neglected tropical diseases (2011-2015) has cited Bomet county as one of the counties in Kenya that has greatly been affected with ascariasis among the pre-school aged children (MOPHS, 2011).

Tenwek mission hospital pediatric admission data indicated that 5% (84) of all pediatric admissions were due to ascariasis. Among the pre-school aged children that developed acute intestinal obstruction, an abdominal surgical emergency that required a surgical operation and prolonged hospitalization in Tenwek mission hospital 90% (27) of them were due to heavy ascariasis infection (Tenwek Mission Hospital, 2012). The high number of surgical emergencies for duration of one year is an indicator of an unresolved underlying problem in this community. This data prompted further analysis of the specific cases, specific findings pointed to the fact that more than 50% of the cases resided in Bomet central division. This data therefore by indication led to the researcher wanting to finding out whether the prevalence and intensity of ascariasis among the pre-school aged children in this community is as high as it is reported by the Tenwek mission hospital admission data since the prevalence and intensity of ascariasis in pre-school aged children has not been determined and hence the magnitude of the problem remains unclear.

Most patients infected with *Ascaris lumbricoides* have a chronic disease course and are generally asymptomatic or present with only mild symptoms (Escobedo *et al*., 2008). However, heavy infections may cause complications such as intestinal obstruction, biliary colic, cholecystitis, pancreatitis (Wani *et al*., 2010) and allergy symptoms (Acar *et al*., 2008;

Joob and Wiwanitkit, 2012) . Young children have a higher infection rate and suffer a heavy burden of *Ascaris lumbricoides* compared to adults *(Albonico et al., 2008b). Ascaris lumbricoides* related intestinal obstruction is more common in children because of the smaller diameter of the lumen of the bowel and often, an increased worm load (Mishra *et al*., 2008) and require surgical intervention (Leow *et al*., 2012). Although preventable, Ascariasis contributed to 84 (5%) of paediatric admissions and 27 (90%) of acute abdominal surgical emergencies in pre- school children aged 12-60months at Tenwek Hospital for the period between June 2011and June 2012 (Tenwek mission hospital, 2012). Despite the challenges faced by children suffering from ascariasis, its intensity burden among the pre-school aged children in Bomet Central division has not been determined.

**Risk factors for ascariasis**

Infestation begins from the time children are weaned, around the age of six months, with peak intensities at 5-10 years (Hotez *et al*., 2006; O'lorcain and Holland, 2000). Ascariasis, manifest themselves as reduced growth rates through impaired nutrient utilization (Crompton and Nesheim, 2002). Consequently the children are not able to achieve their full potential in physical performance and education (Awasthi *et al*., 2003). Bomet Central division, Kenya one of areas in sub-Saharan Africa has low socio-economic status, inadequate sanitation, poor environmental hygiene and warm climate (Amenu, 2014) that favor exposure to and increases risk of infection with *Ascaris lumbricoides* (Amenu, 2014*)*. With a lot of researchers stating a peak intensity of 5-10 years for ascariasis infections among pre-school aged children then a lot of intervention programs are also targeting that group. The risk factors remain the same and pose greater risk to the age group not targeted. Pre-school aged children in Bomet Central Division, Bomet county Kenya seem to be at an equal risk of acquiring ascariasis due to residing in the same environment as the school going children. Therefore there is need to find out whether these risk factors and possibly other factors predispose preschool aged children to ascariasis in Bomet central division.

Targeted administration of anti-helminthic drugs to high risk groups have achieved significant reduction in morbidity, but have failed to reduce transmission in areas where risk factors continue to exist (WHO, 2012). Bomet county had a poverty level of 58% (KNBS, 2013), it is faced by challenges of high rates of unemployment, high number of casual and non-skilled laborers, rural area, tea plucking community and most strikingly resource-constrained health facilities due to poverty(KNBS, 2013). These factors are in agreement to what other researchers state that high prevalence of ascariasis is associated with low socioeconomic status, impoverished health services, poor sanitation and environmental hygiene (Albonico *et al.*, 2008b). These factors are usually coupled with other risk factors like warm climate. Bomet is relatively cold too. It is therefore important to identify the risk factors for ascariasis infection in this exact community among the pre-school aged children as these may serve pointers that will be useful in implementing prevention and control interventions. Lack of research in Bomet central division on risk factors that contribute to ascariasis among pre-school aged children has led the researcher to try find out any underlying factors associated with ascariasis infection in Bomet central division and thus, help provide information that will be useful in coming up of prevention and control strategies.

The aim of this study was to determine the prevalence, intensities of *Ascaris lumbricoides* infections and risk factors associated with Ascariasis among pre-school aged children in Bomet Central Division.

## 1.2 Problem Statement

Ascariasis remains one of the classical neglected tropical diseases in sub-Saharan Africa, Kenya and in Bomet Central division. The national deworming program in Kenya and Bomet Central division is focusing primarily on the school aged children neglecting and leaving out the pre-school aged children in efforts aimed at control ascariasis. Despite the WHO recommending an annual mass deworming program to the at risk population the ministry of public and sanitation in Bomet Central division has carried out this deworming activity only once and targeted only the school going children. In neglecting and leaving out pre-school aged children in ascariasis control program, the achievement made in deworming the school aged children may be reversed as the neglected as this risk group could serve as a potential transmission pool to the rest of the population. This however cannot be addressed by the ministry of health without data on the prevalence of ascariasis thus showing that the pre-school aged children are a real potential transmission pool and hence the need for this research.

Although preventable, Ascariasis contributed to 84 (5%) of paediatric admissions and 27 (90%) of acute abdominal surgical emergencies in pre-school aged children at Tenwek Hospital for the period between June 2011and June 2012. Despite causing significant morbidity and a significant economic burden due to the high hospital admissions and surgical operations needed data on the intensity of *Ascaris lumbricoides* among pre-school aged children in Bomet central division, Bomet county and largely Kenya is scarce thus prevention and control measures cannot be instituted. In order to reduce the morbidity caused by ascariasis data on intensity of *Ascaris lumbricoides* ova infection among the pre-school aged children must be obtained hence the need for this research. Establishing the burden of ascariasis infection among pre-school aged children in Bomet central division would be important for future implementation of programs focusing on its prevention and control.

Ascariasis infection begin at 6 months with the introduction of food to a child and consequently hygiene becomes an issue, infection intensities usually increase with age of the child however with continuous definite exposure *Ascaris lumbricoides* ova the peak intensities can be reached over very short period of time. Low socio-economic status, inadequate sanitation, age, level of education and income level of caregiver, climate and poor environmental hygiene are factors that have been associated with high ascariasis prevalence in other areas. It is therefore important to assess if these risk factors also would be associated with ascariasis among pre-school aged children in Bomet Central division, Bomet County.

## 1.3 Objectives

### 1.3.1 Broad Objective

To assess the prevalence, intensities and risk factors associated with Ascariasis among pre-school aged children in Bomet Central Division, Bomet County, Kenya.

### 1.3.2 Specific Objectives

1. To determine the prevalence of *Ascaris lumbricoides* in pre-school aged children in Bomet Central Division, Bomet County, Kenya.

2. To determine the intensities/ ova load of *Ascaris lumbricoides* in pre-school aged children in Bomet Central Division, Bomet County, Kenya.

3. To identify the risk factors associated with *Ascaris lumbricoides* infection in pre-school aged children in Bomet Central Division, Bomet County, Kenya.

## 1.4 Research Questions

1. What is the prevalence of *Ascaris lumbricoides* in pre-school aged children in Bomet Central Division, Bomet County, Kenya?

2. What is the intensity / ova load of *Ascaris lumbricoides* in pre-school aged children in Bomet Central Division, Bomet County, Kenya?

3. What are the risk factors associated with *Ascaris lumbricoides* infection in pre-school aged children in Bomet Central Division, Bomet County, Kenya?

### 1.5 Significance of the Study

With sub-Saharan Africa leading globally in cases of under-five mortality and morbidity, the millennium development goal of reducing child mortality by two thirds by 2015 will not be achieved. However, with investing in the health and wellbeing of children, Kenya will be making positive strides towards achieving this goal. Ascariasis remains a significant threat to the well-being of pre-school aged children in Bomet Central division, Bomet County and generally all pre-school and school aged children in Kenya. The pre-school aged children have been identified as a potential transmission pool of ascariasis to their siblings the school aged children, therefore, the government of Kenya need to redirect their efforts to deworm this neglected at risk group in order to prevent reversing the efforts achieved by the school deworming program. As such determining the prevalence of ascariasis among the pre-school aged children in Bomet Central division was essential for development and implementation of programs aimed at their inclusion in mass treatment and control program.

This study has highlighted the magnitude of Ascariasis and intensity of the infection among pre-school children in Bomet central Division. It has also shed light on risk factors associated with Ascariasis among pre-school aged children in this region. Information obtained will be used to implement improved sanitation practices that will curb uncontrolled release of *Ascaris lumbricoides* in the environment. To ministry of public health and sanitation, this study suggested practices that break the transmission cycle of *Ascaris lumbricoides* in the environment. Finally the data will inspire policy makers like the WHO to create new policies concerning *Ascaris lumbricoides* prevention and control among pre-school aged children.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Prevalence of *Ascaris lumbricoides*

A study done in Calabar, Nigeria on Ascariasis reported *Ascaris lumbricoides* as the most common worm infestation among pre-school children with prevalence as high as 64.4% (Anah *et al*., 2008). Other studies from Nigeria on Ascariasis indicated a prevalence of 54.7% (Egwunyenga and Ataikiru, 2005) and 34% (Oyewole *et al.*, 2007) while Pakistan reported a prevalence rate of 77% among young children (Hafeez *et al*., 2003), although an Ethiopian study found a much lower prevalence (Tadesse, 2005).

A study done in Nairobi, Kibera slums, Kenya, and published in 2014 on prevalence of Ascariasis infection indicates a prevalence of 24.1% (Davis *et al*., 2014) in pre-school aged children. In addition, the published qualitative studies by Albonico *et al.,* (2008) established that *Ascaris lumbricoides* infection in Kenya has an average prevalence of 20% among the pre-school aged children. These findings are consistent with different studies undertaken in Nigerian in the same age group in different years (Nmorsi *et al*., 2009 and Chijioke, 2011). In addition, studies elsewhere and STHs prevalence reports from endemic countries indicate that ascariasis is more prevalent as compared to other helminthes (Hotez *et al*., 2008 and de Silva *et al.,* 2011). Qualitative studies conducted by Albonico *et al*., (2008) to determine the number of STHs prevalence studies published for the same age group across endemic countries reveals that, *Ascaris lumbricoides* is undisputedly the most dominant infection with the highest prevalence ranging from as low as 3% (in Phillipines rural area) to as high as 88% (in Madagascar). In the same study, *Ascaris lumbricoides* prevalence among preschool children was 20% in Kenya (Albonico *et al*., 2008). The high prevalence of *Ascaris lumbricoides* among preschool children and its dominant trend across endemic countries suggests that it is the most common helminthiases infecting humans of all age groups. These results suggest that the problem of ascariasis in the study area pose significant public health challenge. The World Health Organization recommends treatment of soil transmitted helminthes when the prevalence is above 10% in a given target population and Bomet Central division, Bomet county therefore requires frequent ascariasis treatment, (WHO, 2012).

Ascariasis infections are widespread globally. As soon as an infant starts to explore its environment, it comes into contact with contaminated soil, then the child is at risk of infection according to the levels of transmission in the area (Albonico *et al*., 2008a). Considerable experience and limited quantitative evidence indicate that infections with *Ascaris lumbricoides* usually start to become established in children aged 6 months and older. Since children living in countries where the infections are endemic are at risk of morbidity, even those as young as 6 months may need to be considered for inclusion in public health programs designed to reduce morbidity by means of regular anthelminthic chemotherapy (Montresor *et al*., 2003). Although the infection is often asymptomatic, its effects may contribute substantially to child morbidity (Stephenson, 2000), The manifestations of severe disease include fatal intestinal obstruction (Crompton and Nesheim, 2002).

Despite all the information available on how at risk the pre-school aged children are, the ministry of health in Kenya has continually targeted on the school aged children in deworming programs neglecting the preschool aged children who have resultantly suffered devastating consequences from heavy *Ascaris lumbricoides* infection(Tenwek mission hospital, 2012). Ascariasis contributed to 84 (5%) of paediatric admissions and 27 (90%) of acute abdominal surgical emergencies in pre-school children aged 12-60months at Tenwek Hospital for the period between June 2011and June 2012 (Tenwek mission hospital, 2012). Tenwek mission hospital is located in Bomet county Kenya, Bomet central constituency. In order to reduce child morbidity and mortality from Ascariasis an otherwise preventable illness in Kenya, Bomet central division, a baseline survey on prevalence and intensity among preschool aged children was done to determine the magnitude of the ascariasis infestation hence the study.

### 2.2 Intensity of *Ascaris lumbricoides*.

Ascariasis, an intestinal helminth infection is widespread among children in the tropics and subtropics. These infections are rarely fatal but they may impair growth, physical fitness, cognition, and reduce school attendance and performance (Bethony *et al*., 2006). Children below 14 years of age in developing countries are especially at risk of Ascariasis (Escobedo *et al*., 2008). Ascariasis infections is classified among the seven of the most common neglected tropical infectious diseases that afflict the bottom billion because of their high prevalence and amenability to control (Hotez *et al*., 2009).

Globally, there are an estimated 62 million persons with high-intensity *A. lumbricoides* infestation(Basavaraju and Hotez, 2003). In India, the prevalence of high-intensity *A. lumbricoides* infestation is 768 cases per 100,000 persons; in China, 2179 cases per 100,000 persons; in sub-Saharan Africa, 586 cases per 100,000 persons; and in Latin America, 1802 cases per 100,000 persons. An estimated 8 million persons in Latin America are affected. Although the above data highlights the intensity of Ascariasis, current data on intensity level is lacking thus Ascariasis forms part of the classical neglected tropical diseases (Holland, 2009). National figures on the intensity of ascariasis infection among preschool aged children in Kenya are also lacking thus the current study in aimed at obtaining that information for Bomet central division (MOPHS, 2011).

Intestinal obstruction is an especially acute problem in the developing world (Basavaraju and Hotez, 2003). Intestinal obstruction constitutes the commonest acute complication of

Ascariasis, accounting for almost 57% of all complications, approximately 85% of obstructions occur in children between ages one and five years (Khuroo, 1996). In Tenwek mission hospital, Bomet County, Kenya (June 2011- June 2012) intestinal obstruction as an acute complication of ascariasis infection accounted for 90% of all complications that occurred among preschool aged children in that were admitted in the hospital.

The prevalence of Ascaris-related intestinal obstruction in India is 9.2 cases per 100000 persons. In1990, the total number of cases of intestinal obstruction in India was 79,000; In China, there were 281,000 reports of *Ascaris*-related intestinal obstruction in 1990, and in Latin America and sub-Saharan Africa, there were 95,000 and 38,000 cases, respectively (Basavaraju and Hotez, 2003; Murray and Lopez, 1996). These children are more vulnerable to worm obstruction because of their narrow intestinal lumen diameter (DeSilva *et al*., 1997). Ascariasis induced bowel obstruction account to between 5 and 35 percent of all cases of bowel obstruction in endemic areas (Khuroo, 1996) while the overall incidence of obstruction is approximately 1 in 500 children. For infection to persist beyond the 2-year maximum lifespan of the worms, re-exposure must occur (Haburchak, 2011). Most studies have focused on school children but have neglected the pre-school aged children. In pre-school aged children the possibility of re-exposure /re-infection is high because of their unconscious state of playing with dirt and soil thus remaining in a perpetual state of worm infestation. This therefore underscores the need of assessing the intensity of Ascariasis in pre-school aged children in Bomet Central Division, Bomet County and also to establish the levels of endemicity of Ascariasis in this population.

### 2.2.1 Distribution of *Ascaris lumbricoides*

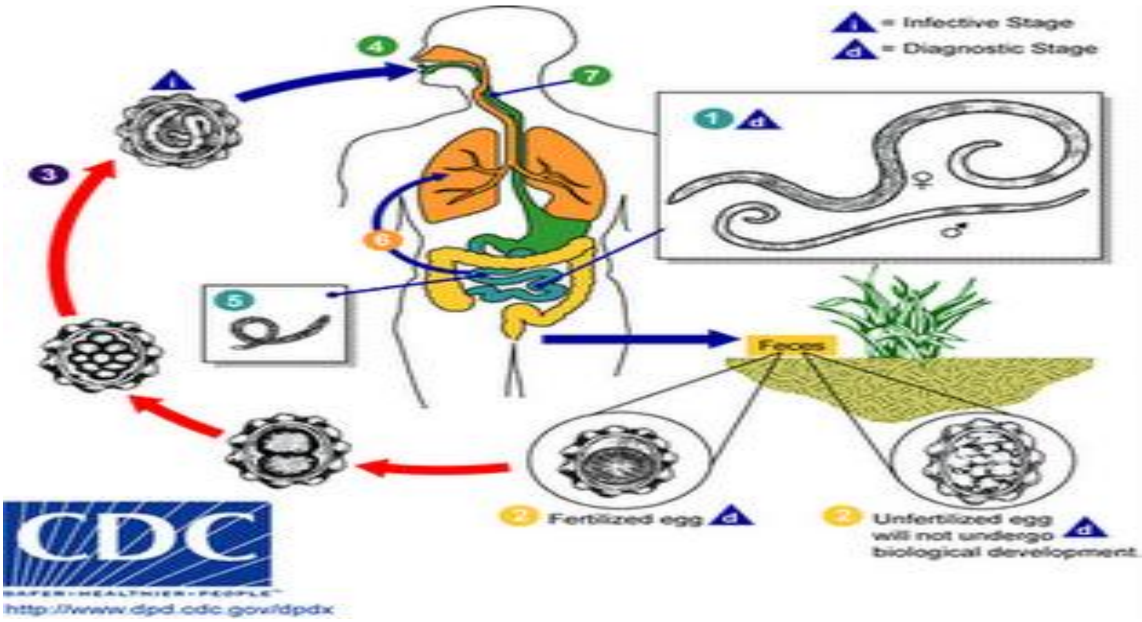
Ascariasis occurs at all ages, populations at high risk of infection include pre-school children aged one to five years (Chiranjay Mukhopadhyay, 2008) and school children up to ten years of age (Albonico *et al*., 2008a). According to WHO data on estimated number of *Ascaris* *lumbricoides* infections by age group 122 and 143 million children between 0-4 years and 5-9 years respectively were infected with round worms worldwide. This reflects the fact that this is a global problem and pre-school aged children are equally at risk as school going children. In Africa the prevalence of round worm infection among pre-school and school going children is the same (28 million) therefore underscoring the importance of focusing not only on school going children but also on pre-school children in prevention and chemotherapeutic programs (Table 2.1).

**Table 2.1: Estimated Number of Roundworm Infections (in millions) by Age Group, 2003**

| WHO Region | 0-4 years | 5-9 years | 10-14 years | >=15 years | Total |
|---|---|---|---|---|---|
| Africa | 28 | 28 | 25 | 92 | 173 |
| Americas | 8 | 10 | 10 | 56 | 84 |
| E. Mediterranean | 3 | 3 | 3 | 14 | 23 |
| South-east Asia | 28 | 33 | 30 | 145 | 237 |
| Western Pacific | 55 | 69 | 76 | 505 | 705 |
| Total | 122 | 143 | 144 | 812 | 1222 |

**Source: WHO 2003 in (USAID, 2012).**

### 2.2.2 Lifecycle of *Ascaris lumbricoides*




**Source: (CDC, 2009)**

**Figure 2.1 : Life cycle of *Ascaris lumbricoides***

Adult worms live and mate in the lumen of the small intestine. A female may produce approximately 200,000 eggs per day, which are passed in the feces/stool of an infected person (CDC, 2009). When stool is deposited in the soil either through improper defecation or poor disposal of child stool it comes into contact with children while playing with the soil. Without washing hands after defecating and without washing hands before eating the ova, in dirty hands is ingested by the child while eating (Kamau *et al*., 2012). Children inevitably play in the soil and are not conscious of their actions. This means that they may eat soil during play thus increases their vulnerability to acquiring ascariasis infection from playing in the soil unsupervised (Gangopadhay *et al*., 2007).

Unfertilized eggs may be ingested but are not infective. Fertile eggs develop into embryos and, depending on the environmental conditions (optimum being moist, warm, and shaded soil), become infective after 18 days to several weeks, but the eggs may remain viable in soil for years. Humans are infected when they ingest soil containing infective eggs (CDC, 2009).

The eggs hatch into larvae within the infected person's intestine. The larvae invade the intestine mucosa and are carried via the portal, then systemic circulation to the lungs.

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. Once the larvae return to the small intestine, they develop into adult worms and mate. The female adult worm, which can grow to more than 30 cm in length, may produce up to 200,000 eggs per day. Between 2 and 3 months are required from ingestion of the infective eggs to ova-position by adult female. An adult Ascaris may live up to 1 to 2 years (CDC, 2009). *Ascaris lumbricoides* are very difficult to eliminate from the soil posing a greater risk to the children (Escobedo *et al*., 2008).

**2.3 Risk factors associated with Ascariasis infection among children**

Ascariasis is a common problem in the tropics and subtropics, where the moist humid climates of alternating dry season and rainy season permit all-year embryonation of the ova of *Ascaris lumbricoides* (IftikharAhmad *et al*., 2008). This is further aggravated by the poor environmental standards, improper disposal of sewage, and low socioeconomic conditions (Mishra *et al*., 2008) that prevails in most cities in Africa. Some of the risk factors for infection implicated in previous studies include inadequate sanitation (Brooker, 2010), lack of personal and food hygiene (Kamau *et al*., 2012), over-crowding (Chakrabarti *et al*., 2011), geophagy (Saathoff *et al*., 2002) and poor health habits (Rinne *et al*., 2005). Each of the above factors can be exaggerated by socio-economic status, with the poorest having the most worm burden (Albonico *et al*., 2008a) and the children whose parents or guardian were less educated having the most worm burden(Naish *et al*., 2004). Poverty, impoverished health services (Albonico *et al*., 2008b), poor environmental and personal hygiene and low socio - economic conditions have been the main factors incriminated (Mishra *et al*., 2008). The high prevalence of these infections is closely correlated with poverty, poor environmental hygiene and impoverished health services which all characterize Bomet County Kenya. Bomet county had a poverty level of 58% (KNBS, 2013), it is faced by challenges of high rates of unemployment, high number of casual and non-skilled laborers, rural area, tea plucking community and most strikingly resource-constrained health facilities due to poverty(KNBS, 2013). The aforementioned risk factors for Ascariasis from previous studies were tested if applicable to pre-school children in Bomet Central Division, Bomet County.

Residence in rural areas was associated with Ascariasis infestation. Transmission occurs when defecation occurs in the open, which leads to high levels of contamination of the environment and an increased possibility of acquisition of infection by a new host (Escobedo *et al*., 2008).

Other studies also indicate large family size / living in relatively crowded conditions, low levels of sanitation, poor socio-economic status (Gunawardena *et al*., 2004), education level of parents (Naish *et al*., 2004); (Okyay *et al*., 2004); (Nematian *et al*., 2004), sometimes or never usage of toilet paper and washing anal area with hands after defaecation (Okyay *et al*., 2004). Children playing in contaminated soil may acquire the parasite from their hands and this can be the reason for greater incidence of this condition in boys as they are more exposed to outdoor activities. Similar high incidence in male patients has also been reported (Gangopadhyay *et al*., 2007). Ascariasis is further transmitted by agricultural use of raw or insufficiently prepared excreta and wastewater (Itchon, 2008). These factors are among the common barriers of a successful intervention program. However, risk factors for ascariasis have rarely been reported and awareness programs are scanty in Bomet Central Division, Bomet County. This study aimed to identify risk factors for Ascariasis infestation in a rural community of Bomet Central Division Bomet County.

Ascariasis egg load in soil as a result of large scale deworming in human communities has led to re-infection in dewormed population (Ravindran, 2013). The Kenyan government program currently involves deworming of school going children exclusively (MOPHS, 2011). Deworming of only school age children in a community could predispose the untreated population who are the pre-school age children to enhanced worm infections and its adverse consequences. The reasoning is that the net viable and infective *A. lumbricoides* egg pool in soil and environment would increase many fold following deworming and this could lead to previously uninfected subjects acquiring infections and/or could increase worm load in subjects already harbouring infections amongst the untreated population in the community. The untreated preschool children later serve as a potential pool of transmission to the rest of the population. This may reverse the achievement made in deworming school going children. Inclusion of the pre-school aged children in deworming programs could help avert this.

## 2.4 Conceptual Framework

Prevalence of *Ascaris lumbricoides*: stool samples were analyzed for presence of the eggs using Kato Katz technique.

Ova load/ intensity of *Ascaris lumbricoides:* were classified *as* light, moderate, or heavy according to thresholds based on number of eggs per gram of feces.

Risk factors: background and intermediate variables were assessed to establish magnitude of individual association to the outcome

Outcome of the assessed variables established either a positive or a negative outcome.

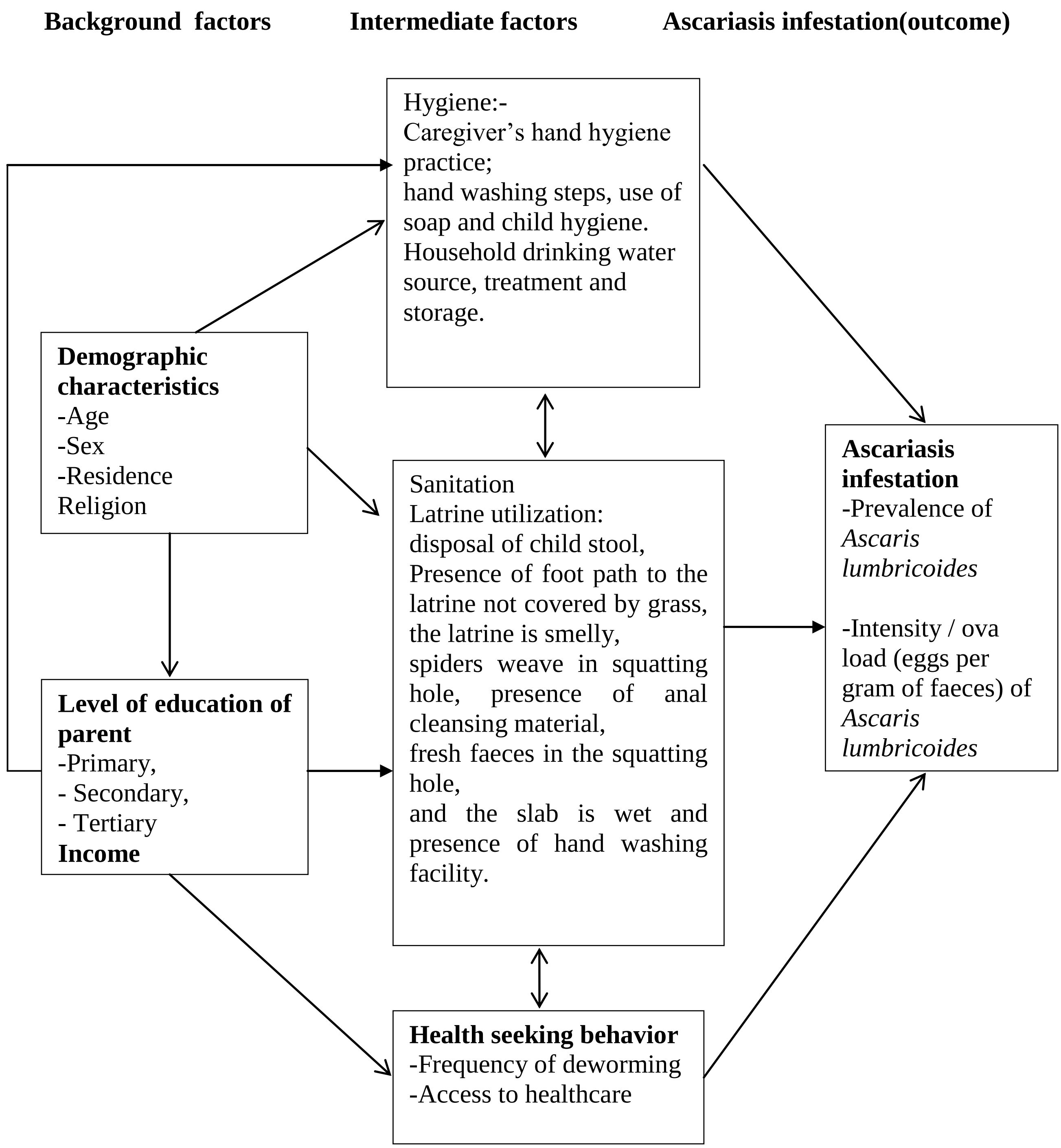



**Figure2. 2: Conceptual framework model**

### 2.4.1 Theoretical framework

The study adopted the health-protective theory which has its roots in the health belief model. Health belief was a psychological model developed by Rosenstock in (1966) for studying and prompting the uptake of services offered by social psychologists. The model was furthered by Becker in 1970s (Becker, 1978). Subsequent amendments were made in 1988 to accommodate evolving evidence generated within the community about the role knowledge and perceptions play in personal responsibility (Glanz *et al.*, 2002).

Originally, this model was designed to predict behavioural responses to treatment received by acutely or chronically ill patients, but in more recent years, the model has been used to predict more general behaviour (Ogden, 2007). The original health belief model constructed by Rosenstock, 1966, was based on core beliefs of individuals, based on their perceptions, for example: perceived susceptibility; perceived severity; and perceived benefit. Constructs of mediating factors were later added to connect the various perceptions with the predicted health behaviour: Cues to action; health motivation; and perceived threat. The prediction of this model is the likelihood of the individual to undertake recommended health action such as preventive and curative health actions.

The study adopted this theory since people's perception determines their uptake of services. Individuals' perception of severity, susceptibility, cost and benefits to adopting a new practice or behaviors can influence different practices and acceptance of services. These factors determine prevalence, intensity of Ascariasis and risk factors associated.

# CHAPTER THREE: MATERIALS AND METHODS

## 3.1 Study Area

This study was conducted in Bomet Central Division, Bomet District of Bomet County, and Kenya. (Appendix I). It lies between $0^0$ 29' and $1^0$ 03' south of the Equator and between longitudes $35^0$ 00' and $35^0$ 32' east of prime meridian (33' East of the Greenwich meridian) (Ministry of State for Planning, National Development and Vision 2030, 2008).

Geographically, Bomet County is divided into four divisions: Bomet Central, Sigor, Siongiroi and Longisa divisions. Bomet central division comprises of 10 locations that is Singorwet, Township, Sibaiyan, Ndaraweta, Merigi, Kiromwok, Kyogong, Chesoen, Itembe with 27 sub-locations.

The main river in the district, River Nyangores, flows from southwest Mau forest, and precedes southwards through Tenwek in Bomet Central division; River Amalo flows along the southwestern boundary of the district; and Kiptiget /Tebenik flows along the northern boundary of the district. The district experiences two rainy seasons; the long rains, which occur from March to October, and the short rains, which occur from November and December all the months have mean rainfall of between 1100mm and 1500mm (Ministry of State for Planning, National Development and Vision 2030, 2008). Clay soil, which covers 43.6 per cent of the district including the municipality, does not allow water to percolate easily and therefore toilets (pit latrines) overflow pouring the sludge on the surface thus causing a threat to human health including causing Ascariasis (Ministry of State for Planning, National Development and Vision 2030, 2008).

Based on 2009 National Census, Bomet County has a population of 724,186 people and a household population of 111258, who occupy 2471km$^2$ surface area of land and a population density of 293 people per km$^2$ (KNBS, 2009). Bomet County has an age distribution of 0-14 years (47.0 %), 15-64 years (49.7 %) and 65+ years (3.3 %). (KNBS, 2013).

Bomet County has a mixture of people from different ethnic groups however it's dominated by the Kalenjin people. The native people practice a lot of tea & coffee farming, horticulture, cattle rearing and animal husbandry. This provides most of the jobs for the people in Bomet Town. Bomet County has a poverty level of 58.7% (KNBS, 2013). Challenges faced by the community include high rates of unemployment; high number of casual and non-skilled laborers and most strikingly, resource-constrained health facilities due to poverty. These act as a draw backs in the control of communicable diseases such as Ascariasis in the area.

Bomet County and Bomet Central division are served by Tenwek Mission Hospital and Longisa Sub District Hospital. This area experiences high rates of morbidity and mortality due to infectious diseases such as malaria, respiratory tract infections, skin diseases and intestinal worms. The infant mortality rate is at 54/1000 and an under five mortality rate of 82/1000. Bomet Central division was of great interest because it is a rural town with a high morbidity of Ascariasis hence selected by indication (Tenwek mission hospital, 2012).

### 3.2 Study Design

This was a cross-sectional survey. It was based on multi-stage and stratified sampling methods. The phenomenon investigated was the prevalence, intensity and risk factors associated with ascariasis among preschool in Bomet Central Division. In a cross-sectional study no attempt is made to change behavior or conditions. Things were measured as. The study design also enables one to obtain information about the situation at hand at one specific time. It shows the current situation of the condition under study in the desired population.

### 3.3 Study Population and Sampling Unit

The study population was pre-school children aged 6-60 months, who were residents of Bomet Central Division of Bomet County for a period of not less than 6 months. Other respondents included the guardian of the children. According to the Kenya National Bureau of Statistics (KNBS, 2009) National Census, Bomet county population pyramid data by age estimates that the population of children between 6 - 60 months is 146,728 with 32,135 estimated for Bomet Central Division and a total number of households at 30,184. The sampling unit was the household within the study site, which had a pre-school child aged between 6 - 60 months.

#### 3.3.1 Inclusion Criteria

Pre-school children aged between 6 - 60 months who assented to participate were included in the study. The child must have resided in Bomet Central Division for not less than six months by the time data collection was done. In households with more than one child aged 12 – 60 months, only the youngest child was selected for inclusion.

#### 3.3.2 Exclusion Criteria

Parents unwilling to give informed consent to participate in the study, children in special schools, household not within the study area and all school going children were excluded in the study. School going children were assumed to have been included in the school deworming program.

## 3.4 Sampling Criteria

### 3.4.1 Sample Size Determination

Owing to practical difficulties with responses from large survey groups, a meaningful survey sample size had to be determined. An appropriate sample size was calculated using Yamane's formula. Yamane formula is best in situations with definite populations (Yamane 1967).

**Using Yamane's formula** (1967)

$n=N/ 1+N (e)^2$

Where by:

n = the sample size required;

N = the population;

e = level of precision at 95% confidence interval;

p = 0.05.

$n= 32,135 /1+32,135 (0.05)^{2;}$

n=395

At-least 10% of the sample size was added to cover for non-response;

=n = 478.

### 3.4.2 Sampling procedure

The study utilized a multi-stage sampling design involving the following stages. The target population was drawn from 27 sub-locations available in the Bomet Central division. To obtain a representative sample, 30% (statistically considered as a critical mass) of the sub-locations were selected using SPSS, therefore, to obtain the minimum number of sub-locations that were included in the survey; thirty percent of the total sub-locations. I.e. 30/100*27= 8. Simple random sampling was used to select the individual sub-locations from the sample frames obtained from the county using Statistical Package of Social Sciences (SPSS). That is, the sample frame consisting of all the sub-locations is entered in SPSS, was then subjected to random sampling command to give the names of the nine sub-locations required. In this study a total of 9 sub-locations were selected (each of the sub-locations had several villages). The following table summarizes the selected sub-locations. Table 3.1 provides a list of selected sub-locations for the survey. Each of the sub-locations selected formed a stratum. Simple random sampling was used again (using SPSS) to select 50% of villages from each stratum/sub-location (Table 3.1).

**Table 3. 1: sub-locations selected for the survey**

| NO. | **Sub-location** | **Population (household)** | **No. of villages** | **50% Villages used** |
|---|---|---|---|---|
| 1 | Singorwet | 1004 | 10 | 5 |
| 2 | Kapsimotwa | 1267 | 12 | 6 |
| 3 | Chepng'aina | 2639 | 26 | 13 |
| 4 | Kapkoros | 2233 | 22 | 11 |
| 5 | Ngainet | 1023 | 10 | 5 |
| 6 | Itembe | 1002 | 8 | 4 |
| 7 | Motigo | 1139 | 10 | 5 |
| 8 | Kiromwok | 1323 | 13 | 6 |
| 9 | Keplelji | 663 | 6 | 3 |

**Summary of villages used from each sub-location: singorwet(5), kapsimotwa(6), chepng'aina(13), kapkoros(11), ngainet(5), Itembe(4), motigo(5), kiromwok(6)and keplelji(3)**

Second stage; Proportionate sample size per selected sub-location was calculated basing on their populations. The result was the specific number of pre-school children included in the sample size from each of the strata i.e. 39 pre-school children were obtained from Singorwet sub-location (Table 3.2).

**Table 3. 2**: **Proportionate sample size per sub-location**

The total number of households (HH) per sub-location (strata) selected were as follows:

| Strata | Household numbers | Sample size to proportion | HH Sample size |
|---|---|---|---|
| Singorwet | 1004 | 1004/12293*100=8.2% | 8.2/100*478=39 |
| Kapsimotwa | 1267 | 1267/12293*100=10.3% | 10.3/100*478=49 |
| Chepng'aina | 2639 | 2639/12293*100=21.5% | 21.5/100*478=103 |
| Kapkoros | 2233 | 2233/12293*100=18.2% | 18.2/100*478=86 |
| Ngainet | 1023 | 1023/12293*100=8.3% | 8.3/100*478=40 |
| Itembe | 1002 | 1002/12293*100=8.2% | 8.2/100*478=39 |
| Motigo | 1139 | 1139/12293*100=9.3% | 9.3/100*478=44 |
| Kiromwok | 1323 | 1323/12293*100=10.8% | 10.8/100*478=52 |
| Keplelji | 663 | 663/12293*100=5.4% | 5.4/100*478=26 |
| Total | 12293 | 100% | 478 |

**Summary of Pre-school aged children sampled: Summary of villages used from each sub-location: singorwet(39), kapsimotwa(49), chepng'aina(103), kapkoros(86), ngainet(40), Itembe(39), motigo(44), kiromwok(52) and keplelji(26)**

Third stage; divide the number of children to be sampled from each of the strata by the number of 50% of the villages in the respective stratum. Resulting in the number of households from each of the villages. I.e. Singorwet sub-location had 10 villages Then 39÷5 = 7.8 ≈ 8. Therefore, 8 households with pre-school aged children were sampled from each selected village in singorwet sub location.

**Table 3. 3: Average number of households sampled from each village.**

| Strata | HH Sample size | 50% Villages used | No. of households from each village |
|---|---|---|---|
| Singorwet | 39 | 5 | = 39/5 = 7.8 ≈ 8 |
| Kapsimotwa | 49 | 6 | = 49/6 = 8.1 ≈8 |
| Chepng'aina | 103 | 13 | =103÷13 = 7.9 ≈ 8 |
| Kapkoros | 86 | 11 | = 86÷11 = 7.8 ≈ 8 |
| Ngainet | 40 | 5 | = 40÷5 =8 |
| Itembe | 39 | 4 | = 39÷4 = 9.8 ≈ 10 |
| Motigo | 44 | 5 | = 44÷5 =8.8 ≈ 9 |
| Kiromwok | 52 | 6 | = 52÷6 =8.7 ≈ 9 |
| Keplelji | 26 | 3 | = 26÷3 =8.7 ≈ 9 |
| Total | 478 | 58 | |

**Summary: an average of 8 households were selected in every village**

A sampling frame of all the households with pre-school aged children aged between 12-60months was obtained from the village elders of each of the strata. Using systematic sampling design, every third household that had a pre-school aged child (6-60 months) was selected, caregiver was interviewed and stool sample collected. In the event that a household declined to provide consent then the next immediate household with a child in this age bracket was picked as a replacement. The mother or the caregiver who spent most of the time with the child was interviewed. Information on water, sanitation, hygiene, access and utilization of health services and their demographic characteristics were collected using the questionnaire (Appendix III). A total of 478 households that had pre-school aged children were sampled from the study area.

## 3.5 Data Collection Methods and Tools

### 3.5.1 Instruments

A semi-structured questionnaire was adopted, piloted and used to collect quantitative data from households in selected sites. A total of 478 respondents who were the primary caregivers of the pre-school aged children were interviewed. The questionnaire consisted of the major components of the risk factors that predispose an individual to ascariasis informed by the existing data collection framework and relevant strategy documents.

The data collected included socio-demographic characteristics, presence of toilets, source, storage and treatment of drinking water. Literacy status of the caregivers, information on sanitation, hygiene related behavior like hand washing after defecation was also obtained according to KNBS and ICF (2010), a questionnaire on WASH household based survey. The primary respondent was the mother of the child, the father acted as the next respondent of choice when the mother was not available, and in the absence of both parents an adult in the household who remained with the child for most of the time was interviewed.

### 3.5.2 Data collection methods

Quantitative data was collected from 478 households. Interviews were done using a semi structured questionnaire which was administered to the guardian or parent in a household with a pre-school aged child aged between 6-60 months. Stool sample was collected from a child in this household. A total of 478 stool samples were collected and processed in the laboratory. Hospital cards were also reviewed to determine the history of recent deworming status if applicable. Data was collected by the researcher and field assistants.

Prior to the actual study, four field assistants residents of Bomet Central Division and from different sub-locations and with a minimum of form four level of education were interviewed and recruited. The field assistants were required to be fluent in English, Swahili and Kalenjin languages. Training of the research assistants on the survey tool and interviewing techniques was done for three days followed by a day of pre-testing the survey tools and methodologies in east kapkoros village, Kapkoros sub-location. This village was then omitted during the main data collection. Based on the experiences and results of the pre-test, further re-training on the questionnaire, refining of interviewing techniques and modification of research tool was done.

## 3.6 Determination of prevalence of *A. lumbricoides* among pre-school aged children.

### 3.6.1 Fecal sample collection and preparation

A stool sample was obtained from every child that was included in the sample size. The study team provided pre-weighed, wide mouthed, labeled corked sterile bottles for stool collection and instructed the parents/ caregivers on the method of collecting pea size (approximately 10g) stool sample. The bottles were provided in the evening and the stool samples collected in the morning.

The samples were transported to Bomet Health Center laboratory for microbiological examination and analyzed for presence of the *A. lumbricoides* eggs using Kato Katz method.

### 3.6.2 Determination of intensity / ova load of *A. lumbricoides* infection

The intensity of *A. lumbricoides* in this study was determined by the Kato-Katz method (Yvette Endriss, 2005) and reported according to the guidelines provided by the World Health Organization (Montresor *et al*., 1998). The prepared slides were transported to KEMRI Kisumu for cross-examination by a different technician.

Briefly, the children and guardians were instructed on the procedure for specimen collection after which they were given labeled specimen containers the day before the test to provide overnight stool the first thing in the morning. The stool specimens were collected by research assistants and taken to the laboratory first thing that morning. Two slides of Kato-Katz thick smear were prepared from each sample using a standard 41.7mg template (Katz *et al*., 1972). The slides were labeled with the sample ID plus letter A or B. A small amount of stool was placed on a glazed tile and a piece of nylon sieve pressed on top so that some of the stool sieve through and accumulate on the top. Using a wooden spatula, the sieved stool was collected and added to fill the hole of the template placed on a slide. The spatula was passed over the filled template to remove excess stool from the edge of the hole. The template was then removed carefully so as to leave the stool on the slide. The stool was then covered with Cellophane strip (pre-soaked in glycerine-malachite green) after which the slide was inverted and pressed firmly to spread evenly. The slide was then placed on the bench with the cellophane upwards to enable evaporation of water while glycerol cleared the stool. The smears were examined within 24 hours and the number of eggs counted and recorded. For *A. lumbricoides* a multiplication factor of 24 was used and the results expressed as eggs per gram of faeces (EPG) and infection intensities categorized as follows: 1–4999 epg as light, 5000–49,999 epg as moderate and >50,000 epg as heavy infections (Table 3.4).

**Table 3. 4: Intensity Threshold / Ova Load**

| Helminthes | Intensity Threshold | | |
|---|---|---|---|
| | Light | Moderate | Heavy |
| *Ascaris lumbricoides* | 1-4,999 epg | 5,000 -49,999 epg | >= 50, 000 epg |
| Trichuris trichiura | 1 – 999 epg | 1,000 – 9,999 epg | >= 10,000 epg |
| Hook worms | 1 – 1,999 epg | 2,000 – 3,999 epg | >= 4,000 epg |

Source: (WHO, 2002) in (Montresor *et al*., 1998).

### 3.6.3 The risk factors associated with *A. lumbricoides*

A structured questionnaire was administered to the caregiver where the preferred respondent was the mother. The questionnaire was administered within the homestead and some sections were filled by the interviewer's observation. For the parts filled by interviewer's observation the following measurements were used to arrive at the various conclusions.

#### 3.6.3.1 Measurement of variables

- **Latrine utilization (observation)**

**Satisfactory latrine utilization:** is a households having functional latrines, safe disposal of child faeces, no observable faeces in the compound and show at least one sign of use (foot path to the latrine not covered by grass, the latrine is smelly, spider weave in squatting hole, presence of anal cleansing material, fresh faeces in the squatting hole, and the slab is wet).

**Hygienic:** means no feacal matter presents inside the facility on floor or walls, which are not full and not smell bad.

**Functional latrine:** is a latrine that provided services at the time of data collection even if the latrine required maintenance.

**Access to hand washing facilities:** is availability of hand washing facilities at the entry or adjacent to the latrine.

**A Child friendly feature of latrine facility:** means availability of at least one of the following features; small squatting hole, lower seat and presence of potty.

- **Child grooming (observation)**

  Child: child should be appropriately dressed while playing; child is supervised to not play with dirt: presence of an adult while child is playing to ensure minimal ingestion of dirt and ensure hand washing facility available.

  Child bathed, clean, hair is kept short and well combed, child nail trimmed and regularly cleaned as there is no dirt under the nails. Child having visible rashes or persistent skin disorders resulting from improper care or lack of hygiene

- **Proper hand washing steps (according to WHO)(observation)**

a) Wet hands and apply soap. Rub palms until soap is bubbly
b) Rub each palm over the back of the other hand
c) Rub between fingers on each hand
d) Rub your hands with the fingers together
e) Rub around each of your thumbs
f) Rub in circles on your palms. Then rinse and dry your hands

### 3.7 Data analysis and presentation

Statistical analyses were performed using Statistical Packages for Social Sciences (SPSS, version 16.0; SPSS, Inc., Chicago, IL). Descriptive statistics was used to obtain prevalence data for *Ascaris lumbricoides*. Frequencies and percentages were used to summarize the data. For inferential statistic Pearson Chi-square test analysis was used to test for the relationship between infection status and selected independent variables and whether distribution between the variables differ from one another. For all tests a P-value ($P \leq 0.05$) was considered as statistically significant. The data was then presented in the form of frequencies and percentages in tables and charts.

### 3.8 Ethical considerations

The study protocol was approved by Maseno University Ethical Review Board (Appendix V). The aim and purpose of all components of the study was discussed and agreed upon with local leaders, and legal consent was obtained from authorities. The study was conducted between the April 2014 and August 2014 with full permission from all the mentioned authorities. The researcher always briefed the respondents about the nature of the research, its purpose, and implications in order to obtain informed consent from the respondents before interview. Verbal and written consent was also sort from the care givers or mothers of those aged 12- 60 months before the interview. Confidentiality of the information given was assured to the respondents before starting each interview. Children who were found positive for *Ascaris lumbricoides* were treated with Albendazole 400mg stat and referred to Tenwek mission hospital for further management.

# CHAPTER FOUR: RESULTS

## 4.1 Introduction

In this study, 478 households that were sampled were all included in the analysis. This chapter presents the results of the prevalence of ascariasis among pre-school aged children, intensities of the infection and the associated risk factors. This chapter presents the data analysis, interpretation and discussion of research findings. The findings are mainly quantitative and therefore descriptive statistics were used.

## 4.2 Socio - Demographic Profile of Study Participants

The demographic characteristics of the respondents (parents/guardians) and their pre-school aged children include: sex, age, education level, religion, and occupation, monthly level of income, marital status and religion were presented (Table 4.1). Ages of the respondents were recorded in months and the age was grouped into categories as shown in the table.

Literacy was assessed by the highest level of education attained. Primary education included the individuals who never went to school at all, dropped out and those who completed primary education. The individual's religion was expected to influence hygiene practices especially in relation to toilet use. The respondents were categorized according to their occupation (Table 4.1). The income distribution of the respondents was the monthly average of the total income the respondents earned given in Kenyan Shillings.

Out of the 478 participants who revealed their age, majority of the parents/guardians were 358(74.6%) aged 35 years and below while children were 314(65.6%) between 11-36months old. Majority of the pre-school aged children 249(52.1) were male. A higher number of respondents 186(38.9%) had primary school education and below and high school education was 161(33.7). Many of the respondents 427(89.4%) were Christians. Few 51(10.7%) of the respondents were Muslim. Many of the respondents were casual laborers 180(37.7%)

followed closely by farmers 140(29.2%). The least occupation was the civil servants 57(11.9%). The results of this study also shows that majority 259(54.2%) of the respondents had a monthly income of 6,000 shillings or less. Family sizes of respondents was an average with families with less than 4 members being 172(36%) with 162(33.9%) having more than 7 individuals. 271(56.5%) of the respondents were from rural area, while 207(43.2%) were town residents.

**Table 4.1:Demographic characteristics of caregivers and preschool aged children**

| Variable | Category | No. of respondent (478) | Percentage (%) |
|---|---|---|---|
| Age of the pre-school aged children in months | 6 – 24 months | 158 | 33 |
| | 25-36 months | 156 | 32.6 |
| | 37- 48 months | 83 | 17.3 |
| | 49 –60 months | 81 | 17 |
| Sex of the pre-school aged children | Male | 249 | 52.1 |
| | Female | 229 | 47.9 |
| Age of the caregivers | 16 - 25 years | 194 | 40.3 |
| | 26 years – 35 years | 164 | 34.3 |
| | 36 years – 45 years | 59 | 12.3 |
| | 46years -55years | 40 | 8.4 |
| | Over 55 | 21 | 4.4 |
| Education level of the caregivers | Primary school | 186 | 38.9 |
| | High school | 161 | 33.7 |
| | Tertiary Education | 131 | 27.4 |
| Religion of the caregivers | Catholic | 185 | 38.7 |
| | Muslim | 51 | 10.7 |
| | Christian (protestant) | 242 | 50.7 |
| Occupation of caregivers | Civil servants | 57 | 11.9 |
| | Casual laborers | 180 | 37.7 |
| | Business persons | 101 | 21.1 |
| | Farmers | 140 | 29.2 |
| Monthly income level of the caregivers(KSh) | ≤6000(KSh) | 259 | 54.2 |
| | 6001-14999(KSh) | 112 | 23.4 |
| | ≥15000(KSh) | 107 | 22.3 |
| Family size | <4members | 172 | 36 |
| | 5-7members | 144 | 30.2 |
| | >7 members | 162 | 33.9 |
| Residence | Town | 207 | 43.2 |
| | Rural | 271 | 56.5 |

Total sample size, n = 478. Data shown are frequencies (n) of subjects and proportions (%).

### 4.2.1 Socio-demographic and other characteristics of guardians associated with prevalence of ascariasis among pre-school aged children

These characteristics were; age, sex, education level, employment status, monthly income, religious affiliation, family size of respondents and place of residence.

**Table 4. 2: Socio-demographic and other characteristics of guardians associated with prevalence of ascariasis among pre-school aged children sampled.**

| Variable | Category | Ascariasis | | $\chi^2$ Results |
|---|---|---|---|---|
| | | **Ova present (n=202)(%)** | **Ova absent (n=276)(%)** | |
| Age of the pre-school aged children in months | 6 – 24 months | 61(12.8) | 97(20.2) | $\chi^2$ = 2.27<br>df = 3<br>p= *0.519* |
| | 25-36 months | 72(15.06) | 84(17.5) | |
| | 37- 48 months | 37(7.7) | 46(9.6) | |
| | 49 –60 months | 32(6.7) | 49(10.3) | |
| Sex of the pre-school aged children | Male | 107(22.4) | 142(29.7) | $\chi^2$ = 0.108<br>df = 1<br>p=0.742 |
| | Female | 95(19.9) | 134(28) | |
| Age of the caregivers | 16 - 25 years | 73(15.3) | 121(25.3) | $\chi^2$ = 55.9<br>df = 4<br>**p≤0.001** |
| | 26 years – 35 years | 47(9.8) | 117(24.5) | |
| | 36 years – 45 years | 33(6.9) | 26(5.4) | |
| | 46years -55years | 34 (7.1) | 6(1.3) | |
| | Over 55 | 15(3.1) | 6(1.3) | |
| Education level of the caregivers | Primary school | 121(25.3) | 65(13.6) | $\chi^2$ = 81.9<br>df = 2<br>**p≤0.001** |
| | High school | 62(13) | 99(20.7) | |
| | Tertiary Education | 19(4) | 112(23.4) | |
| Religion of the caregivers | Catholic | 77(16.1) | 108(22.6) | $\chi^2$ = 1.27<br>df = 2<br>p=0.529 |
| | Muslim | 18(3.8) | 33(6.9) | |
| | Christian | 106(22.2) | 136(28.5) | |
| Occupation of caregivers | Civil servants | 3(0.6) | 54(11.3) | $\chi^2$ = 50.4<br>df = 3<br>**p≤0.001** |
| | Casual laborers | 76(15.9) | 104(21.8) | |
| | Business persons | 59(12.3) | 37(7.7) | |
| | Farmers | 64(13.4) | 81(16.9) | |
| Monthly income level of the caregivers(KSh) | ≤6000(KSh) | 110(23) | 149(31.2) | $\chi^2$ = 67.2<br>df = 2<br>**p≤0.001** |
| | 6001- 14999(KSh) | 77(16.1) | 35(7.3) | |
| | ≥15000(KSh) | 15(3.1) | 92(19.2) | |
| Family size | <4members | 56(11.7) | 116(24.3) | $\chi^2$ = 24.6<br>df = 2<br>**p=0.001** |
| | 5-7members | 61(12.8) | 83(17.4) | |
| | >7 members | 85(17.8) | 77(16.1) | |
| Residence | Town | 62(12.9) | 145(30.3) | $\chi^2$ = 22.7<br>df = 1<br>**p≤0.001** |
| | Rural | 140(29.1) | 131(27.4) | |

Total sample size, n = 478. Data shown are frequencies (n) of subjects and proportions (%).

The study compared prevalence of Ascariasis infestation among pre-school aged children and demographic characteristics of the respondents and the results were presented in the table 4.2 above. Age of the respondents/caregivers and their pre-school aged children were important factor to consider. There was a significant statistical difference (**p≤0.001**) between age of caregivers and prevalence of ascariasis among the pre-school aged children. However, there was no significant statistical association (p = 0.519) between age of the pre-school aged children and prevalence of ascariasis (Table 4.2).

Education level, family size, monthly income, occupation, religion and residence were considered in regard to prevalence of ascariasis. Results showed that there was a statistical relationship between education level of caregivers **(p≤ 0.001)** and prevalence of ascariasis. Pre-school aged children whose caregivers had primary education were more likely to have ascariasis. There was a significant statistical relationship between family size and prevalence of ascariasis **(p =0.001**). Pre-school aged children of respondents who had family sizes of over seven members were more likely to have ascariasis than those from families with less than four members. There was statistical significance between monthly income **(p≤0.001)** and prevalence of ascariasis. Pre-school aged children of respondents with a monthly income of less than 6000 Kenya shillings were more likely to have ascariasis. There was a statistical significance between occupation **(p ≤ 0.001)** and prevalence of ascariasis. Pre-school aged children of respondents who were casual laborers and farmers were more likely to be infected with *Ascaris lumbricoides* ova. However, there was no significant statistical relationship between religion (p= 0.529) and ascariasis (Table 4.2). There was a significant statistical relationship between location of residence and ascariasis infection **(p≤0.001).** Respondents who were rural dwellers were more likely to be infected with ascariasis more than the urban dwellers.

## 4.3 The prevalence of *A. lumbricoides* among pre-school aged children in Bomet Central Division.

In this study, prevalence is the total number of children whose stool samples were reported to be present of ova/ eggs of *Ascaris lumbricoides* **/ total population of pre-school aged children sampled *100.** The prevalence of ascariasis or its co-infection among the pre-school aged children sampled was 42.3%.

**Parasite specific and combination prevalence**

In this study, infection with *Ascaris lumbricoides* had a predominant prevalence rate of 42.3% among preschool age children in Bomet Central division followed by *Ascaris lumbricoides* and hookworm infection with a prevalence rate of 31.2% and the least prevalent worm species combination was *Ascaris lumbricoides* and Trichuris trichiura (8.6%), (see Table 4.3). Parasite pairing with *T. trichura* and Hookworm was not reported. There were no triple infections of *Ascaris lumbricoides,* hookworm and *Trichuris trichiura*.

**Table 4. 3: Prevalence of *A. lumbricoides* and combination prevalence among preschool aged children in Bomet Central division.**

| **Worm infestation** | **Ova present(n) (N=478)** | **Prevalence(%) = (x/N*100)** |
|---|---|---|
| *A. lumbricoides* | 202 | 42.3% |
| *A. lumbricoides* + hookworm co-infection | 149 | 31.2% |
| *A. lumbricoides* + *Trichuris trichiura* | 41 | 8.6% |

Total sample size, N = 478. Data are presented as number (n) of subjects and proportions (%).

### 4.4 Intensity / Ova load of *A. lumbricoides* in pre-school aged children in Bomet Central Division.

This study aimed to look at the overall distribution of children according to age in months and *Ascaris lumbricoides* ova load. *Ascaris lumbricoides* ova were present in 42.3% (202) of all the children sampled in the study. 75 (37%) of the pre-school aged children had light intensities of ascariasis infection, 121 (60%) of the pre-school aged children had moderate intensities of ascariasis and finally 6 (3%) of the pre-school aged children had heavy intensities of ascariasis infections (Table 4.4).

Further analysis of intensity threshold of Ascariasis infections among the pre-school aged children revealed, that approximately two thirds 127(62.87%) of the pre-school aged children infected with *Ascariasis* had moderate and heavy intensities of *Ascaris lumbricoides* ova load while slightly over one third, 75(37.12%) had light intensities of the *Ascaris lumbricoides* ova load. It is therefore evident that the intensity of the *Ascaris lumbricoides* in this study population is high with a large number of infected pre-school aged children having moderate and heavy intensity / ova load count.

**Table 4. 4**: **Distribution of *A. lumbricoides* ova load in pre-school aged children by age category.**

| **Age (months)** | **Distribution of children n (%) by age category (N = 202) by ova load.** | | | |
|---|---|---|---|---|
| Infection intensity | Light (N=202)(%) | Moderate (N=202)(%) | Heavy (N=202)(%) | $\chi^2$ Results |
| 6-24 | 21(10.3) | 39(19.3) | 0(0) | $\chi^2$ = 7.97 df=6 p =0.240 |
| 25-36 | 28(13.8) | 44(21.7) | 1(0.5) | |
| 37-48 | 14(6.9) | 19(9.4) | 2(1.0) | |
| 49-60 | 12(5.94) | 19(9.4) | 3(1.5) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

### 4.5 The risk factors associated with Ascariasis infection in pre-school aged children in Bomet Central Division.

The risk factors associated with *Ascaris lumbricoides* infestation that were investigated include:

i) Drinking water sources and handling for example household's main source of drinking water; household water treatment and treatment methods; drinking water storage;

ii) Sanitation for example presence and utilization of toilet facility by household members;

iii) Disposal of child stools; hand washing practices and finally access and utilization of health facility services.

### 4.6 *A. lumbricoides* ova load versus source of household drinking water.

In order to investigate the main sources of household drinking water that influenced ascariasis, the water sources were stratified into borehole, open/unprotected well; open/unprotected spring; river/stream. Most respondents reported the river 139(68.7%) as the primary source of household drinking water. *Ascaris lumbricoides* ova was significantly affected by the type household's drinking water source ($\chi^2$ =54.6, df=6, **p =<0.001)**. These results therefore show that use of water from rivers increased the risk of families acquiring Ascariasis infections. People swimming in the rivers, defecation on the river banks and occasionally in the river from the sources contaminate the water leaving the users at risk of infections. Occasional flooding of rivers bring water into contact with the poorly built traditional latrines all of which are optimum conditions for survival and development of *Ascaris lumbricoides* ova leading to contamination. When the contaminated water is consumed without being properly treated, results in Ascariasis.

**Table 4. 5**: **Household drinking water sources versus *Ascaris lumbricoides* ova load**.

| Household drinking water source | Frequency n =202(42.3%) | | | |
|---|---|---|---|---|
| **Infection intensity** | **Light (N=202)(%)** | **Moderate (N=202)(%)** | **Heavy (N=202)(%)** | **$\chi^2$ Results** |
| Borehole | 39(19.3) | 9(4.4) | 0(0) | $\chi^2$ =54.6 df=6 **p =<0.001** |
| Open well | 0(0) | 3(1.4) | 0(0) | |
| Open spring | 3(1.4) | 8(3.9) | 1(0.4) | |
| River | 33(16.3) | 101(50) | 5(2.4) | |

Data shown are frequencies (n) of subjects and proportions (%). df- degrees of freedom, $\chi^2$-Pearson's chi-square. Value in bold is significant *P*-values.

### 4.7 *Ascaris lumbricoides* ova load versus household water treatment methods.

An assessment of how household water was handled before use revealed that many respondents mainly filtered water before use 94(46.3%), 44(21.7%) used sedimentation as a way of treating water while 48(23.6%) did not know any water treatment method and didn't treat household water before use (Table 4.6). *Ascaris lumbricoides* infection seems to be significantly affected by the type of household water treatment method ($\chi^2$ = 81.7, df=8, **p <0.001). F**iltering water, sedimentation and not treating household drinking water was mostly reported and are likely to have caused ascariasis among the pre-school aged children.

**Table 4. 6: *A. lumbricoides* ova load versus household water treatment methods**.

| Water treatment method | Frequency n =202(42.3%) | | | |
|---|---|---|---|---|
| **Infection intensity** | **Light (N=202)(%)** | **Moderate (N=202)(%)** | **Heavy (N=202)(%)** | **$\chi^2$ Results** |
| Filters | 7(3.4) | 86(42.5) | 1(0.4) | $\chi^2$ = 81.7 df=8 **p <0.001** |
| Boil | 5(2.4) | 5(2.4) | 0(0) | |
| Chlorine | 2(0.9) | 4(2.0) | 0(0) | |
| Sedimentation | 36(17.8) | 8(3.9) | 0(0) | |
| Don't know | 27(13.3) | 20(9.9) | 1(0.4) | |

Data shown are frequencies (n) of subjects and proportions (%). df- degrees of freedom, $\chi^2$- Pearson's chi-square. Value in bold is significant *P*-values.

### 4.8 *Ascaris lumbricoides ova versus* primary drinking water storage facility.

Many of respondents infected with ascariasis reportedly used earthen pot 117(57.9%) and jerican 55(27.1%) as the main items to store drinking water in the household. Further chi-square analysis reveals that risk of acquiring Ascariasis *is* significantly associated with type of drinking water storage facility ($\chi^2$ = 17.2, df=8, **p =0.028).** Ascariasis seems to be affected mainly by the use of earthen pots followed by jericans as primary water storage facilities in homesteads. Earthen pots were not regularly cleaned therefore left to form a sludge that provides a medium for ova to mature. Ova could easily be introduced into it from dirty hands during water collection because of its wide mouth. Jericans also pose as risk due to the fact that they have narrow mouth thus frequent cleaning would become a challenge eventually they are left to form a sludge that is favourable for ova to mature.

**Table 4. 7:** ***Ascaris lumbricoides ova*** **versus primary drinking water storage facility.**

| **Water storage method** | **Frequency n (%)** | | | |
|---|---|---|---|---|
| **Infection intensity** | **Light (N=202)(%)** | **Moderate (N=202)(%)** | **Heavy (N=202)(%)** | **$\chi^2$ Results** |
| Jerican | 32(15.8) | 23(11.3) | 0(0) | $\chi^2$ = 17.2 df=8 **p =0.028** |
| Sufuria | 1(0.5) | 3(1.5) | 0(0) | |
| Earthen pot | 39(19.3) | 78(38.6) | 1(0.5) | |
| Drums | 12(5.9) | 5(2.5) | 0(0) | |
| Plastic tanks | 5(2.5) | 3(1.5) | 0(0) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

### 4.9 Ascariasis and type of toilet facility.

Traditional pit latrines 190(94.0%) were highlighted as the primary facilities that were mostly used by families sampled in the study. The remaining number of pre-school aged children 12 (6%) infected with ascariasis were reported as not having a toilet facility for use within the homestead. Absence of a toilet facility and use of traditional pit latrine significantly influenced ascariasis infection ($\chi^2$ = 68.1, df=2, **p =0.00014).** Ascariasis seems to be affected by presence of a toilet facility and the type of toilet facility used (Table 4.8).

**Table 4. 8:** ***Ascaris lumbricoides*** **ova load versus type of toilet facility**

| **Toilet facility** | **Frequency n=202(%)** | | | |
|---|---|---|---|---|
| **Infection intensity** | **Light (N=202)(%)** | **Moderate (N=202)(%)** | **Heavy (N=202)(%)** | **$\chi^2$ Results** |
| Pit latrine | 75(37.1) | 115(56.9) | 0(0) | $\chi^2$ = 68.1 df=2 **p =0.00014** |
| No facility | 0(0) | 8(3.9) | 4(1.9) | |
| Total | 75(37.1) | 123(60.8) | 4(1.9) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

### 4.9.1 Ascariasis infection against number of families sharing toilet facilities.

Majority of the families with pre-school aged children infected with ascariasis 138 (68.7%) were sharing a facility among 5-10 individuals while only 4(2%) of those not sharing a toilet facility were infected with ascariasis. Sharing of toilet facilities in this region, therefore, significantly predisposed pre-school aged children to Ascariasis *(*$\chi^2$ = 10.4, df=4, **p =0.034***)* (Table 4.9). Due to inconsistent and improper usage of pit latrines they were often carpeted with fresh feces. With larger numbers of families sharing a pit latrine keeping the latrines clean always was probably a challenge therefore a larger group of people were predisposed to *Ascaris lumbricoides* ova.

**Table 4. 9: Number of families sharing toilet facilities and** ***A. lumbricoides*** **ova load**

| **Number of family sharing** | **Frequency n (%)** | | | |
|---|---|---|---|---|
| **Infection intensity** | **Light (N=202)(%)** | **Moderate (N=202)(%)** | **Heavy (N=202)(%)** | **$\chi^2$ Results** |
| 1-5 | 44(21.8) | 16(7.9) | 0(0) | $\chi^2$ = 10.4 df=4 **p =0.034** |
| 5-10 | 73(36.1) | 63(31.2) | 2(0.9) | |
| Not sharing facility | 4(2) | 0(0) | 0(0) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

### 4.9.2 Latrine Utilization (Observation)

To determine the extent of latrine utilization the following factors were observed and reported during data collection. Latrine utilization: is a households having functional latrines, no observable faeces in the compound and show at least one sign of use (foot path to the latrine not covered by grass, the latrine is smelly thus presence of flies, spider weave in squatting hole, fresh faeces in the squatting hole, and the slab is wet)(Table 4.10).

**Table 4. 10: *A. lumbricoides* ova load versus observation of latrine utilization indicators**

| **Latrine utilization indicators** | ***Frequency Ascaris lumbricoides n (%)*** | | |
|---|---|---|---|
| | **YES** | **NO** | **$\chi^2$ Results** |
| absence of foot path (covered by grass) | 199(98.5) | 3(1.5) | $\chi^2$=11.1<br>df =4<br>**p=0.026** |
| Visible feces in the compound | 201(99.5) | 1(1.5) | |
| Latrine is smelly thus Presence of flies | 193(95.5) | 9(4.5) | |
| Spider weave in squatting hole | 200(99) | 2(1) | |
| Slab is not wet | 199(98.5) | 3(1.5) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

Generally families that had a footpath that was visibly being utilized, there were no visible feces, no spider weave in the squatting hole and the slab was wet were observed to have practiced proper latrine utilization thus had lower levels of ascariasis infection. Proper and consistent usage of latrine significantly decreased the risk acquiring *Ascaris lumbricoides* ova ( $\chi^2$=11.1, df =4, **p=0.026)** see Table 4.10**.**

### 4.10 Hygiene practices and Ascariasis.

#### 4.10.1 Caregiver's hand washing practice

Caregiver's hygiene practices were assessed in relation to the prevalence of *Ascaris lumbricoides* ova in pre-school aged children.

**Table 4. 11: *Ascaris lumbricoides* ova load versus caregiver hand washing practice**

| | ***Ascaris lumbricoides* N=202(%)** | | **$\chi^2$ Results** |
|---|---|---|---|
| **Hand washing practice** | **YES** | **NO** | |
| after visiting the toilet | 7(3.5) | 195(96.5) | $\chi^2$=17.3, df =4 **p=0.002** |
| Before cooking | 2(1) | 200(99) | |
| Before feeding the baby/before eating | 5(2.5) | 197(97.5) | |
| After changing baby's diaper | 3(1.5) | 199(98.5) | |
| Hand washing Using soap | 15(7.4) | 187(92.6) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

Hand washing practice among the caregivers was reported as in table 4.10. Majority of the respondents whose pre-school aged children had ascariasis reported not washing hands :- after visiting the toilet 195(96.5%), before cooking 200(99%), before feeding the baby/before eating 197(97.5%), after changing baby's diaper 199(98.5%) and 187(92.6%) of them did not wash hands using soap (Table 4.11). Ascariasis in this study was significantly affected by the caregivers hand washing practice ($\chi^2$=17.3, df =4, p**=0.002).** Use of soap, proper and consistent hand washing hygiene practice significantly reduced the level of ascariasis infections. Poor hand washing practices by caregivers was probably due to the lack of knowledge of hand contamination and the risk associated to the health of preschool children.

#### 4.10.2: Proper hand washing steps

Knowledge of proper hand washing steps of caregivers was assessed in relation to the prevalence of ascariasis among the pre-school aged children sampled. Proper hand washing steps is recorded (Table 4.12). Majority of the respondents did not have adequate knowledge of proper hand washing steps 184(91%). Only 18(9%) of the respondents had basic knowledge on proper hand-washing steps. The number of respondents who could carry out the required hand washing steps decreased the further you advance into the procedure. Ability to carry out all the hand-washing steps correctly decreased with increase in the number of preschool children harbouring *Ascaris lumbricoides* ova (Table 4.12). According to the results there was a decrease in awareness of proper hand washing steps and thus increase in number of pre-school aged children reported with ascariasis, hence lack of knowledge on proper hand washing technique according to the WHO significantly increased the level of ascariasis infections ($\chi^2$=18.5, df = 5, **p=0.002).**

**Table 4. 12: proper hand washing steps versus presence of *Ascaris lumbricoides* ova**

| **Hand washing steps** | ***Ascaris lumbricoides*** **N=202(%)** | | **$\chi^2$ Results** |
|---|---|---|---|
| | **yes** | **no** | |
| use bubbly soap | 18(9) | 184(91) | $\chi^2$=18.5 df = 5 **p=0.002** |
| Rub palm over back of hand | 11(5.4) | 191(94.6) | |
| Rub between fingers | 9(4.5) | 193(95.5) | |
| Rub hands with fingers together | 7(3.5) | 195(96.5) | |
| Rub hands around each thumb | 5(2.5) | 197(97.5) | |
| Rub hands in circles on palm, rinse and dry | 2(1) | 200(99) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

### 4.10.3: Child hygiene practices by caregivers.

Knowledge of child hygiene practices for caregivers was assessed in relation to the prevalence of ascariasis among the pre-school aged children sampled.

**Table 4. 13: Ascariasis infection versus child hygiene practices**

| **Child hygiene practices** | ***Ascaris lumbricoides* Frequency N=202(%)** | | **$\chi^2$ Results** |
|---|---|---|---|
| | **YES** | **NO** | |
| Child appropriately dressed during play | 8(4) | 194(96) | $\chi^2$=9.86<br>df = 4<br>**P=0.043** |
| Child supervised to not play with dirt | 5(2.5) | 197(97.5) | |
| Child bathed, clean, combed hair | 3(1.5) | 199(98.5) | |
| Child nail trimmed | 2(1) | 200(99) | |
| Child having visible rashes resulting from improper care | 11(6.5) | 189(93.5) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

Majority of the caregivers with pre-school aged children were reported not to practice safe child hygiene practices as shown (Table 4.13). Presence of *Ascaris lumbricoides* ova in sampled pre-school aged children is significantly affected by the caregivers child hygiene practices ($\chi^2$=9.86, df = 4, **P=0.043**). This study concludes that trimming of child's fingernails, regularly bathing a child, combing their hair, keeping them clean, supervising children while playing with dirt to ensure that they don't eat dirt, dressing a child well during play and ensuring that all rashes and skin diseases are treated are safe practices by caregivers that are likely to decrease the levels of ascariasis infections in pre-school aged children. Proper knowledge of the caregiver on child hygiene practices is very important in preventing ascariasis.

### 4.10.4: Child stool disposal practices by caregivers

Knowledge of child stool disposal practices by caregivers was assessed in relation to the prevalence of ascariasis among the pre-school aged children sampled.

**Table 4. 14: *Ascaris lumbricoides* ova load versus child stool disposal practices**

| Child stool disposal practices | *Ascaris lumbricoides* ova Frequency N=202(%) | | $\chi^2$ Results |
|---|---|---|---|
| | **Yes** | **No** | |
| Do not throw in latrine | 200(99) | 2(1) | $\chi^2$=17.1 df = 4 **P=0.002** |
| Throw outside dwelling | 195(97) | 7(3) | |
| Do not bury in compound | 197(98) | 5(2) | |
| do not Rinse away | 190(94) | 12(6) | |
| Do not dispose | 185(91.6) | 17(8.4) | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

Majority of the caregivers reported improper child stool disposal practices e.g. not throwing in the child stool in the latrine 200(99), throwing outside the dwelling 195(97), not rinsing away 190(94) and not disposing child stool 185(91.6) (see Table 4.14). The analysis (Table 4.14) shows that child stool disposal practices are likely to increase the risk of ascariasis infection ($\chi^2$=17.1, df = 4, **P=<0.002).** This is possibly due to the fact that people in this community believe that it is harmless compared to stool from an adult. Health education on the mode of transmission of A*scaris lumbricoides* ova would help combat this phenomenon.

### 4.11 Ascariasis versus access and utilization of health facility services.

An assessment of the respondents access and utilization of the health facility services over a two year period prior to the study revealed that 174(86%) respondents had access to and utilized the nearest government hospital while 28(14) could not access a health facility easily (Figure 4.1). Therefore most of the respondents in this region had access to a health center. At the government health facility albendazole(ABZ) the drug of choice for deworming in Kenya was reportedly available by only 57(28%) of the caregivers who needed it for their pre-school aged children while 145(72%) reported that ABZ was not available at the government facility when they sought healthcare services.

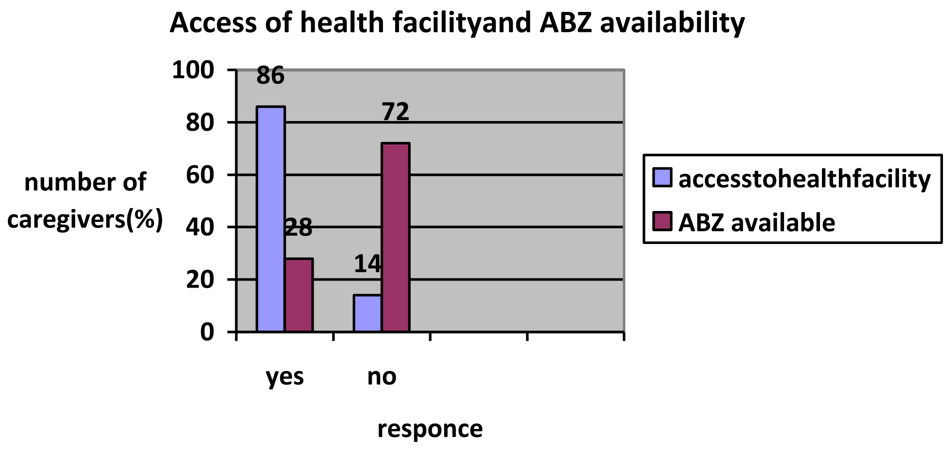



**Figure 4. 1 Access and utilization of health facility services**

Only 26(12.8%) of caregivers reportedly dewormed their children less than 6 months prior to the study whereas many respondents 121(60%) had never dewormed their children in their life time. Ascariasis is therefore affected significantly by the deworming status of the community ($\chi^2$=13.3, df = 2, **P=0.001).** According to analysis (Table 4.15) not frequently deworming preschool children at least twice a year as required is the likely cause of the high prevalence of ascariasis in the community. This could be due to frequent drug stock outs in the local and rural health centers.

**Table 4. 15: frequency of deworming among pre-school aged children sampled**

| **Deworming status** | ***Ascaris lumbricoides* ova** Frequency N=202(%) | | $\chi^2$ Results |
|---|---|---|---|
| | **YES** | **NO** | $\chi^2$=13.3 df = 2 **P=0.001** |
| **ABZ not taken between 6-12 months** | **180(89)** | **22(11)** | |
| **ABZ taken >1year ago** | **189(94)** | **13(6)** | |
| Never taken ABZ | **198(98)** | **4(2)** | |

Data shown are frequencies (n) of subjects and proportions (%). df, degrees of freedom $\chi^2$, Pearson's chi-square. Value in bold is significant *P*-values.

# CHAPTER FIVE: DISCUSSION

## 5.1 Introduction

This study was designed to establish the "prevalence, intensity and risk factors associated with Ascariasis among pre-school aged children in Bomet central Division, Bomet County, Kenya" was with the aim of providing epidemiological data, particularly parasite prevalence and intensity. The independent variables, which were postulated to influence the prevalence of ascariasis among pre-school aged children, were analyzed. In keeping with specific objectives of the study, the following summary of the main findings will glimpse at the prevalence of ascariasis, socio-demographic characteristics that influence the prevalence of ascariasis, the intensity of *Ascaris lumbricoides* ova load and the risk factors associated with ascariasis in this community.

## 5.2 Prevalence of *Ascaris lumbricoides* among pre-school aged children in Bomet Central Division

The study set out to determine the prevalence, intensity and risk factors of Ascariasis infection among pre-school aged children in Bomet central Division, Bomet County, Kenya. The prevalence of ascariasis among pre-school aged children Bomet Central Division, Bomet County, Kenya was 42.3%. This finding is inconsistent with another Kenyan study, carried out in Kibera slums on pre-school aged children that reported a prevalence of 24.1% (David *et al*., 2014). This finding is however consistent to studies from Nigeria that reported a prevalence rate of 44% among pre-school children (Oyewole *et al*., 2007); another Nigerian study on children less than five years reported a prevalence rate of 47.6% (Kirwan *et al*., 2009); others reported a higher prevalence as high as 64.4% (Anah *et al*., 2008); prevalence of 54.7% (Egwunyenga and Ataikiru, 2005) while Pakistan reported a prevalence rate of

77%  among young children (Hafeez *et al*., 2003), although an Ethiopian study found a much lower prevalence (Tadesse, 2005).

Studies elsewhere and STHs prevalence reports from endemic countries indicate that ascariasis is more prevalent as compared to other helminthes (Hotez *et al*., 2008 and de Silva *et al*., 2011). Qualitative studies conducted by Albonico *et al*., (2008) to determine the number of STHs prevalence studies published for the same age group across endemic countries reveals that, *Ascaris lumbricoides* is undisputedly the most dominant infection with the highest prevalence ranging from as low as 3% (in Phillipines rural area) to as high as 88% (in Madagascar). In the same study, *Ascaris lumbricoides* prevalence among preschool children was 20% in Kenya (Albonico *et al*., 2008). The high prevalence of *Ascaris lumbricoides* among preschool children and its dominant trend across endemic countries suggests that it is the most common helminthiases infecting humans of all age groups.

Although currently the government of Kenya is receiving more concerns on deworming of pre-school children there is a continued scale-up of deworming with a focus on School going children which leaves pre-school aged children as a potential pool of re-infecting their other school going siblings. Although some (Taylor-Robinson *et al* 2012; Godlee 2013) have raised broader questions about the effectiveness of current specific mass drug administration approaches, it is widely accepted that infected children do benefit from treatment (Hall *et al*., 2008) and as such, actively including pre-school aged children in the evolution of deworming approaches is critical to controlling the local and global burden of ascariasis infection.

This study, conducted to assess the prevalence rates and risk factors of *Ascaris lumbricoides* found that approximately half of the young children suffer from *Ascaris lumbricoides* or *Ascaris lumbricoides* co-infections that are potentially treatable. This finding is in agreement with data from the nearby Tenwek Mission and referral hospital, that highlight Ascariasis as a major cause of morbidity in pre-school and school age children in this community (Tenwek mission hospital, 2012).

### 5.3 Intensity / Ova load of *A. lumbricoides* in pre-school aged children in Bomet Central Division.

The intensity of ascariasis was as follows: 37% pre-school aged children had light infections, 60% moderate infection level while 3% children had heavy infections.

The findings of the study also revealed that (62.8%) more than half of the total infections by *A. lumbricoides* were of moderate-to-heavy intensities. This prevalence is alarming considering the fact that clinical manifestations and other consequences of these infections tend to be positively correlated with the burden of infection (Ahmed *et al*., 2011; Yap P *et al.*, 2012).

Besides the continuous exposure to the infection in these communities, 59.9% of pre-school aged children had never been dewormed in their lives or 52.9% had not been dewormed 12 months prior to commencement of the study. This study affirms to an earlier report that in the absence of effective control and preventive measures, it is more likely that Ascariasis infections will continue to have devastating consequences and public health implications in communities (Nasr Nabil *et al.*, 2013).

The WHO defines *Ascaris lumbricoides* as a public-health problem when more than 1% of the at-risk population has infection of moderate or high intensity and its control requires the delivery of one or more public health interventions (WHO, 2012) this study therefore highlights that Ascariasis is a major public health problem since moderate infections have been reported at 63% thus its control requires multiple public health interventions to reduce the morbidity they cause to levels that can be controlled through routine health-care or school-based services (WHO, 2012).

WHO recommends periodic drug treatment without previous individual diagnosis to all at risk people living in endemic areas. Treatment should be given once a year when the prevalence Ascariasis infections in the community is over 20%, and twice a year when the prevalence of Ascariasis infections in the community is over 50% (WHO bulletin update, 2014). With an overall Ascariasis or Ascariasis co-infection prevalence of 42.3% and 62.8% having moderate-to-heavy worm burden/ intensity, this community is therefore recommended an annual periodic deworming program.

The new vision for a world free of childhood morbidity due to these helminthes, according to the WHO, is reducing the prevalence of Ascariasis a soil transmitted helminth infection of moderate and heavy intensity to ≤1% (WHO, 2012). Endemic communities for soil transmitted helminthes are classified into 3 transmission categories for the adoption of treatment strategy in preventive chemotherapy; category I (high), category II (medium), and category III (low) (WHO, 2012). Based on this classification, our study area and most probably all of Bomet county falls within the second category (medium risk communities), with an Ascariasis prevalence of 42.3% and 62.8% of these infections being of moderate-heavy intensity. Hence, this high prevalence calls for urgent interventions particularly considering the fact that these infections lead to malnutrition and growth retardation (Al-Mekhlafi HMS *et al*., 2005; Yap *et al*., 2012) and overall poor productivity (Brooker *et al*., 2006). Therefore, these data alone underscore the need for Bomet county to initiate a deworming program for pre-school aged children, continue and sustain its school deworming programs, and more importantly, to implement and monitor integrated control efforts.

**5.4 Socio-Demographic and other Characteristics associated with ascariasis among pre-school aged children.**

In the current study, age of the mother/caregiver, level of education, occupation, family size, location of residence and monthly income were found to be significantly associated with prevalence of ascariasis among the pre-school aged children.

Low levels of maternal education, low income and the nature of parent's occupation are all risk factors to ascariasis **(all P values ≤0.001).** A study conducted by Wani in Jammu and Kashmir State, India showed that maternal education was a significant risk factor for the prevalence of *Ascaris lumbricoides* infections. The prevalence of ascariasis infection decreases as the level of maternal education increases (Wani *et al*., 2010). Maternal education has been found to be the most important risk factor for intestinal parasitism in other studies as well (Phiri *et al*., 2000). This results agree with EL-Masry who showed that low level of parents education, low level of parents income, occupation and low social classes were significant risk factors for ascariasis infections (El-Masry *et al*., 2010).another research has also mentioned level of education to having implications in spreading Ascariasis infections (Traub *et al*., 2004).

In this study increase in maternal level of education was directly related to increased monthly income, increased frequency of deworming and consequently reduced levels of ascariasis infection. This finding is similar to a study in southern Tanzania that demonstrated that children from relatively poorer households were taken to health facilities less promptly and were less likely to receive appropriate care than children from wealthier households. However, they also showed that once the children received treatment, adherence to treatment was not affected by socioeconomic status (Schellenberg *et al*., 2003). Therefore, we recommend adequate stock levels of anti-helminthic drugs in the local health centers in Bomet County, as this will improve the general deworming status in the community.

Age, sex and religion of the pre-school aged children, were not a significant predictor of ascariasis among the pre-school aged children. This could be attributed to the fact that the care of such pre-school aged children was entirely under the primary guardian. As such it is evident that infection status of a child is dependent more on the knowledge and care offered by the primary guardian or mother. On the contrary other studies however have cited age distribution among the children as a factor in acquiring ascariasis infection (Kirwan *et al*., 2009). Another study also cited religion to having implications in spreading Ascariasis infections (Traub *et al*., 2004). Age of the caregiver significantly affected presence of ascariasis. other studies have also reported age of primary caregiver to having positive implications in spreading of ascariasis(Wani *et al*., 2010). Although investigators have reached various conclusions regarding the age groups at greatest risk, the relationship is complex and depends on determinants such as social, cultural, economic and physical environment in which individuals live (Assis *et al*., 2004). The findings are similar to the study that reported that intensity of ascariasis is influenced by socio-economic factors (Fernando *et al*., 2002).

Children who belong to large families (≥7 members) were more at risk of acquiring ascariasis. This finding is consistent with previous studies that attribute this to horizontal spread of infection among family members within the vicinity of the home (Al-Mekhlafi *et al*., 2007; Nasr-Nabil *et al*., 2013). According to this study, larger household sizes, due to economic strain, need more finances to maintain, hence would have survival strategies such as not practicing frequent deworming or not deworming their children at all. Moreover, a significant association between Ascariasis infections and the presence of other infected family members has been reported, a possibility due to horizontal spread among family members within the home (Anuar *et al*., 2012). These results are similar to studies done by Mahmoud, and EL-Masry who showed that a large family size was a significant risk factors for ascariasis (El-Masry *et al*., 2010; Mahmoud, 2000). Another study also cited household crowding to having implications in spreading Ascariasis infections (Traub *et al*., 2004). Location of residence was identified as significant factor in predisposing to ascariasis other studies have also demonstrated that residing in the rural areas also predisposes pre-school aged children to ascariasis (Kirwan *et al*., 2009)

### 5.5 Risk factors for ascariasis

The study found that household drinking water source, treatment and storage; type of toilet facility, its utilization; caregiver and child hygiene placed children with an increased risk of Ascariasis infections. These findings are in agreement with previous studies that report that Ascariasis generally infects people who live in poverty with poor sanitary conditions and lack adequate safe water. Current knowledge suggests that intensity of infection is influenced by sanitation, hygiene as well as environmental factors (Carneiro *et al*., 2002).

Sources of drinking water were analyzed and water obtained from the river and boreholes significantly affected the prevalence of ascariasis infection. Consistently other researchers have found these associations (Oyewole *et al*., 2007). People swimming in the rivers, defecation on the river banks and occasionally in the river from the sources contaminate the water leaving the users at risk of infections. Occasional flooding of rivers bring water into contact with the poorly built traditional latrines all of which are optimum conditions for survival and development of *Ascaris lumbricoides* ova leading to contamination. When the contaminated water is consumed without being properly treated, results in Ascariasis. Risk of infection from water obtained from the river in spreading of *Ascaris lumbricoides* has also been reported by other researchers (Stephenson *et al*., 1993).

Assessment of method of handling household water identified filtering, sedimentation and not treating household drinking water as significantly affecting the prevalence of ascariasis. This is consistent to a report on Ascariasis that the eggs of *Ascaris lumbricoides* are not removed by sedimentation and filtration (Jessika and Peter, 2004).

In developing countries, it is not only water contaminated at source or during distribution that is an issue but also water stored within the home may also become contaminated (arguably a hygiene issue like not washing the storage containers regularly, left to form sludge which provides a medium for ova to mature). A literature review found 11 observational studies showing that mean coliform levels (an indicator of contamination) were considerably higher in household water containers than in the original source waters (Annette *et al*., 2000). Similarly, the use of earthen pots and jericans were significantly associated with the risk acquiring ascariasis infections in this study.

Proper sanitation should result in destruction of pathogenic materials and hence, a break in the transmission pathway. Absence of latrines and the use of pit latrines and sharing of latrines were significantly associated with ascariasis among pre-school aged children in Bomet central division. Similar to other reports absence of latrines leads to open defecation that is significant in the lifecycle of *Ascaris lumbricoides* (Awasthi *et al*., 2003). Majority of traditional pit latrines are usually carpeted with dry and fresh human wastes this could be attributed to the fact that these pit latrines are not children friendly thus children defecate outside the hole. Moreover, sharing of these facilities thereby increases the chances of infections. Improper disposal of human wastes has been associated with Ascariasis infections by other studies (Asaolu *et al*., 2002), thereby indicating that members of the public are at risk of acquiring Ascariasis infections where traditional (thatched, non-ventilated and old) latrines were commonly used (Chigozie *et al*., 2007).

Utilization of latrines indicators was significantly associated with the risk of *Ascaris lumbricoides* infection. This finding is consistent to other studies have shown that children living in homes without latrines have a higher prevalence of Ascariasis than those living in homes with latrines, introduction of proper improved ventilated pit latrines and correct use of it can help lower the prevalence of helminthic infections (Smith *et al*., 2001).

Consistent use of soap when washing hands was significantly associated with prevalence of ascariasis. similarly a review of hand hygiene literature suggests that hand washing with soap can reduce micro-organism levels close to zero (Kampf, 2004). The finding was consistent to Fung and Cairncross who found that washing hands with soap as one of the most cost-effective means of preventing ascariasis infestations in developing countries (Fung, 2009). Olsen, also reported that not using soap was identified as a risk factor for infection of intestinal helminthes in Kenya (Olsen *et al*., 2001). Similarly, a study conducted by Tadesse in Ethiopia showed a higher rate of ascariasis infection among children who didn't wash their hands regularly before meals(Tadesse, 2005). In this study therefore we recommend improving family health by teaching caregivers and children on use of soap during hand washing and proper hand washing steps.

Caregivers hand hygiene practices significantly predisposed pre-school aged children to ascariasis. This finding was consistent with Campos, who found that 100% of caregivers did not practice proper hand washing hygiene a situation that reflected significantly in hand contamination, in which fecal coli forms were detected on 55.6% of the hands analyzed. Hand contamination lead to transmission of Ascariasis among children less than five years old (Campos *et al*., (2009). Hand washing with soap before feeding children and after cleaning them can interrupt the transmission of fecal-oral microbes in the domestic environment (Joe-Brown *et al*., 2014). Estimates of the impact of hand washing with soap on health from systematic reviews suggest large effects (up to 48% reduction in ascariasis)(Waddington *et al*., 2009);(Fewtrell *et al*., 2005;). The study concludes that the households sampled did not have sufficient knowledge of minimum hygiene standards, suggesting the need for interventions that impact knowledge on basic minimum hygiene package for the community that will help prevent Ascariasis.

Lack of knowledge on proper hand-washing techniques significantly predisposed pre-school aged children to ascariasis infection. These findings are similar to a study on Knowledge and practice of Caregivers on Intestinal helminthes infections that found only 20.0% of caregivers rub fingers circular during hand washing (Naglaa *et al*., 2014). Another research states that proper hand-washing technique should include water, a washing agent such as soap and a drying phase (Jumaa, 2005). Lack of knowledge on proper hand washing techniques therefore lead to increased risk of ascariasis infection. This study therefore recommends community sensitization on proper hand washing technique according to WHO guidelines.

Child hygiene indicators were assessed as child appropriately dressed during play; supervised during play to not play with dirt; bathed, clean, combed hair; child nail trimmed; child having visible rashes or persistent skin disorders resulting from improper care or lack of hygiene. Child hygiene indicators were identified as significant predisposing factors to ascariasis among the pre-school aged children sampled. These findings are consistent to a study conducted in India that showed lower infection rates among children who were bathed and had clean nails (58.3%) than those who were playing with dirt and had dirty nails (83.3%)(Wani *et al*., 2010). Another study conducted by Tadesse in Ethiopia also showed higher infection rates among children having dirty fingernail (28%) than clean fingernail (25.4%) (Tadesse, 2005). When children play with soil, *Ascaris lumbricoides eggs* tend to reside under the fingernails, and from there they are easily introduced or reintroduced into the body starting new infections. For this reason mothers/ caregivers should keep their fingernails and that of their children short and clean in order to break *Ascaris lumbricoides ova* transmission pathway.

Child stool disposal practices were significantly associated with the likelihood of acquiring ascariasis infection. Many cultures consider the stools of infants fed on breast milk harmless, or at least less harmful than those of adults, because they are smaller, their feces smell less, and contain less visual food residues (Gil *et al*., 2004);(Yeager *et al*., 1999). Additionally, most latrines are not designed for use of, and may not be used by, small children. They might be afraid to use them for the risk of falling in, bad smells, or the fear of dark spaces. Because nappies, child-sized potties and washing machines are not available in many poor settings, defecation on the floor is common and potentially seen as the most practical option until the child is trained on how to use the latrine. As a result, latrine use by children is low, as was shown by a study in Lima, Peru, where less than 25% of under five-year-olds used a toilet (Yeager *et al.,* 1999). Because of a much higher prevalence of *Ascaris lumbricoides ova* in children, child stool often poses a greater health risk than those of adults (Feachem *et al.*, 1983a). To date, safe disposal of children's stools has received relatively little attention in sanitation programs and researchers.

Access and utilization of the public health center was at 86% however it was not significant in preventing ascariasis. However, availability and use of deworming drug of choice, albendazole, was significantly associated with ascariasis infection levels among the pre-school aged children sampled. This is probably because ABZ the drug of choice for deworming was not always available at the health center and thus a low access of the albendazole for deworming. These results compare to previous ones in Cambodia in which access to drugs in remote areas was shown to be low (Yeung *et al*., 2008). Another study conducted in Kenya to assess availability of drugs in the government health facilities revealed that majority especially the facilities in the rural areas, basics drugs were not always available(Chuma *et al*., 2007). Additional studies on policy in practice in Kenya showed that health facilities suffered from chronic drug shortages due to delays in drug deliveries from the central level and the failure to adjust drug quantities to suit seasonal fluctuations in disease burden (Chuma *et al*., 2009b).  Other studies have also revealed that reduced charges at health facilities can improve accessibility of drugs by the community members (Chuma *et al*., 2007; Noor *et al*., 2003; Zurovac *et al*., 2005). Our local government facilities should therefore have anti-helminthic drugs available at all times.

# CHAPTER SIX: CONCLUSION AND RECOMMENDATION

## 6.1 Conclusion

1) Results from this study show that the moderate prevalence (42.3%), approximately half of the young children suffered from single or multiple geo-helminthes infections that are potentially treatable by a single dose of albendazole (400 mg stat). Compared to all other studies done in Kenya among preschool aged children, Bomet central has a relatively higher prevalence of ascariasis that needs urgent attention.
2) The moderate prevalence and moderate to high intensity ascariasis (62.7%) infection in these pre-school aged children necessitate treatment of these children in their homesteads. Ascariasis still is a significant problem in this region and will most likely continue to do so in the future without proper intervention.
3) Age and education level of mother, household income, lack of proper and improved toilet facilities; large family size ($\geq$ 7 members), contaminated water sources, lack of knowledge on water treatment methods and safe storage of household drinking water, hand washing without soap, not washing hands before eating or feeding the baby, and after visiting the toilet or changing the baby's diaper; child stool disposal practices and poor health seeking behaviour were the key factors significantly associated with ascariasis infections in the studied population. Based on these findings, implementing periodic school-based de-worming programs, providing proper sanitation and portable safe water supply, and providing proper health education pertinent to good personal hygiene and good sanitary practices will help in reducing the prevalence and intensity of ascariasis in these communities.

### 6.2 Recommendations

1) With an overall ascariasis prevalence of 42.3% and 62.8% having moderate-to-heavy intensity, this community is recommended an annual deworming program for the pre-school aged children this should in line with the country's annual school deworming program that is currently running. The ministry of health in order to protect the already dewormed school going children from being re-infected by the pre-school aged children who have been identified as a potential transmission pool to their older school going siblings should expand the deworming program to include pre-school age children in the community.
2) Behaviour - change- communication programs should be initiated in the community. Health education on proper sanitation, caregiver hand washing practice and child hygiene, protecting water sources, proper water treatment and proper storage of household drinking water in regularly cleaned containers that have lids be offered to the public in this region. We also recommend community sensitization on proper hand washing technique according to WHO guidelines. Simple community based measures such as increasing public awareness about increasing latrine coverage, having well ventilated pit latrines and their utilization, safe disposal of child feces can be used.
3) The ministry of health should consider providing and ensuring that albendazole the drug of choice for deworming among the preschool aged children is available at all times in the local rural health centers where most of the community seeks health services.
4) National data for the prevalence of ascariasis among preschool age children is required in order to design mass deworming campaign programs targeting this age group.

### 6.3 Recommendation for further studies

1. In connection with the importance of community participation in the prevention and control activities, it is essential to evaluate knowledge, attitude and practices of this population to ascariasis among pre-school aged children before attempting to introduce any change or innovation.
2. Prevalence of other soil transmitted helminthes in this region is relatively high therefore soil and environmental studies need to be done to ascertain whether agricultural and climatical factors promote the presence of other soil transmitted helminthes in this region.

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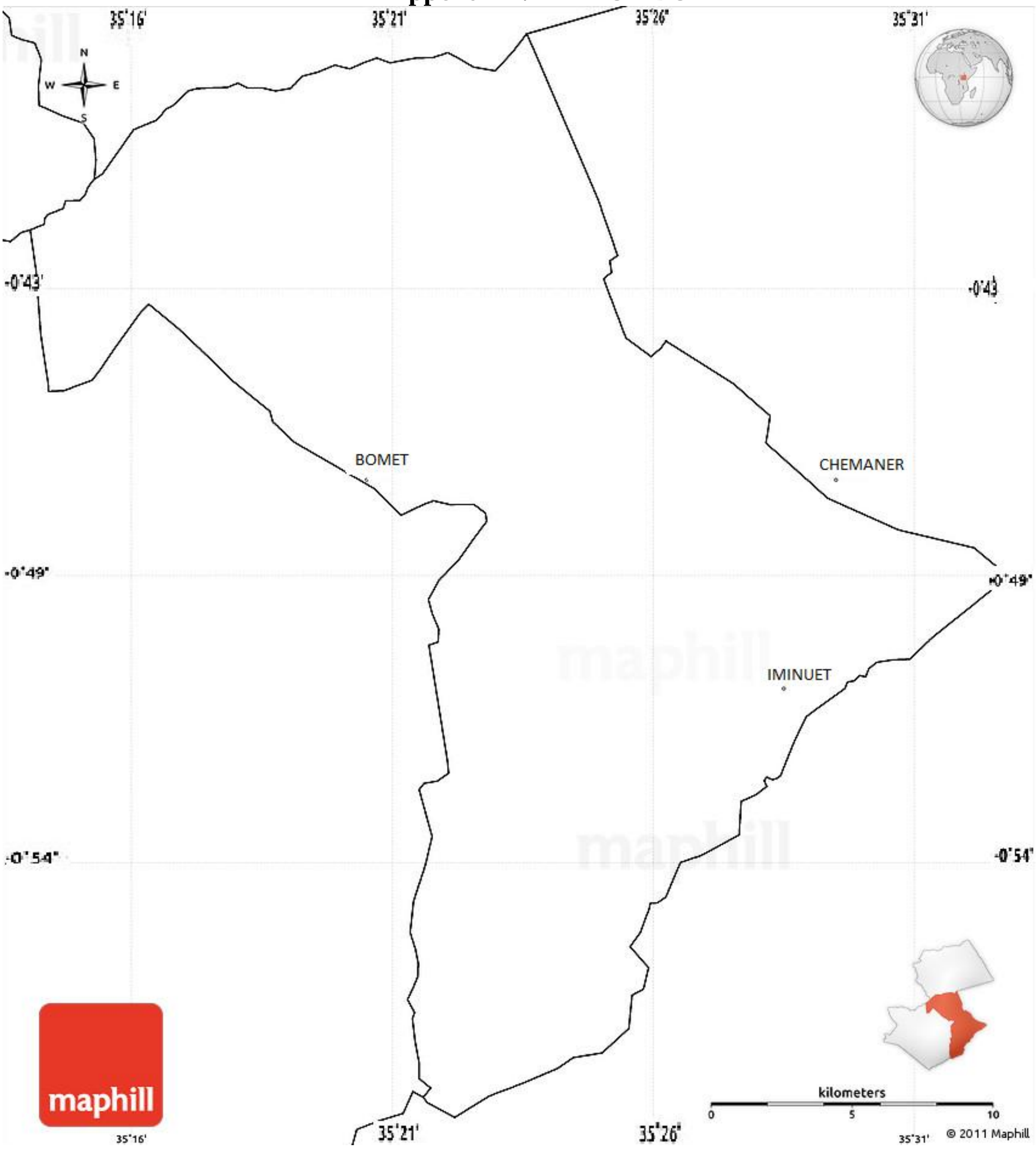
## Appendix I: MAP OF BOMET




(Maphill, 2013Maphill, 2013)

## Appendix II: DATA COLLECTION FORM

**Child Form (WHO, 1998)**

The following form is a form which could be used in a soil-transmitted helminthiasis survey for collecting data on each child.

Part I should be completed when collecting stool samples.

Part II should be completed during the microscopic analysis of samples.

**Soil-Transmitted Helminthiasis Survey Child Form**

**I Personal data**

House Number ________ Village __________

Name ________-__________-_________

Sex M-F Age __________

**Other data (optional)**

Weight __ __, __ kg Height __ __ , __ cm __ MUAC

**II Parasitological data**

**a) Stool examination**

*Ascaris lumbricoides* eggs/slide _______ eggs/gram _______

*Trichuris trichiura* eggs/slide _______ eggs/gram _______

Hookworms eggs/slide _______ eggs/gram _______

Other parasites identified ___________-___________-

## Appendix III: QUESTIONNAIRE

### 1: Introduction and Consent

### 1.0 Identification

Questionnaire Code……………… Date of Interview…………………

Respondent Name…………….………..Household Number………………

Residence…………………………….

### 1.1 Introduction

My name is …………...  I am a postgraduate student undertaking Masters in Public Health at Maseno University. We are carrying out a study that aims to establish the prevalence, intensity and identify risk factors for Ascariasis, in pre-school aged children in Bomet central division.

### 1.2 Benefits

The information from this study will be strictly for learning purposes. It may also be used by the Ministry of Health and other stakeholders to create new policies concerning *Ascaris lumbricoides* prevention in this age group.

### 1.3 Basis of participation

Your participation will purely be voluntary. You will need approximately 20 minutes to respond to the questions. The information will be given to the researcher and it will be treated with confidentiality.  Your sincere and true response will contribute to the achievement of the aim of this study.

May I begin the interview now? *(If answer is yes, sign and administer the questionnaire, if no go to the next household)*

Signature of interviewee:……………………… Date:……………………..

Signature of interviewer:……………………… Date:……………………

*II. Demographic Characteristics*

*We would first like to obtain some information about your household and the people who live in it.*

| *Line No.* | (1) Residents | (2) Sex | (3) Marital Status | (4) Age | Religion | Education | | |
|---|---|---|---|---|---|---|---|---|
| | Please give the 1st name of the people who live in your house, starting with the head of household. | Is (*Name)* male (1) or female (2)? | What is the marital status of *(name)*? ** | How old is *(name)? **If** 11-24= 1 25-36=2 37-48=3 49-60=4 All in months. ***If** >60 months record in years.* | (5) What is the religion of (*name*)? | (6) *If No, skip to #22 Y=1 N=2* | (7) Is *(name)* currently attending school? Y=1 N=2 | (8) What is the highest level *(name)* has attended? **** |
| *1* | | | | | | | | |
| *2* | | | | | | | | |
| *3* | | | | | | | | |
| *4* | | | | | | | | |
| *5* | | | | | | | | |
| *6* | | | | | | | | |
| *7* | | | | | | | | |

***Codes for Q.3** – Marital Status:* 1=Single 2=Single, with live-in partner 3=Married 4=Divorced/Separated 5=Widowed
***Codes for Q.5** – Religion:* 1=Roman Catholic 2=Protestant/Other Christian 3=Muslim
***Codes for Q.8** – Level of school attended:* 1=Primary school 2=Secondary school 3=college

### III. Household Characteristics

## A. Water/Sanitation

| no | Question, response and coding | Comment |
|---|---|---|
| **10** | What is your household's main source of drinking water?<br>Piped into dwelling………………01<br>Piped water, public tap…………..02<br>Borehole…………………………03<br>Protected well…...………………..04<br>Open/unprotected well…………..05<br>Protected spring………………….06<br>Open/unprotected spring…………07<br>River/stream……………………..08<br>Rainwater………………………..09<br>Bottled Water……………………11<br>Other ______________________ 95 (specify) | |
| **11** | Does your household treat the water before drinking it?<br>Yes………………………………1<br>No………………………………..2 | *If No, skip to question #13 And 12=0.* |
| **12** | What method does your household use to treat water before drinking?<br>Filters……………………………01<br>Boils……………………….…….02<br>Chemicals (chlorination tablets)...03<br>Decantation/Sedimentation……..04<br>Other ______________________ 95 | |
| **13** | Does your household store drinking water in your home?<br>Yes………………………………...1<br>No…………………………………2 | *If No, skip to question #15 And 14=0* |
| **14** | How does your household store drinking water?<br>Plastic Jeri-cans…………………..01<br>Plastic/Brick tank……………….02<br>Cement/concrete tank……………03<br>Earthen pots……………………..05<br>Drums……………………………06<br>Sufurias…………………………07<br>Other ______________________ 95 (specify) | |
| **15** | What kind of toilet facility does your household use?<br>Flush toilet………………………01<br>Ventilated Improved Pit Latrine<br>(V.I.P.)…………………………...03<br>Traditional Pit Latrine…………....04<br>No facility………………………..05<br>Other _______________________ 95 (Specify) | If 5, then 16=0; 17=0; 20=3 & 21=2. |
| **16a** | Is this toilet facility shared with other families?<br>Yes………………………………1<br>No………………………………..2 | *If No, skip to question #18* |
| **16b** | How many families is it shared with?<br>Less than 5………………………1 | |

| | | |
|---|---|---|
| | 5-10 Families…………………….2<br>More than 10……………………..3 | |
| **17** | What is usually done to dispose of your child's stool when he/she does not use any toilet facility?<br>Child always uses toilet/latrine….01<br>Throw in the toilet/latrine……….02<br>Throw outside the dwelling……...03<br>Throw outside the compound……04<br>Bury in the compound……………05<br>Rinse away……………………….06<br>Use disposable diapers…………...07<br>Use washable diapers…………….08<br>Not disposed of…………………..09<br>Other________________________95 (Specify) | *If no child under the age of 15 living in household, skip to question #20 19=0* |
| **18** | *Record Observation*<br>Location of toilet facility<br>Inside dwelling…………………….1<br>Outside dwelling…………………..2<br>No facility…………………………3 | |
| **19** | *Latrine utilization*<br>no observable faeces in the compound and show at least one sign of use :<br>**YES** **NO**<br>1) foot path to the latrine not covered by grass ………1 2<br>2) latrine is smelly ……………………………… 1 2<br>3) spider weave in squatting hole ………………… 1 2<br>4) presence of anal cleansing material ……………….1 2<br>5) fresh faeces in the squatting hole,…………………..1 2<br>**6)** the slab is wet ………………………………...1 2 | |
| **20** | *Presence of flies*<br>Yes………………………………….*1*<br>No……………………………………2 | |

B. **Socioeconomic Status Assessment**

| | | |
|---|---|---|
| **21** | What is the highest attained education level of the care giver/mother?<br>Primary………………..01<br>High school ……………02<br>Tertiary…………………03 | |
| **22** | What is the occupation/main source of income to the household?<br>Civil servants……………01<br>Casual laborers…………02<br>Business persons……….03<br>Farmers…………………04<br>Other……………………05 | |
| **23** | Approximately, how much money does the household income per month (Ksh.)?<br>< 6000/-……………….01<br>6001- 14999/-………….02<br>>15000/-...………………..*03* | |
| **24** | What if the number of family members who slept there last night?<br><4members………….01<br>5-7members…………02<br>>7 members…………03 | |

C. **hygiene**

| | | |
|---|---|---|
| **25** | How often do you wash hands?<br>Before visiting the toilet…1<br>After visiting the toilet……..2<br>Before cooking……………….3<br>Before eating………………….4<br>After eating…………………….5<br>After changing a diaper….6<br>Don't know……………….7<br>Other…………………….95 (Specify) | |
| **26** | Use soap for washing hands<br>Yes …………………………..1<br>No…………………………….2 | |
| **27** | **Observation:**<br>Finger nails trimmed.<br>Yes……………………………1<br>No…………………………….2. | |
| **28** | **Observation**:<br>Is the child well groomed<br>Yes……………………………1<br>No…………………………….2. | |

| | | |
|---|---|---|
| **29** | **Observation:**<br>Hand washing steps<br>Wet hands and apply soap. Rub palms until soap is bubbly…………..1<br>Rub each palm over the back of the other hand………………………….2<br>Rub between fingers on each hand….3<br>Rub your hands with the fingers together…4<br>Rub around each of your thumbs…..5<br>Rub in circles on your palms. Then rinse and dry your hands……..6 | **Record number of steps done correctly.** |

**IV. Access & Utilization of Health Services**

*I would like to ask you a few questions about the health services available to you.*

| | | |
|---|---|---|
| *30* | What health facilities/providers are available in your community? *Circle all that apply.*<br>**YES NO**<br>Hospital………………………….1 2<br>Public Health center/Dispensary..1 2<br>Private Clinic…………………….1 2<br>Pharmacy/Chemist……………….1 2<br>Herbal clinic……………………..1 2<br>Traditional healer…………….....1 2<br>No facility | |
| *31* | In the past 2 years, has anyone in your household used the public health Centre's services?<br>Yes…………………………………01<br>No…………………………………02<br>DK…………………………………98 | |
| *32* | Was the anti-helminthic always available at the health center?<br>Yes………………………………….01<br>No…………………………………..02<br>Not applicable………………………03<br>DK…………………………………98 | |
| *33* | Time since last anthelminthic treatment?<br><6 months…………………01<br>6–12 months………………02<br>>1 year…………………….03<br>Never……………………..04 | |

*Thank you for your responses.*

## Appendix IV: RESEARCH APPROVAL.

**MASENO UNIVERSITY**

**SCHOOL OF GRADUATE STUDIES**

*Office of the Dean*

**Our Ref:** PG/MPH/117/2011

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 01st August, 2013

**TO WHOM IT MAY CONCERN**

**RE: PROPOSAL APPROVAL FOR CAROLINE KERUBO ONGERI— PG/MPH/117/2011**

The above named is registered in the Master of Public Health Programme of the School of Public Health and Community Development, Maseno University. This is to confirm that her research proposal titled "Prevalence and Risk Factors Associated with Ascariasis among Pre-School Children (12-60 Months) in Bomet Central Division" has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

Prof. P.O. Owuor
**DEAN, SCHOOL OF GRADUATE STUDIES**

MASENO UNIVERSITY
DIRECTOR
05 AUG 2013
SCHOOL OF GRADUATE STUDIES

*Maseno University* *ISO 9001:2008 Certified*

**Appendix V: MASENO UNIVERSITY ETHICS REVIEW COMMITTEE APPROVAL**

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221

Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

**FROM**: SECRETARY - MUERC

**DATE**: 4th October, 2013

**TO**: Caroline Kerubo Ongeri
Maseno University

**REF**: MSU/DRPC/MUERC/000035/13

**PROPOSAL REFERENCE NO.: MSU/DRPC/MUERC/00035/13 – PREVALENCE AND RISK FACTORS ASSOCIATED WITH ASCARIASIS AMONG PRE-SCHOOL CHILDREN (12-60 MONTHS) IN BOMET CENTRAL DIVISION.**

This is to inform you that Maseno University Ethics Committee (MUERC) determined that the ethics issues were adequately addressed in the proposal presented.

Consequently, the study is granted approval for implementation effective this 4th day of October 2013 for a period of one (1) year.

Please note that authorization to conduct this study will automatically expire on 5th October 2014. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 4th September 2014

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach the MUERC Secretariat by 4th September 2014

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

Yours faithfully,

for **Dr. Bonuke Anyona,**
**SECRETARY,**
Maseno University Ethics Review Committee.

Cc: Chairman,
Maseno University Ethics Review Committee

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED